EARTHBOUND
"Holdowns That Work"

Earthbound System
Submittal Package for:

Central Lofts
8608 N Lonbard St.,
Portland, OR 97203

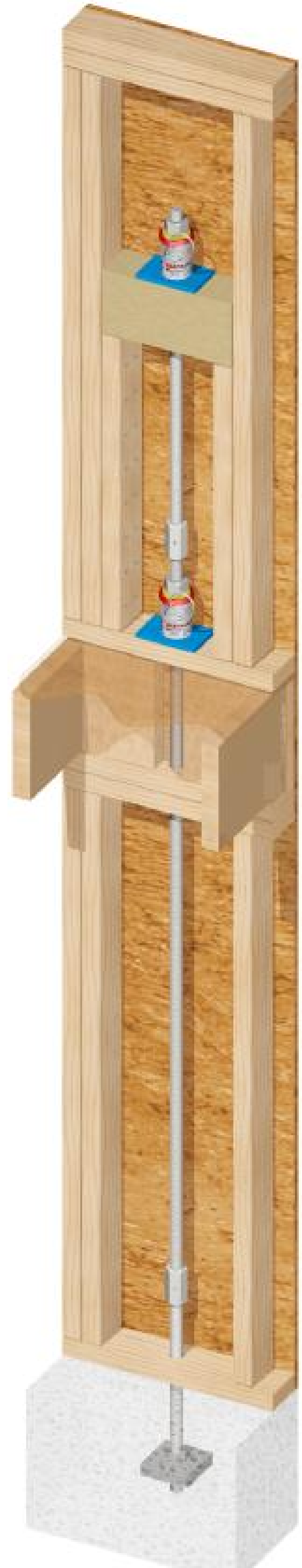
EB Corp. Job: 19548

STRUCTURAL REGISTERED PROFESSIONAL ENGINEER 92628
OREGON
SEPT. 12, 2017
CRAIG F. ROBERTS
02/05/2021

Rev B

February 5, 2021

Contains:
1) Run Type Analysis
2) IAPMO ER-0429
3) Bridge and Nailing Calculations



Prepared by:
Earthbound Corporation
17361 Tye Street SE
Monroe, WA 98272
800-944-5669
360-863-0724
http://www.holdown.com

☒ REVIEWED ☐ REVISE AND RESUBMIT
☐ REJECTED ☐ FURNISH AS CORRECTED

Corrections or comments made on the shop drawings during this review do not relieve contractor from compliance with requirements of the drawings and specifications. This check is only for review of general conformance with the design concept of the project and general compliance with the information given in the contract documents. This contractor is responsible for confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.

FROELICH CONSULTING ENGINEERS, INC.
DATE: 02-12-2021 BY: TWN

DATE: February 5, 2021

PROJECT: Central Lofts
8608 N Lonbard St.,
Portland, OR 97203

SUBJECT: Calculations Package

The following package is submitted for review:

1) Earthbound Run Analysis
2) IAPMO ER-0429 ("Earthbound Corporation")
3) Bridge and Nailing Calculations

Calculation Assumptions:

1) Earthbound Corporation took no part in the preparation or review of the project structural design and disclaims any liability regarding shear wall design, determination of holdown locations in the structure and/or magnitude of the holdown forces.
2) The specified uplift loads were based from the structural drawings.
3) Slackjack Devices are referenced from IAPMO ER-0429. This report is included in this submittal.
4) All full height compression members are referred back to Structural Plans. Earthbound is responsible for the compression bridge and trimmer design at the top of each run type. Wood buckling and compression perpendicular to grain calculations are not required by Earthbound.

Earthbound Corporation
17361 Tye Street SE
Monroe, WA 98272

www.holdown.com
Phone: (360) 863-0722
Fax: (360) 863-0724

EARTHBOUND CORPORATION

17361 Tye Street, SE
Monroe, WA 98272

Project #	19548	*CALCULATION SUMMARY OF ASSIGNED RUN TYPES*
Project:	Central Lofts	
Date:	2/05/2021	

A	B	C	D	E	F	G	H			I	J	K	L	M	N	O

Plans Date: 6/21/2020

CALCULATION NOTES ON COLUMNS:

A	Tension load provided by the structural plans.
B	Floor to floor differential loads.
C	Collected differential loads, if tiedowns on floors are skipped, the loads are brought up to the next level.
D	Assigned rod loads may be increased over column A if tiedowns are skipped on lower stories.
E	Final rod selection in accordance to specified design code (ASD)
F	Earthbound Shrinkage Fastener assigned to differential load (Column C) and travel required.
G	Bearing plate assigned to differential loads of Column C. Actual size shown.
H	Bearing plate is sized for both net area perpendicular to wood grain and bending thickness
I	Rod elongation based on PL/AE where A = nominal area and E = 29,000,000 psi.
J	Plates are sized to minimize plate crushing perpendicular to grain = 0.040 deflection per NDS. (J = D / H * 0.040 in) Oversized (area) bearing plates used can reduce this amount linearly to 0.020 max per 2015 NDS Equation 4.2-1.
K	Device looseness is stated values of travel increments per IAPMO ER-0429.
L	Device capacity as stated in IAPMO ER-0429.
M	Device deflection is linear ratio of (applied load / rated load capacity of shrinkage fastener) x (displacement at rated load capacity) (M = C / L * Device Deflection at Rated Load)
N	Deflection total of Columns I thru M.
O	Quick check results if total system elongation is greater than required by the plans or local jurisdiction.

A	B	C	D	E	F	G	H			I	J	K	L	M	N	O

RUN TYPE 2

WOOD FLOOR LEVEL	UPLIFT TENSION LOADS	CALCULATED DIFFERENTIAL LOADS	COLLECTED DIFFERENTIAL LOADS	ASSIGNED ROD TENSION LOADS	FINAL ROD SIZE	SHRINKAGE FASTENER SIZE	EBOUND PLATE PART NO.	ACTUAL PLATE DIMENSIONS	RATED PLATE CAPACITY	DEFLECTION CHECK: THREADED ROD DIA. (IN)	THREADED ROD LENGTH (FT)	NOMINAL AREA	ROD ELONG.	PLATE CRUSHING	DEVICE LOOSENESS	DEVICE CAPACITY	DEVICE DEFLECTION	SYSTEM EL/DEFL.	0.200 LIMIT?
5th																			
4th	3,300 #	3,300 #	3,300 #	3,300 #	R4	MJ200	P6-4	3.00 x 3.50 x 1/4	6,650 lbs	0.500 in	8.0 FT	0.196 in^2	0.056 in	0.013 in	0.031 in	4,900 #	0.022 in	0.122 in	OK
3rd	8,000 #	4,700 #	4,700 #	8,000 #	R6	SJA226	PW18	5.38 x 6 x 1/2	19,600 lbs	0.750 in	10.0 FT	0.442 in^2	0.075 in	0.007 in	0.039 in	7,730 #	0.011 in	0.132 in	OK
2nd	13,900 #	5,900 #	5,900 #	13,900 #	R7	SJA217	PW18	5.38 x 6 x 1/2	19,600 lbs	0.875 in	10.0 FT	0.601 in^2	0.096 in	0.008 in	0.032 in	7,360 #	0.010 in	0.147 in	OK
1st	24,800 #	10,900 #	10,900 #	24,800 #	R10-12	SJA4110	PW18-10	5.38 x 6 x 1/2	19,600 lbs	1.250 in	13.0 FT	1.227 in^2	0.109 in	0.016 in	0.032 in	14,000 #	0.017 in	0.174 in	OK

RUN TYPE 3

WOOD FLOOR LEVEL	UPLIFT TENSION LOADS	CALCULATED DIFFERENTIAL LOADS	COLLECTED DIFFERENTIAL LOADS	ASSIGNED ROD TENSION LOADS	FINAL ROD SIZE	SHRINKAGE FASTENER SIZE	EBOUND PLATE PART NO.	ACTUAL PLATE DIMENSIONS	RATED PLATE CAPACITY	DEFLECTION CHECK: THREADED ROD DIA. (IN)	THREADED ROD LENGTH (FT)	NOMINAL AREA	ROD ELONG.	PLATE CRUSHING	DEVICE LOOSENESS	DEVICE CAPACITY	DEVICE DEFLECTION	SYSTEM EL/DEFL.	0.200 LIMIT?
5th																			
4th	5,000 #	5,000 #	5,000 #	5,000 #	R5	SJA225	P6	3.00 x 3.50 x 1/4	6,650 lbs	0.625 in	8.0 FT	0.307 in^2	0.054 in	0.030 in	0.041 in	7,730 #	0.012 in	0.137 in	OK
3rd	11,200 #	6,200 #	6,200 #	11,200 #	R7	SJA227	PW18	5.38 x 6 x 1/2	19,600 lbs	0.875 in	10.0 FT	0.601 in^2	0.077 in	0.009 in	0.037 in	7,730 #	0.014 in	0.137 in	OK
2nd	20,100 #	8,900 #	8,900 #	20,100 #	R9	SJA419	PW18-9	5.38 x 6 x 1/2	19,600 lbs	1.125 in	10.0 FT	0.994 in^2	0.084 in	0.013 in	0.034 in	14,000 #	0.014 in	0.144 in	OK
1st	34,000 #	13,900 #	13,900 #	34,000 #	R12-12	HJA7112	PW18-12	5.38 x 6 x 1/2	19,600 lbs	1.500 in	13.0 FT	1.767 in^2	0.103 in	0.030 in	0.000 in	15,650 #	0.013 in	0.147 in	OK

RUN TYPE 4

WOOD FLOOR LEVEL	UPLIFT TENSION LOADS	CALCULATED DIFFERENTIAL LOADS	COLLECTED DIFFERENTIAL LOADS	ASSIGNED ROD TENSION LOADS	FINAL ROD SIZE	SHRINKAGE FASTENER SIZE	EBOUND PLATE PART NO.	ACTUAL PLATE DIMENSIONS	RATED PLATE CAPACITY	DEFLECTION CHECK: THREADED ROD DIA. (IN)	THREADED ROD LENGTH (FT)	NOMINAL AREA	ROD ELONG.	PLATE CRUSHING	DEVICE LOOSENESS	DEVICE CAPACITY	DEVICE DEFLECTION	SYSTEM EL/DEFL.	0.200 LIMIT?
5th																			
4th																			
3rd	7,100 #	7,100 #	7,100 #	7,100 #	R5	SJA215	P8	3.25 x 4.25 x 1/4	8,470 lbs	0.625 in	8.0 FT	0.307 in^2	0.077 in	0.032 in	0.036 in	7,360 #	0.013 in	0.157 in	OK
2nd	19,100 #	12,000 #	12,000 #	19,100 #	R9	SJA419	PW18-9	5.38 x 6 x 1/2	19,600 lbs	1.125 in	10.0 FT	0.994 in^2	0.080 in	0.017 in	0.034 in	14,000 #	0.019 in	0.150 in	OK
1st	38,000 #	18,900 #	18,900 #	38,000 #	R12-12	HJS4112	PW22-12	5.38 x 7 x 5/8	22,960 lbs	1.500 in	13.0 FT	1.767 in^2	0.116 in	0.033 in	0.006 in	22,000 #	0.017 in	0.172 in	OK

EARTHBOUND CORPORATION

17361 Tye Street, SE
Monroe, WA 98272

Project #	19548	*CALCULATION SUMMARY*
Project:	Central Lofts	*OF ASSIGNED RUN TYPES*
Date:	2/05/2021	

	A	B	C	D	E	F	G	H			I	J	K	L	M	N	O

RUN TYPE 5

WOOD FLOOR LEVEL	UPLIFT TENSION LOADS	CALCULATED DIFFERENTIAL LOADS	COLLECTED DIFFERENTIAL LOADS	ASSIGNED ROD TENSION LOADS	FINAL ROD SIZE	SHRINKAGE FASTENER SIZE	EBOUND PLATE PART NO.	ACTUAL PLATE DIMENSIONS	RATED PLATE CAPACITY	DEFLECTION CHECK									
										THREADED ROD		NOMINAL AREA	ROD ELONG.	PLATE CRUSHING	DEVICE LOOSENESS	DEVICE CAPACITY	DEVICE DEFLECTION	SYSTEM EL/DEFL.	0.200 LIMIT?
										DIA. (IN)	LENGTH (FT)								
5th																			
4th	3,800 #	3,800 #	3,800 #	3,800 #	R4	MJ200	P6-4	3.00 x 3.50 x 1/4	6,650 lbs	0.500 in	8.0 FT	0.196 in^2	0.064 in	0.015 in	0.031 in	4,900 #	0.026 in	0.135 in	OK
3rd	10,900 #	7,100 #	7,100 #	10,900 #	R7	SJA227	PW18	5.38 x 6 x 1/2	19,600 lbs	0.875 in	10.0 FT	0.601 in^2	0.075 in	0.010 in	0.037 in	7,730 #	0.017 in	0.139 in	OK
2nd	21,200 #	10,300 #	10,300 #	21,200 #	R9	SJA419	PW18-9	5.38 x 6 x 1/2	19,600 lbs	1.125 in	10.0 FT	0.994 in^2	0.088 in	0.015 in	0.034 in	14,000 #	0.016 in	0.153 in	OK
1st	37,000 #	15,800 #	15,800 #	37,000 #	R12-12	HJS4112	PW18-12	5.38 x 6 x 1/2	19,600 lbs	1.500 in	13.0 FT	1.767 in^2	0.113 in	0.034 in	0.006 in	22,000 #	0.014 in	0.167 in	OK

RUN TYPE 6

WOOD FLOOR LEVEL	UPLIFT TENSION LOADS	CALCULATED DIFFERENTIAL LOADS	COLLECTED DIFFERENTIAL LOADS	ASSIGNED ROD TENSION LOADS	FINAL ROD SIZE	SHRINKAGE FASTENER SIZE	EBOUND PLATE PART NO.	ACTUAL PLATE DIMENSIONS	RATED PLATE CAPACITY	DEFLECTION CHECK									
										THREADED ROD		NOMINAL AREA	ROD ELONG.	PLATE CRUSHING	DEVICE LOOSENESS	DEVICE CAPACITY	DEVICE DEFLECTION	SYSTEM EL/DEFL.	0.200 LIMIT?
										DIA. (IN)	LENGTH (FT)								
5th																			
4th	5,300 #	5,300 #	5,300 #	5,300 #	R5	SJA225	P6	3.00 x 3.50 x 1/4	6,650 lbs	0.625 in	8.0 FT	0.307 in^2	0.057 in	0.032 in	0.041 in	7,730 #	0.012 in	0.142 in	OK
3rd	14,700 #	9,400 #	9,400 #	14,700 #	R8	SJA428	PW18	5.38 x 6 x 1/2	19,600 lbs	1.000 in	10.0 FT	0.785 in^2	0.077 in	0.013 in	0.032 in	14,000 #	0.020 in	0.143 in	OK
2nd	28,400 #	13,700 #	13,700 #	28,400 #	R10	SJA4110	PW18-10	5.38 x 6 x 1/2	19,600 lbs	1.250 in	10.0 FT	1.227 in^2	0.096 in	0.020 in	0.032 in	14,000 #	0.022 in	0.169 in	OK
1st	44,000 #	15,600 #	15,600 #	44,000 #	R12-12	HJA7112	PW18-12	5.38 x 6 x 1/2	19,600 lbs	1.500 in	13.0 FT	1.767 in^2	0.134 in	0.034 in	0.000 in	15,650 #	0.015 in	0.183 in	OK

EARTHBOUND CORPORATION
17361 Tye Street, SE
Monroe, WA 98272
Phone: (360) 863-0722
Fax: (360) 863-0724

Project:	Central Lofts
Project #	19548
Date:	2/05/2021

EARTHBOUND THREADED ROD CAPACITIES (IBC 2015)

ROD SIZE	ROD SIZE (INCHES)	ALLOWABLE TENSION LOAD IBC 2015	ROD REMARKS	SLACKJACK SIZE
R4	1/2" DIA.	4,470 LBS	ASTM A 307 (UNC)	MJ100, MJ200
R5	5/8" DIA.	7,120 LBS	ASTM A 307 (UNC)	SJA 215, 225, 415, 425
R6	3/4" DIA.	10,540 LBS	ASTM A 307 (UNC)	SJA 216, 226, 416, 426, HJA 716, 726
R7	7/8" DIA.	14,540 LBS	ASTM A 307 (UNC)	SJA 217, 227, 417, 427, HJA 717, 727
R8	1" DIA.	19,080 LBS	ASTM A 307 (UNC)	SJA 218, 228, 418, 428, HJA 718, 728
R9	1 1/8" DIA.	24,040 LBS	ASTM A 307 (UNC)	SJA 219, 229, 419, 429, HJA 719, 729
R10	1 1/4" DIA.	30,530 LBS	ASTM A 307 (UNC)	SJA 4110, 4210, HJA 7110, 7210, HJS 4110, 4210
R12	1 1/2" DIA.	44,270 LBS	ASTM A 307 (UNC)	SJST 4112, 4212, HJA 7112, 7212, HJS 4112, 4212
R14	1 3/4" DIA.	59,830 LBS	ASTM A 307 (UNC)	-----
R6M	3/4" DIA.	13,170 LBS	ASTM F1554 GR55 (UNC)	SJA 216, 226, 416, 426, HJA 716, 726
R7M	7/8" DIA.	18,180 LBS	ASTM F1554 GR55 (UNC)	SJA 217, 227, 417, 427, HJA 717, 727
R8M	1" DIA.	23,850 LBS	ASTM F1554 GR55 (UNC)	SJA 218, 228, 418, 428, HJA 718, 728
R9M	1 1/8" DIA.	30,050 LBS	ASTM F1554 GR55 (UNC)	SJA 219, 229, 419, 429, HJA 719, 729
R10M	1 1/4" DIA.	38,160 LBS	ASTM F1554 GR55 (UNC)	SJA 4110, 4210, HJA 7110, 7210, HJS 4110, 4210
R12M	1 1/2" DIA.	55,330 LBS	ASTM F1554 GR55 (UNC)	SJST 4112, 4212, HJA 7112, 7212, HJS 4112, 4212
R14M	1 3/4" DIA.	74,790 LBS	ASTM F1554 GR55 (UNC)	-----
R6HS	3/4" DIA.	21,950 LBS	ASTM A193 B7 (UNC)	SJA 216, 226, 416, 426, HJA 716, 726
R7HS	7/8" DIA.	30,300 LBS	ASTM A193 B7 (UNC)	SJA 217, 227, 417, 427, HJA 717, 727
R8HS	1" DIA.	39,750 LBS	ASTM A193 B7 (UNC)	SJA 218, 228, 418, 428, HJA 718, 728
R9HS	1 1/8" DIA.	50,090 LBS	ASTM A193 B7 (UNC)	SJA 219, 229, 419, 429, HJA 719, 729
R10HS	1 1/4" DIA.	63,600 LBS	ASTM A193 B7 (UNC)	SJA 4110, 4210, HJA 7110, 7210, HJS 4110, 4210
R12HS	1 1/2" DIA.	92,220 LBS	ASTM A193 B7 (UNC)	SJST 4112, 4212, HJA 7112, 7212, HJS 4112, 4212
R14HS	1 3/4" DIA.	124,650 LBS	ASTM A193 B7 (UNC)	-----

EARTHBOUND BEARING PLATE CAPACITIES (DF)

PLATE SIZE	DIFFERENTIAL LOAD	COLOR CODE	PLATE DIMENSIONS (INCHES) AT 4" WALLS			PLATE DIMENSIONS (INCHES) AT 6" WALLS		
			WIDTH	LENGTH	THICK.	WIDTH	LENGTH	THICK.
P6	6,650 LBS	GREEN	3"	3.5"	1/4"	N/A	N/A	N/A
P8	8,470 LBS	BLACK	3-1/4"	4.25"	1/4"	N/A	N/A	N/A
P10	10,320 LBS	BLUE	3-1/4"	5"	3/8"	N/A	N/A	N/A
P12/PW-12	*12,840 LBS	GRAY	3-1/4"	6"	5/8"	4"	5"	3/8"
P14/PW-14	*15,360 LBS	RED	3-1/4"	7"	3/4"	4 3/4"	5"	3/8"
P18/PW-18	*19,600 LBS	YELLOW	3-1/2"	9"	1"	5-3/8"	6"	1/2"
P20/PW-20	*22,960 LBS	BROWN	3-1/2"	10"	1"	5-3/8"	7"	5/8"
P22/PW-22	*22,960 LBS	WHITE	3-1/2"	11"	1 1/4"	5-3/8"	7"	5/8"
P24/PW-24	*25,336 LBS	GOLD	3-1/2"	11.5"	1 1/4"	5-3/8"	8"	3/4"
P26/PW-26	*27,673 LBS	ORANGE	3-1/2"	12.5"	1 1/2"	5-3/8"	9"	1"
P30/PW-30	*30,011 LBS	PURPLE	3-1/2"	14.25"	1 1/2"	5-3/8"	10"	1"
P32/PW-32	*30,011 LBS	PINK	3-1/2"	15.25"	1 3/4"	5-3/8"	10"	1"

PW = INDICATES WIDE BEARING PLATES FOR USE AT 6x WALLS.

*CALCULATED BEARING CAPACITY DUE TO DF BOTTOM PLATE RESTIN ON SPF CLT FLOOR SYSTEM.

NOTES:

1. TENSION LOAD WAS CALCULATED FROM THE FOLLOWING EQUATION:
   A. ASTM A 307 Threaded Rod Capacities are F'u = 60,000 psi. UNC thread pitch
      M Rods are based on ASTM F1554 GR55, F'u = 75 ksi.
      HS Rods are based on ASTM A193 B7, F'u = 125 ksi
   B. The IBC 2015 column is calculated in accordance to Section 1905 and ASCE 7-10.
2. PLATE STEEL SHALL BE ASTM A36: F'u = 60,000 PSI.
3. SUBSTITUTIONS OF DESIGNATED BEARING PLATE SHALL NOT BE PERMITTED, OBTAIN WRITTEN APPROVAL FROM THE ENGINEER.
4. ALL BEARING PLATES CAPACITIES ARE BASED ON 1-1/16" HOLE, UNLESS NOTED OTHERWISE.
5. SLACKJACK SELECTION NOTES:
   THE SIZES SHOWN ABOVE ARE FOR BOTH ONE AND TWO INCH TRAVEL ("SJA 4xy") (x = TRAVEL HEIGHT IN INCHES, y = ROD SIZE). TWO INCH TRAVEL SLACKJACKS ARE REQUIRED ON FOURTH WOOD FRAME LEVELS AND HIGHER.
6. THIS TABLE IS FOR REFERENCE OF FULL PRODUCT LINE, SOME ROD AND PLATE SIZES MAY NOT BE IN USE. THE ENGINEER OF RECORD SHALL REVIEW AND APPROVE CAPACITIES.

SJA ROD SIZE CODES

PART NO.	ROD DIAMETER	ROD SIZE	WASHER COLOR
MJ100 or MJ200	1/2"	R4	PURPLE
SJA 2x5 or 4x5	5/8"	R5	BLACK
SJA 2x6 or 4x6, HJA 7x6	3/4"	R6 or R6HS	GRAY
SJA 2x7 or 4x7, HJA 7x7	7/8"	R7 or R7HS	BLUE
SJA 2x8 or 4x8, HJA 7x8	1"	R8 or R8HS	YELLOW
SJA 2x9 or 4x9, HJA 7x9	1 1/8"	R9 or R9HS	WHITE
SJA 4x10, HJA 7x10, HJS 4x10	1 1/4"	R10 or R10HS	GREEN
SJST 4x12, HJA 7x12, HJS 4x12	1 1/2"	R12 or R12HS	RED

"x" = SLACKJACK TRAVEL IN "INCHES"

EARTHBOUND CORPORATION
17361 Tye Street S.E.
Monroe, Washington 98272
(800) 944-5669
www.slackjack.com

SLACKJACK®, HEAVYJACK™ AND MINIJACK® SHRINKAGE COMPENSATION DEVICES

CSI Section:
06 05 23 Wood, Plastic and Composite Fastenings

1.0 RECOGNITION

SlackJack®, HeavyJack™ and MiniJack®, manufactured by Earthbound Corporation, were evaluated for use as compression-controlled shrinkage compensation devices in wood-framed construction. The structural properties of the devices were evaluated for compliance with the following codes and regulations:

- 2018, 2015, 2012, 2009 and 2006 International Building Code® (IBC)
- 2018, 2015, 2012, 2009 and 2006 International Residential Code® (IRC)
- 2016 and 2013 California Building Code (CBC) – See attached Supplement
- 2016 and 2013 California Residential Code (CRC) – See attached Supplement
- 2017 Florida Building Code, Building (FBC, Building) – See attached Supplement
- 2017 Florida Building Code, Residential (FBC, Residential) – See attached Supplement
- 2017 City of Los Angeles Building Code (LABC) – See attached Supplement
- 2017 City of Los Angeles Residential Code (LARC) – See attached Supplement

2.0 LIMITATIONS

Use of the SlackJack, HeavyJack and MiniJack Shrinkage Compensation Devices recognized in this report are subject to the following limitations:

2.1 The SlackJack, HeavyJack and MiniJack devices shall be limited to installations in dry, interior locations.

2.2 Use of the SlackJack, HeavyJack and MiniJack devices in direct contact with fire-retardant or preservative-treated wood is beyond the scope of recognition of this report.

2.3 Where required, designs using these products shall be submitted to the building code official for review.

2.4 No increase in the allowable capacities shown in Table 4 of this report shall be permitted.

2.5 The dead load is limited to the self-weight of the SlackJack, HeavyJack and MiniJack devices. Additional dead load on the devices is beyond the scope of this report.

2.6 The maximum offset tolerance shall be 1.33 degrees from vertical.

2.7 "When the devices are used in continuous rod systems that resist light-frame shear wall overturning forces, calculations shall be submitted to the code official confirming that the total vertical displacement, which would include steel rod elongation and the shrinkage compensating device deflection is less than or equal to 0.20 inch (5 mm) for each story, or between restraints, whichever is more restrictive, using allowable stress design (ASD). Shear wall drift limit calculations shall consider the 0.20 inch (5 mm) vertical displacement limit. This 0.20-inch (5 mm) vertical displacement limit may be exceeded when it can be demonstrated that the shear wall story drift limit and the deformation compatibility requirements of IBC Section 1604.4 are met when considering all sources of vertical displacement." (AC316)

2.8 Buildings constructed to the IRC shall have engineered designs performed on the elements of construction using this device as required in Section R301.1.3.

2.9 The shrinkage compensation devices recognized in this report are produced by Earthbound Corporation in Monroe, Washington.

3.0 PRODUCT USE INSTRUCTIONS

3.1 The Earthbound installation instructions, this evaluation report, and the applicable provisions of the building code shall be followed when installing this product. Where conflicts occur between these documents, the more restrictive provisions shall govern. The published installation instructions shall be available at the jobsite during construction for use by installers and for quality assurance.

3.2 Where required by the code official or other authority having jurisdiction, calculations based on applied loads to the device shall be provided by a registered design professional to show the basis for its selection. The calculations shall show the projected shrinkage, deflection, and settlement the device will compensate for, and the method of transferring the loads through the supports. The appropriate SlackJack, HeavyJack and MiniJack device shall be chosen based on the model and series characteristics. The Rated Shrinkage Capacity, Allowable

Compression Load, Deflection at Allowable Load and Device Average Travel and Seating Increment, Δ_R, for each model are shown in Table 4 of this report.

3.3 The chosen SlackJack, HeavyJack or MiniJack device shall be slid over a threaded-rod or anchor bolt, over an approved bearing surface or plate. The appropriate color-coded swivel washer (listed in Table 4 of this report), shall be installed as required by the manufacturer's installation instructions with the flat side up. A hex nut shall be installed over the rod and hand tightened.

To place the device into service, the pull clip shall be completely removed and placed on the device to show that the device has been activated.

Where necessary, the devices may be reset in the field. The manufacturer's installation instructions shall be referenced for details.

3.4 SlackJacks may be substituted and interchangeable with HeavyJack devices per Table 3 of this report.

4.0 PRODUCT DESCRIPTION

4.1 SlackJack, HeavyJack and MiniJack Shrinkage Compensation Devices are spring-loaded, compression-controlled shrinkage compensating devices that are designed to work with threaded-rod or anchor bolt hold-down systems in wood-frame construction. The devices are cylindrical, high-strength structural connectors that enable axial compression travel along a bolted or sliding connection but to withstand movement due to tensile loads.

4.2 The materials used for the inner and outer cylinders, locking rings, springs, pull-clips, capture-rings and swivel washers, for the SlackJack, HeavyJack and MiniJack models are shown in Table 1 of this report.

4.3 The model and series number describe the attributes of each shrinkage compensation device. The devices are color-coded to identify the specific model type, which varies based on strength and length of travel. The available travel lengths are: 1 inch, 1 ½ inches, 2 inches, and 3 inches (25.4 mm, 38.1 mm, 50.8 mm, and 76.2 mm). Table 2 of this report describes the model and series notations. Color coding is also used to identify the size of the swivel washer for the SlackJack devices as shown in Table 5 of this report.

5.0 IDENTIFICATION

A label shall be affixed on at least one of the following: product, packaging, installation instructions or descriptive literature. The label shall include the Earthbound name or trademark, the device model number, the IAPMO Uniform ES Mark of Conformity and the Evaluation Report Number (ER-429) to identify the products recognized in this report. A die-stamp label may be used as a substitute for the label. Either Mark of Conformity may be used as shown below:

IAPMO ES or UES

IAPMO UES ER-429

6.0 SUBSTANTIATING DATA

Data in accordance with ICC-ES Acceptance Criteria for Shrinkage Compensating Devices (AC316), dated June 2013 (Editorially Revised November 2017).

7.0 STATEMENT OF RECOGNITION

This report describes the results of research carried out by the IAPMO Uniform Evaluation Service on Earthbound's SlackJack, HeavyJack and MiniJack Shrinkage Compensation Devices to assess their conformance to the codes and standards listed in Section 1.0 and serves as documentation of the product certification. Products are manufactured at the location noted in Section 2.9 of this report under a quality control program with periodic inspection under the supervision of IAPMO UES.

Brian Gerber, P.E., S.E.
Vice President, Technical Operations
Uniform Evaluation Service

Richard Beck, PE, CBO, MCP
Vice President, Uniform Evaluation Service

GP Russ Chaney
CEO, The IAPMO Group

For additional information about this evaluation report please visit www.uniform-es.org or email us at info@uniform-es.org

TABLE 1 – Material Information for SlackJack, HeavyJack and MiniJack Devices

Component	Material
Internal and Outer Cylinders for HeavyJack Models HJS and HJX	ASTM A513/5 520 DOM Steel
Internal and Outer Cylinders for SlackJack Models SJT and SJA, HeavyJack Model HJA and MiniJack Model MJ	ASTM B221-08 6061-T6511 Aluminum
Locking Components for all Models	ASTM A313 Stainless Steel
Springs and Pull Clips for all Models	ASTM A764 Galvanized Hard Drawn Spring Wire
Capture Rings for all Models	Plastic Injection Molded
Swivel Washers	ASTM A108 12L14 Steel

TABLE 2 – Model and Series Notations

Notation	
Model Type	MJ = MiniJack, HJ = HeavyJack SJ = SlackJack
First Number (Series Type)	2= 2 Locking Rings 3= 3 Locking Rings 4= 4 Locking Rings 6= 6 Locking Rings 7=7 Locking Rings
Second Number (Rated Shrinkage Capacity)	1 = 1 inch 1-5 = 1.5 inches 2 = 2 inches 3 = 3 inches
Third Number (Swivel Washer Code/Color)	See Table 5

Example Nomenclature: SlackJack model with a series number A420, the letter "A" indicates the model number, with the first number "4" which has 4 locking rings. The second number indicates the rated compensation capacity, which in this case is 2 inches and finally, the third number indicates the diameter of the rod and color code for the swivel washer. For example, if the rod is ½ inch in diameter, the swivel washer color will be purple.

TABLE 3 – HeavyJack Device Substitution for SlackJack Devices

HJA, HJS, HJX Series HeavyJacks are interchangeable and maybe substituted where SJA, SJS, and SJX devices are specified under the following conditions:

SlackJack Devices	Allowed HeavyJack Substitution Devices	Conditions of Use
SJS-410	HJA-710	Loads up to 15,650 lbs
SJS-420	HJA-720	Loads up to 15,590 lbs
SJS-410	HJS-410	Any SJS-410 Load Conditions
SJS-420	HJS-420	Any SJS-420 Load Conditions
SJA-610	HJA-710	Loads up to 15,650 lbs
SJA-620	HJA-720	Loads up to 15,590 lbs
SJT-610	HJA-710	Loads up to 15,650 lbs
SJT-620	HJA-720	Loads up to 15,590 lbs
SJX-410	HJA-710	Loads up to 15,650 lbs
SJX-410	HJS-710	Any SJX-410 Load Conditions
SJX-410	HJX-410	Any SJX-410 Load Conditions

TABLE 4 - Attributes for the SlackJack, HeavyJack and MiniJack Shrinkage Compensating Devices

Model[3] & Series Number	Capture Ring Color Code	Additional Color Code	Nominal Dimensions (Inches) Figure 1 Shows Dimensions A, B And C			Rated Shrinkage Capacity (Inches)	Allowable Compression Load [1,2,] (lbs)	Δ_A Deflection at Allowable Load (inch)[5]	Δ_R[5] (inch)
			Height Before Activation (A)	Outer Diameter of Body (B)	Inner Diameter of Body (C)				
MJ100[4]	Red	N/A	2.540	1.349	0.532	1.0	5,000	0.028	0.032
MJ150[4]	Green	N/A	3.040	1.349	0.532	1.5	5,000	0.030	0.032
MJ200[4]	Orange	N/A	3.540	1.349	0.532	2.0	4,900	0.033	0.031
SJA-210	Blue	N/A	3.330	2.365	1.420	1.0	7,360	0.013	0.045
SJA-21-50	White	N/A	3.830	2.365	1.420	1.5	8,000	0.018	0.047
SJA-220	Yellow	N/A	4.330	2.365	1.420	2.0	7,730	0.018	0.050
SJT-410	Orange	N/A	3.700	2.365	1.375	1.0	9,000	0.020	0.024
SJT-420	Black	N/A	4.700	2.365	1.375	2.0	9,000	0.018	0.028
SJA-410	Red	N/A	3.800	2.365	1.250	1.0	14,000	0.022	0.051
SJA-420	Green	N/A	4.800	2.365	1.250	2.0	14,000	0.030	0.047
SJA-430	Brown	N/A	5.800	2.365	1.250	3.0	14,750	0.033	0.046
SJA-610	Tan	N/A	4.800	2.365	1.250	1.0	20,340	0.028	0.045
SJA-620	White	Blue[6]	5.800	2.365	1.250	2.0	20,100	0.038	0.048
HJA-710	Purple	N/A	4.730	2.500	1.625	1.0	15,650	0.015	0.015
HJA-720	Gray	N/A	5.730	2.500	1.625	2.0	15,590	0.018	0.014
HJS-410[8]	Black	Blue[7]	3.270	2.500	1.625	1.0	22,000	0.020	0.028
HJS-420[8]	Black	Yellow[7]	4.270	2.500	1.625	2.0	22,000	0.026	0.028
HJS-710	Black	Green[7]	4.730	2.500	1.625	1.0	39,190	0.029	0.012
HJS-720	Black	Orange[7]	5.730	2.500	1.625	2.0	37,770	0.030	0.011
HJX-410[8]	Black	Gold[7]	3.700	2.500	1.625	1.0	34,220	0.035	0.047

(Information in Table 4 and Notes 1-4 are from Earthbound QC ("QC") Documentation and Test Data)

Notes to Table 4:

1. "Tabulated allowable loads are for the shrinkage compensating device only. The attached components (including anchors, tension rods, bearing plates, wood framing members, etc.) shall be designed to resist design loads in accordance with the applicable code." (QC)
2. "No further increases to the tabulated allowable loads are permitted." (QC)
3. "Model numbers beginning with an A or T are designed for use with W3 through W10 swivel washers capable of fitting over threaded rods or bolts having diameters ranging from 3/8 inch to 1¼ inches. Model numbers beginning with an S or X are designed for use with W10 or W12 swivel washers capable of fitting over threaded rods or bolts having diameters of 1 ¼ inches and 1 ½ inches respectively." (QC)
4. "MJ100, MJ150 and MJ200 Series are for either 3/8 -inch or 1/2 -inch rod diameter. Requires Heavy Hex nut when installing on 3/8-inch-diameter rod." (QC)
5. "The device Δ_R and Δ_A describe the total movement of the device at allowable load, Δ_T, and are additive. Take up devices that have a swivel washer to allow for threaded rods to be out of plumb yet allow for the device to rest on a bearing plate without angular deflection may provide a compensating adjustment to reduce Δ_T. The Δ_R values applicable when using swivel washers are available in Table 6 of this report. For design loads, P_D, less than the allowable load, P_A, the total movement of the device, Δ_T, is calculated as follows:

   $\Delta_T = \Delta_R + \Delta_A(P_D/P_A)$" (AC316)

6. Additional color code for this series is a painted compression spring.
7. Additional color code for this series is a painted outer cylinder.
8. Earlier series of SlackJacks SJS-4xx and SJX-41x are relabeled as HJS-4xx and HJX-41x HeavyJacks respectively in this report.

Table 5 – Swivel Washer Color Code

Number	Diameter of Rod	Color
	0=Base Model	
3	3/8"	Orange
4	1/2"	Purple
5	5/8"	Black
6	3/4	Gray
7	7/8"	Blue
8	1"	Yellow
9	1 $^{1}/_{8}$"	White
10	$1^{1}/_{4}$”	Green
12	$1^{1}/_{2}$”	Red

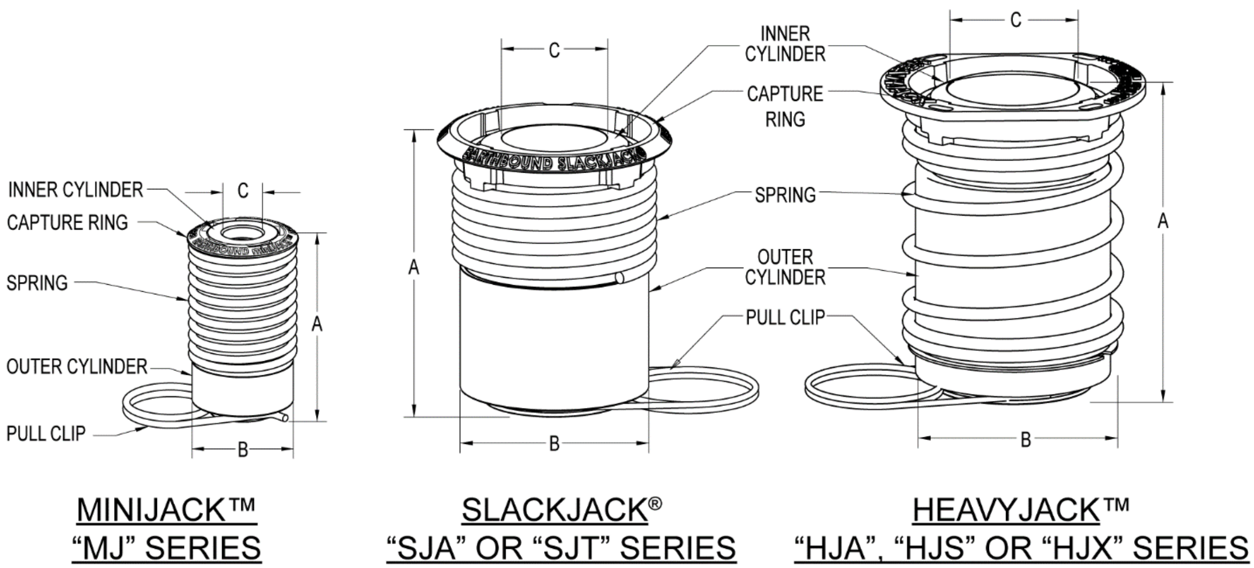


FIGURE 1 - SLACKJACK®, HEAVYJACK™ AND MINIJACK™ SHRINKAGE COMPENSATING DEVICES

TABLE 6 - Δ_R VALUES FOR USE WITH SWIVEL WASHERS

SLACKJACK ALUMINUM 200 SERIES

DEVICE	SERIES	ROD DIA.	TRAVEL	Δ_R
SJA214	SJA-210	1/2	1.0 in	0.038
SJA215	SJA-210	5/8	1.0 in	0.036
SJA216	SJA-210	3/4	1.0 in	0.034
SJA217	SJA-210	7/8	1.0 in	0.032
SJA218	SJA-210	1	1.0 in	0.030
SJA219	SJA-210	1 1/8	1.0 in	0.028
SJA2110	SJA-210	1 1/4	1.0 in	0.026

DEVICE	SERIES	ROD DIA.	TRAVEL	Δ_R
SJA224	SJA-220	1/2	2.0 in	0.043
SJA225	SJA-220	5/8	2.0 in	0.041
SJA226	SJA-220	3/4	2.0 in	0.039
SJA227	SJA-220	7/8	2.0 in	0.037
SJA228	SJA-220	1	2.0 in	0.035
SJA229	SJA-220	1 1/8	2.0 in	0.033
SJA2210	SJA-220	1 1/4	2.0 in	0.031

SLACKJACK ALUMINUM 400 SERIES

DEVICE	SERIES	ROD DIA.	TRAVEL	Δ_R
SJA414	SJA-410	1/2	1.0 in	0.044
SJA415	SJA-410	5/8	1.0 in	0.042
SJA416	SJA-410	3/4	1.0 in	0.040
SJA417	SJA-410	7/8	1.0 in	0.038
SJA418	SJA-410	1	1.0 in	0.036
SJA419	SJA-410	1 1/8	1.0 in	0.034
SJA4110	SJA-410	1 1/4	1.0 in	0.032

DEVICE	SERIES	ROD DIA.	TRAVEL	Δ_R
SJA424	SJA-420	1/2	2.0 in	0.040
SJA425	SJA-420	5/8	2.0 in	0.038
SJA426	SJA-420	3/4	2.0 in	0.036
SJA427	SJA-420	7/8	2.0 in	0.034
SJA428	SJA-420	1	2.0 in	0.032
SJA429	SJA-420	1 1/8	2.0 in	0.030
SJA4210	SJA-420	1 1/4	2.0 in	0.028

DEVICE	SERIES	ROD DIA.	TRAVEL	Δ_R
SJA434	SJA-430	1/2	3.0 in	0.039
SJA435	SJA-430	5/8	3.0 in	0.037
SJA436	SJA-430	3/4	3.0 in	0.035
SJA437	SJA-430	7/8	3.0 in	0.033
SJA438	SJA-430	1	3.0 in	0.031
SJA439	SJA-430	1 1/8	3.0 in	0.029
SJA4310	SJA-430	1 1/4	3.0 in	0.027

DEVICE	SERIES	ROD DIA.	TRAVEL	Δ_R
SJT414	SJT-410	1/2	1.0 in	0.017
SJT415	SJT-410	5/8	1.0 in	0.015
SJT416	SJT-410	3/4	1.0 in	0.013
SJT417	SJT-410	7/8	1.0 in	0.011
SJT418	SJT-410	1	1.0 in	0.009
SJT419	SJT-410	1 1/8	1.0 in	0.007
SJT4110	SJT-410	1 1/4	1.0 in	0.005

DEVICE	SERIES	ROD DIA.	TRAVEL	Δ_R
SJT424	SJT-420	1/2	2.0 in	0.021
SJT425	SJT-420	5/8	2.0 in	0.019
SJT426	SJT-420	3/4	2.0 in	0.017
SJT427	SJT-420	7/8	2.0 in	0.015
SJT428	SJT-420	1	2.0 in	0.013
SJT429	SJT-420	1 1/8	2.0 in	0.011
SJT4210	SJT-420	1 1/4	2.0 in	0.009

SLACKJACK ALUMINUM 600 SERIES

DEVICE	SERIES	ROD DIA.	TRAVEL	Δ_R
SJA614	SJA-610	1/2	1.0 in	**0.038**
SJA615	SJA-610	5/8	1.0 in	**0.036**
SJA616	SJA-610	3/4	1.0 in	**0.034**
SJA617	SJA-610	7/8	1.0 in	**0.032**
SJA618	SJA-610	1	1.0 in	**0.030**
SJA619	SJA-610	1 1/8	1.0 in	**0.028**
SJA6110	SJA-610	1 1/4	1.0 in	**0.026**

DEVICE	SERIES	ROD DIA.	TRAVEL	Δ_R
SJA624	SJA-620	1/2	2.0 in	**0.041**
SJA625	SJA-620	5/8	2.0 in	**0.039**
SJA626	SJA-620	3/4	2.0 in	**0.037**
SJA627	SJA-620	7/8	2.0 in	**0.035**
SJA628	SJA-620	1	2.0 in	**0.033**
SJA629	SJA-620	1 1/8	2.0 in	**0.031**
SJA6210	SJA-620	1 1/4	2.0 in	**0.029**

DEVICE	SERIES	ROD DIA.	TRAVEL	Δ_R
SJT614	SJT-610	1/2	1.0 in	**0.028**
SJT615	SJT-610	5/8	1.0 in	**0.026**
SJT616	SJT-610	3/4	1.0 in	**0.024**
SJT617	SJT-610	7/8	1.0 in	**0.022**
SJT618	SJT-610	1	1.0 in	**0.020**
SJT619	SJT-610	1 1/8	1.0 in	**0.018**
SJT6110	SJT-610	1 1/4	1.0 in	**0.016**

DEVICE	SERIES	ROD DIA.	TRAVEL	Δ_R
SJT624	SJT-620	1/2	2.0 in	**0.023**
SJT625	SJT-620	5/8	2.0 in	**0.021**
SJT626	SJT-620	3/4	2.0 in	**0.019**
SJT627	SJT-620	7/8	2.0 in	**0.017**
SJT628	SJT-620	1	2.0 in	**0.015**
SJT629	SJT-620	1 1/8	2.0 in	**0.013**
SJT6210	SJT-620	1 1/4	2.0 in	**0.011**

SLACKJACK STEEL 400 SERIES

DEVICE	SERIES	ROD DIA.	TRAVEL	Δ_R
SJS415	SJS-410	5/8	1.0 in	**0.019**
SJS416	SJS-410	3/4	1.0 in	**0.017**
SJS417	SJS-410	7/8	1.0 in	**0.015**
SJS418	SJS-410	1	1.0 in	**0.013**
SJS419	SJS-410	1 1/8	1.0 in	**0.011**
SJS4110	SJS-410	1 1/4	1.0 in	**0.009**
SJS4112	SJS-410	1 1/2	1.0 in	**0.006**

DEVICE	SERIES	ROD DIA.	TRAVEL	Δ_R
SJS425	SJS-420	5/8	2.0 in	**0.019**
SJS426	SJS-420	3/4	2.0 in	**0.017**
SJS427	SJS-420	7/8	2.0 in	**0.015**
SJS428	SJS-420	1	2.0 in	**0.013**
SJS429	SJS-420	1 1/8	2.0 in	**0.011**
SJS4210	SJS-420	1 1/4	2.0 in	**0.009**
SJS4212	SJS-420	1 1/2	2.0 in	**0.006**

DEVICE	SERIES	ROD DIA.	TRAVEL	Δ_R
SJX415	SJX-410	5/8	1.0 in	**0.038**
SJX416	SJX-410	3/4	1.0 in	**0.036**
SJX417	SJX-410	7/8	1.0 in	**0.034**
SJX418	SJX-410	1	1.0 in	**0.032**
SJX419	SJX-410	1 1/8	1.0 in	**0.030**
SJX4110	SJX-410	1 1/4	1.0 in	**0.028**
SJX4112	SJX-410	1 1/2	1.0 in	**0.025**

HEAVYJACK STEEL 400 SERIES (SAME AS SLACKJACK STEEL 400 SERIES)

DEVICE	SERIES	ROD DIA.	TRAVEL	Δ_R
HJS415	HJS-410	5/8	1.0 in	0.019
HJS416	HJS-410	3/4	1.0 in	0.017
HJS417	HJS-410	7/8	1.0 in	0.015
HJS418	HJS-410	1	1.0 in	0.013
HJS419	HJS-410	1 1/8	1.0 in	0.011
HJS4110	HJS-410	1 1/4	1.0 in	0.009
HJS4112	HJS-410	1 1/2	1.0 in	0.006

DEVICE	SERIES	ROD DIA.	TRAVEL	Δ_R
HJS425	HJS-420	5/8	2.0 in	0.019
HJS426	HJS-420	3/4	2.0 in	0.017
HJS427	HJS-420	7/8	2.0 in	0.015
HJS428	HJS-420	1	2.0 in	0.013
HJS429	HJS-420	1 1/8	2.0 in	0.011
HJS4210	HJS-420	1 1/4	2.0 in	0.009
HJS4212	HJS-420	1 1/2	2.0 in	0.006

DEVICE	SERIES	ROD DIA.	TRAVEL	Δ_R
HJX415	HJX-410	5/8	1.0 in	0.038
HJX416	HJX-410	3/4	1.0 in	0.036
HJX417	HJX-410	7/8	1.0 in	0.034
HJX418	HJX-410	1	1.0 in	0.032
HJX419	HJX-410	1 1/8	1.0 in	0.030
HJX4110	HJX-410	1 1/4	1.0 in	0.028
HJX4112	HJX-410	1 1/2	1.0 in	0.025

HEAVYJACK ALUMINUM 700 SERIES

DEVICE	SERIES	ROD DIA.	TRAVEL	Δ_R
HJA715	HJA-710	5/8	1.0 in	0.006
HJA716	HJA-710	3/4	1.0 in	0.004
HJA717	HJA-710	7/8	1.0 in	0.002
HJA718	HJA-710	1	1.0 in	0.000
HJA719	HJA-710	1 1/8	1.0 in	0.000
HJA7110	HJA-710	1 1/4	1.0 in	0.000
HJA7112	HJA-710	1 1/2	1.0 in	0.000

DEVICE	SERIES	ROD DIA.	TRAVEL	Δ_R
HJA725	HJA-720	5/8	2.0 in	0.005
HJA726	HJA-720	3/4	2.0 in	0.003
HJA727	HJA-720	7/8	2.0 in	0.001
HJA728	HJA-720	1	2.0 in	0.000
HJA729	HJA-720	1 1/8	2.0 in	0.000
HJA7210	HJA-720	1 1/4	2.0 in	0.000
HJA7212	HJA-720	1 1/2	2.0 in	0.000

HEAVYJACK STEEL 700 SERIES

DEVICE	SERIES	ROD DIA.	TRAVEL	Δ_R
HJS715	HJS-710	5/8	1.0 in	0.003
HJS716	HJS-710	3/4	1.0 in	0.001
HJS717	HJS-710	7/8	1.0 in	0.000
HJS718	HJS-710	1	1.0 in	0.000
HJS719	HJS-710	1 1/8	1.0 in	0.000
HJS7110	HJS-710	1 1/4	1.0 in	0.000
HJS7112	HJS-710	1 1/2	1.0 in	0.000

DEVICE	SERIES	ROD DIA.	TRAVEL	Δ_R
HJS725	HJS-720	5/8	2.0 in	0.002
HJS726	HJS-720	3/4	2.0 in	0.000
HJS727	HJS-720	7/8	2.0 in	0.000
HJS728	HJS-720	1	2.0 in	0.000
HJS729	HJS-720	1 1/8	2.0 in	0.000
HJS7210	HJS-720	1 1/4	2.0 in	0.000
HJS7212	HJS-720	1 1/2	2.0 in	0.000

For SI: 1 inch = 25.4 mm

EARTHBOUND CORPORATION
17361 Tye Street, SE
Monroe, WA 98272

Phone: (360) 863-0722
Fax: (360) 863-0724

Project:	Central Lofts		***WOOD COMPRESSION CALCULATION BASED ON IBC 2012 (NDS 2012)***
Project #	19548		***BASED ON NO. 1 DOUG FIR STUDS/POSTS ON DOUG FIR PLATES***
Date:	2/05/2021		***SEE SPECIFIC MEMBER HEIGHTS***
Struct Plans Date:	6/21/2020		

POST COLUMN DESIGN STUD HEIGHT #1

DOUG-FIR POSTS ON DOUG FIR FLOOR PLATES

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
Size	Grade	Height h inch	PARALLEL F_{cll} psi	DURATION C_D	REPETITIVE C_r	SIZE FACT. C_F	M.O.E E ksi	PERPENDICULAR TO GRAIN F_{cp} psi	C_b	WIDTH b(d) inch	THICK t inch	E_{min} ksi	F_{c^*} psi	l_e/d	F_{ce} = (0.822*Emin)/(le/d)^2	COLUMN FACTOR C_p	COL. STRESS F'_c psi	VERTICAL CAPACITY P_v lbs	BEARING CAPACITY P_b lbs	ALLOW. P_c lbs	Size
2 x 4	No. 2	116	1,350	1.60	1.00	1.15	1,600	625	1.00	3.50	1.50	584	2,484	33.00	441.19	0.171	423.76	2,225	3,281	**2,225**	**2 x 4**
3 x 4	No. 2	116	1,350	1.60	1.00	1.15	1,600	625	1.00	3.50	2.50	584	2,484	33.00	441.19	0.171	423.76	3,708	5,469	**3,708**	**3 x 4**
4 x 4	No. 2	116	1,350	1.60	1.00	1.15	1,600	625	1.00	3.50	3.50	584	2,484	33.00	441.19	0.171	423.76	5,191	7,656	**5,191**	**4 x 4**
4 x 6	No. 2	116	1,350	1.60	1.00	1.10	1,600	625	1.00	3.50	5.50	584	2,376	33.00	441.19	0.178	422.88	8,140	12,031	**8,140**	**4 x 6**
4 x 8	No. 2	116	1,350	1.60	1.00	1.05	1,600	625	1.00	3.50	7.25	584	2,268	33.00	441.19	0.186	421.90	10,706	15,859	**10,706**	**4 x 8**
4 x 10	No. 2	116	1,350	1.60	1.00	1.00	1,600	625	1.00	3.50	9.25	584	2,160	33.00	441.19	0.195	420.82	13,624	20,234	**13,624**	**4 x 10**
4 x 12	No. 2	116	1,350	1.60	1.00	1.00	1,600	625	1.00	3.50	11.25	584	2,160	33.00	441.19	0.195	420.82	16,570	24,609	**16,570**	**4 x 12**
2 x 6	No. 2	116	1,350	1.60	1.00	1.00	1,600	625	1.00	5.50	1.50	584	2,160	21.00	1089.46	0.437	943.23	7,782	5,156	**5,156**	**2 x 6**
3 x 6	No. 2	116	1,350	1.60	1.00	1.05	1,600	625	1.00	5.50	2.50	584	2,268	21.00	1089.46	0.420	951.81	13,087	8,594	**8,594**	**3 x 6**
6 x 4	No. 1	116	1,500	1.60	1.00	1.10	1,700	625	1.00	5.50	3.50	621	2,640	21.00	1157.56	0.389	1026.83	19,767	12,031	**12,031**	**6 x 4**
6 x 6	No. 1	116	1,000	1.60	1.00	1.10	1,600	625	1.00	5.50	5.50	584	1,760	21.00	1089.46	0.512	900.67	27,245	18,906	**18,906**	**6 x 6**
6 x 8	No. 1	116	1,000	1.60	1.00	1.10	1,600	625	1.00	5.50	7.25	584	1,760	21.00	1089.46	0.512	900.67	35,914	24,922	**24,922**	**6 x 8**
6 x 10	No. 1	116	1,000	1.60	1.00	1.10	1,600	625	1.00	5.50	9.25	584	1,760	21.00	1089.46	0.512	900.67	45,821	31,797	**31,797**	**6 x 10**
2 x 8	No. 2	116	1,350	1.60	1.00	1.15	1,600	625	1.00	7.25	1.50	584	2,484	15.93	1893.06	0.591	1468.42	15,969	6,797	**6,797**	**2 x 8**

2 x 4	No. 2	71	1,350	1.60	1.00	1.15	1,600	625	1.00	3.50	1.50	584	2,484	20.14	1184.16	0.417	1035.94	5,439	3,281	**3,281**	**2 x 4**
2 x 6	No. 2	71	1,350	1.60	1.00	1.15	1,600	625	1.00	5.50	1.50	584	2,484	12.82	2924.15	0.744	1848.57	15,251	5,156	**5,156**	**2 x 6**

COLUMN NOTES

A	Nominal Member Size
B	Lumber Grade
C	Nominal Post Height - 4.5 inches for double 2x top plate and single 2x bottom plate.
D - J	Coefficients and parameters per NDS 2012
K	Lumber depth (3.5" in 4" wall, 5.5" in 6" wall)
L	Lumber thickness parallel to wall direction
M	Emin' = (2.03)(E)(2-2.645(CoVE)))/2.66, CoVE = 0.25 for sawn lumber
N	$F^*_c = (F_{cll})(C_d)(C_r)(C_F)$ - (Columns D, E, F, G)
O	Slenderness Ratio: Effective Length / depth ratio: (Col. C / Col. K)
P	Emin' = Euler critical buckling stress for columns Fce = 08.22(Emin')/(le/d)2. Equation H-2 in NDS 2012.
Q	Column Stability Factor CP, Equation 3.7-2 in NDS 2012
R	Column Stress F'c = F*c x Cp (Col. N x Col. Q). Equation H-2 in NDS 2012
S	Final Buckling Capacity: Post Area x F'_c. (Col. K x Col. L x Col. R)
T	Maximum Bearing Capacity Perpendicular to Grain Code Limitation: (Col. I x Col. K x Col. L).
U	Final Post Capacity, minimum value of Col. S or Col. T.
V	Nominal Member Size (Same as Col. A)

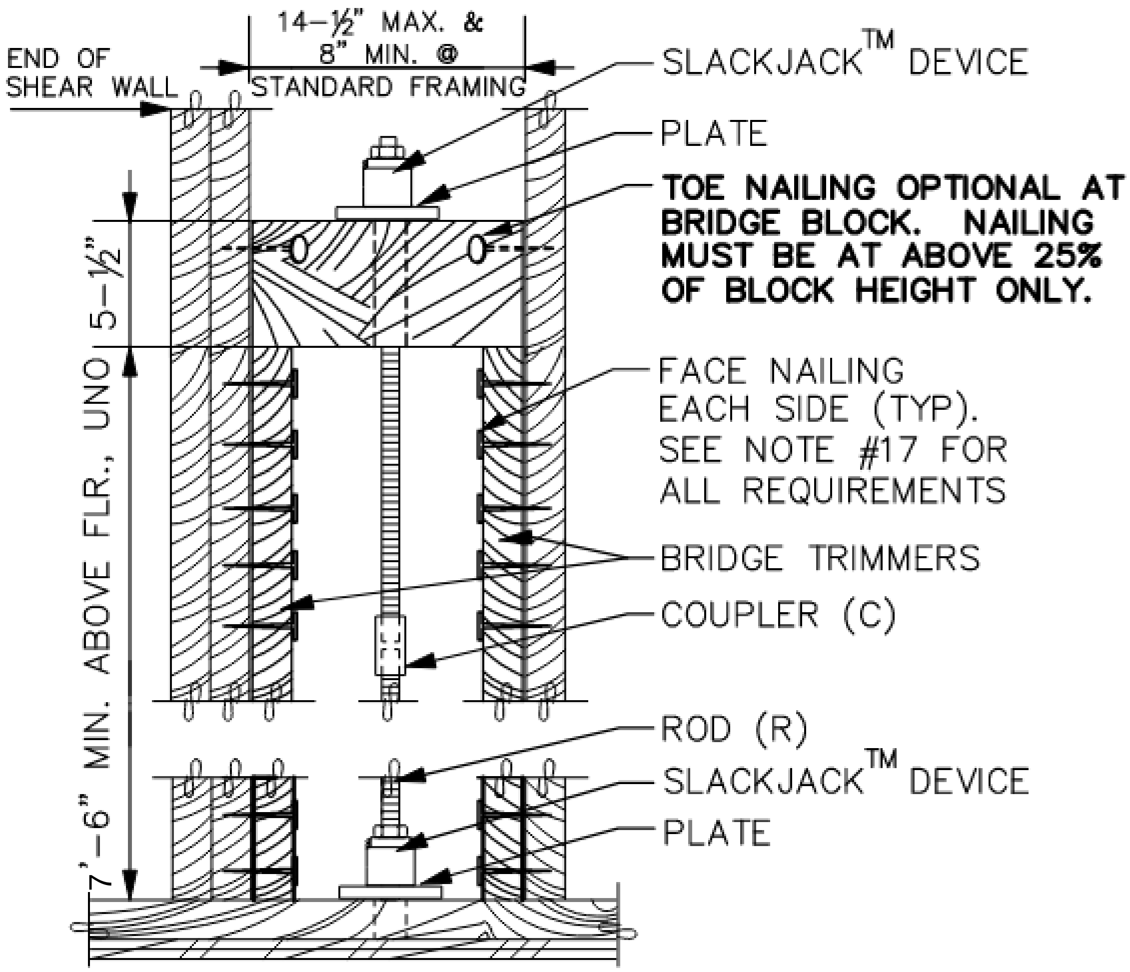
Earthbound System Compression Bridge and Support Trimmer Calculation

Summary of Compression Bridge Concept:

The "Compression Bridge" consists of 4x6 sawn lumber turned upright (or 6x6) and framed in the stud bay at each end of a shear wall. These bridges are utilized at the top floor of every holdown run in the Earthbound System. The 4x6 is framed in the wall similar to a header where it is supported by cripple studs. Depending on load, the minimum number of cripple studs is two, one at each end of the 4x6 bridge.

If the bearing load exceeds the maximum bearing pressure of the cripple studs peripendicular to grain of the floor plate, more studs can be added under the bridge. The outermost cripple studs are faced nailed two (2) nails on 4" o.c. to the adjacent full height stud members. The following example calculation will be based on **7'-6"** tall cripple studs in performing the face nail calculation. The Earthbound System also recommends these cripple studs receive nailing for redundancy from the sheathing side equivalent to required plywood edge nailing schedules for the shear wall. For this calculation, we will use 4" o.c. plywood edge nailing.

The Slackjack or MiniJack Device is mounted at the top of the bridge resting on the Earthbound System bearing plates. The holdown load path is intended to transfer down via the bearing plate through the 4x6 bridge to the cripple studs with load transferring from the face nails into the full length studs.



Objective: Calculate lumber and nailing capacities to support holdown load under the Shrinkage Device and bearing plate. We are using face nailing and diaphragm nailing to transfer holdown load back into wall:

Define Variables and Coefficients:

From Table 10.3.1 2015 NDS (attached at end of calculation), the following are Adjustments Factors for Corrections applicable in calculating nail and spike capacities (under Dowel-Type Fasteners)

$C_D := 1.33$;Load Duration Factor = 1.33 for seismic

$C_{D\_Nails} := 1.60$;Load Duration Factor = 1.6 for Nails in 2015 NDS.

$C_M := 1.0$;Wet Service Factor = 1.0 if dry conditions

$C_t := 1.0$;Temperature Factor = 1.0 if below 100 degrees

$C_\Delta := 1.0$;Geometry Factor = 1.0 unless you have a split ring or shear plate connection.

$C_{eg} := 1.0$;End Grain Factor = 1.0 if non end grain nailing application

$C_{di} := 1.0$;Diaphragm Factor = 1.0 if non diaphragm nailing application. 1.1 if diaphragm nailing

$C_{tn} := 1.0$;Toenail Factor = 1.0 if non toe nailing application

$Z := 93\text{lbf}$;Box Nail Shear Design values from supplemental calculation from WWPA Wood-To-Wood Single Shear Connections is at the end of this document. WWPA = 148 lbs / 1.6 (Cd) = 93 lbf

Calculate Shear Value of one FACE nail based on above adjustment factors:

$Z_{nail} := Z \cdot C_{D\_Nails} \cdot C_M \cdot C_t \cdot C_\Delta \cdot C_{eg} \cdot C_{di} \cdot C_{tn}$ $Z_{nail} = 148.8 \cdot \text{lbf}$

Calculate Face Nailing Capacity based on two (2) nails on 4"o.c. rows and 7'-6" trimmer stud length:

$\text{StudHeight} := 7.5\text{ft}$;Typically Trimmer Stud Height is set at mid floor or 1/2 full length studs used for wall framing

$\text{NailRowSeperationOC} := 4.0\text{in}$

$$\text{NumberNailRows} := \left(\frac{\text{StudHeight} \cdot 12\frac{\text{in}}{\text{ft}}}{\text{NailRowSeperationOC}}\right) - 1$$

;We subtract one row of nails for spacing and clearance to the bridge.

$\text{NumberNailRows} = 22$

$\text{NumberNailsPerRow} := 2$

$\text{NumberofRowArrays} := 2$

$\text{TotalFaceNailCapacity} := \text{NumberNailRows} \cdot \text{NumberNailsPerRow} \cdot \text{NumberofRowArrays} \cdot Z_{nail}$

$\text{TotalFaceNailCapacity} = 12797 \cdot \text{lbf}$;This is (number of rows) x (2 nails per row) x (2 rows, one each side) x (nail capacity)

Nailing Capacity Summary: The above calculation is based on the cripple stud height used and the spacing between rows of nails. Note that the Earthbound System does recommend sheathing nailing to match plywood edge nailing schedules. The additional transfer from shear panel nails is calculated later in this document.

Calculate Cripple Stud Bearing Capacity: This is a calculation of the maximum capacity per stud bearing perpendicular to grain on the bottom plates:

$l_e := StudHeight \times \frac{12in}{1ft}$ $l_e = 90 \times in$;Stud Height in inches

$d := 3.5in$;Stud Depth

$t := 1.5in$;Stud Thickess

$A := t \times d$;Stud Bearing Area

$A = 5.25 \times in^2$;Note the effective stud bearing area for a 2x6 cripple stud will be based on a 2x4 (1.5 in x 3.5 in) because we specify a 4x6 bridge turned upwards, the effective stud bearing area will be the same for a 2x4 or 2x6.

$Fc_{perp} := 625psi$;From 2015 NDS Table 4A Douglas Fir Stud Grade = 625 psi

$StudBearingCapacity := A \times Fc_{perp}$

$StudBearingCapacity = 3281 \times lbf$;NDS does not allow for Load Duration Factor greater than 1.0 to be applied to loads perpendicular to grain.

Calculate Trimmer Stud Vertical (Column Buckling) Capacity: This is a calculation of the maximum buckling or column capacity per stud. Calculations are based from 2015 NDS:

$Fc_{para} := 850psi$;Fc (parallel): Douglas Fir (stud grade) = 850 psi

$C_D := 1.333$;Load Duration Factor = 1.33 for seismic

$C_r := 1.00$;Repetitive Member Factor = 1.00

$C_F := 1.05$;Size Factor = 1.05, From 2015 NDS Table 4A for 2,3,4 inch width Stud Grade

$C_M := 1.0$;Wet Service Factor = 1.0, From 2015 NDS Table 4A, assume lumber is below 19% moisture content

$E := 1400000psi$;Modulus of Elasticity of wood, From 2015 NDS Table 4A: Douglas Fir Stud. Grade = 1,400,000 psi

$c := 0.80$;c = 0.8 for sawn lumber

$Adjusted\_Fc_{para} := Fc_{para} \times C_D \times C_F \times C_M$;Adjusted_Fc(para) is also known as F*c from NDS 2015 reference. Mathcad cannot show the asterisk in "F*c".

$Adjusted\_Fc_{para} = 1189.7 \times psi$

$CoV_E := 0.25$;Coefficient of variation of E, CoV(E) = 0.25 for sawn lumber, 0.10 for glue lam lumber per NDS 2015 Appendix F.2.

$$E_{min} := 1.03 \cdot E \cdot \frac{(1 - 1.645 \cdot CoV_E)}{1.66}$$

$$E_{min} = 511432.2 \cdot psi$$

;Equation D-4 in NDS 2015. Determine reference modulus of elasticity where:
E = Modulus of Elasticity
1.03 = adjustment factor to convert E to pure bending basis. Use 1.05 for structural glued laminated timber.
1.66 = factor of safety
CoV(E) = cofficient of varation in modulus of elasticity defined in NDS 2015 Appendix F.2.
Emin represents an approx 5% lower exclusion value on pure bending MOE, plus a factor of safety of 1.66.

$$F_{cE} := \frac{(0.822 \cdot E_{min})}{\left(\frac{l_e}{d}\right)^2} \qquad F_{cE} = 636 \cdot psi$$

;Equation H-2 in NDS 2015: The 0.822 factor in Equation H-2 represents the Euler buckling coefficient for rectangular columns calulated as $p^2/12$. MOE for beam and column stability Emin in H-2 represents an approximate 5% lower exclusion value on pure bending MOE, plus a 1.66 factor of safety (See NDS 2015 D.4.)

We effectively removed the 1.66 factor of safety from Equation H-2 by dividing Emin by 1.66 used in Equation D-4 above.

The maximum design value Fc in psi of cross-sectional area of individual members of columns shall be determined in accordance with the following formula. (Taken from 2015 NDS Equation 3.7-1).

$$F_c := Adjusted\_Fc_{para} \cdot \left[\frac{\left[1 + \left(\frac{F_{cE}}{Adjusted\_Fc_{para}}\right)\right]}{2 \cdot c} - \sqrt{\left[\frac{\left[1 + \left(\frac{F_{cE}}{Adjusted\_Fc_{para}}\right)\right]}{2 \cdot c}\right]^2 - \left(\frac{\frac{F_{cE}}{Adjusted\_Fc_{para}}}{c}\right)} \right]$$

$$F_c = 544.1 \cdot psi$$

The vertical capacity of this column if design value Fc multiplied by the bearing area of the stud, in this case a 2x4:

$$d = 3.5 \cdot in \qquad t = 1.5 \cdot in$$

$$StudVerticalCapacity := d \cdot t \cdot F_c$$

$$StudVerticalCapacity = 2856 \cdot lbf$$

$$StudBearingCapacity = 3281 \cdot lbf$$

;From above bearing calculations, based on DF at Fc(perp)=625 psi.

The allowable stud capacity should be the lower value between Vertical Capacity and Bearing Capacity:

$$AllowStudCapacity := if(StudBearingCapacity > StudVerticalCapacity, StudVerticalCapacity, StudBearingCapacity)$$

;The above formula is a conditional statement inherent to Mathcad to use the lower capacity as the final value.

$$AllowStudCapacity = 2856 \cdot lbf$$

Calculate Shear Value of 10d nail assuming 1/2" Plywood:

$Z := 70\text{lbf}$;Box Nail Shear Design values from 2015 NDS Table 12Q (attached at end of calc) using 1/2" side member thickness 10d nails (x 3 inches nail length) and Douglas Fir Larch lumber.

$C_{di} := 1.1$;Cdi is 1.1 for diaphragm nailing.

$Z_{nail} := Z \cdot C_{D\_Nails} \cdot C_M \cdot C_t \cdot C_\Delta \cdot C_{eg} \cdot C_{di} \cdot C_{tn}$;Incorporate all adjustment factors including C(D_Nails) = 1.60

$Z_{nail} = 123.2 \cdot \text{lbf}$

Calculate Plywood Side Nailing Capacity based on 4"o.c. and 7'-6" trimmer stud length:

$\text{StudHeight} := 7.5\text{ft}$

$\text{NailRowSeperationOC} := 4.0\text{in}$

$$\text{NumberNailsPerStud} := \left(\frac{\text{StudHeight} \cdot 12\frac{\text{in}}{\text{ft}}}{\text{NailRowSeperationOC}}\right) - 1$$

$\text{NumberNailsPerStud} = 21.5$

$\text{NumberStuds} := 4$

$\text{TotalPlywoodNailCapacity} := \text{NumberNailsPerStud} \cdot \text{NumberStuds} \cdot Z_{nail}$

$\text{TotalPlywoodNailCapacity} = 10595 \cdot \text{lbf}$

$\text{TotalNailCapacity} := \text{TotalPlywoodNailCapacity} + \text{TotalFaceNailCapacity}$; See Page 2 for Face Nail Calc...

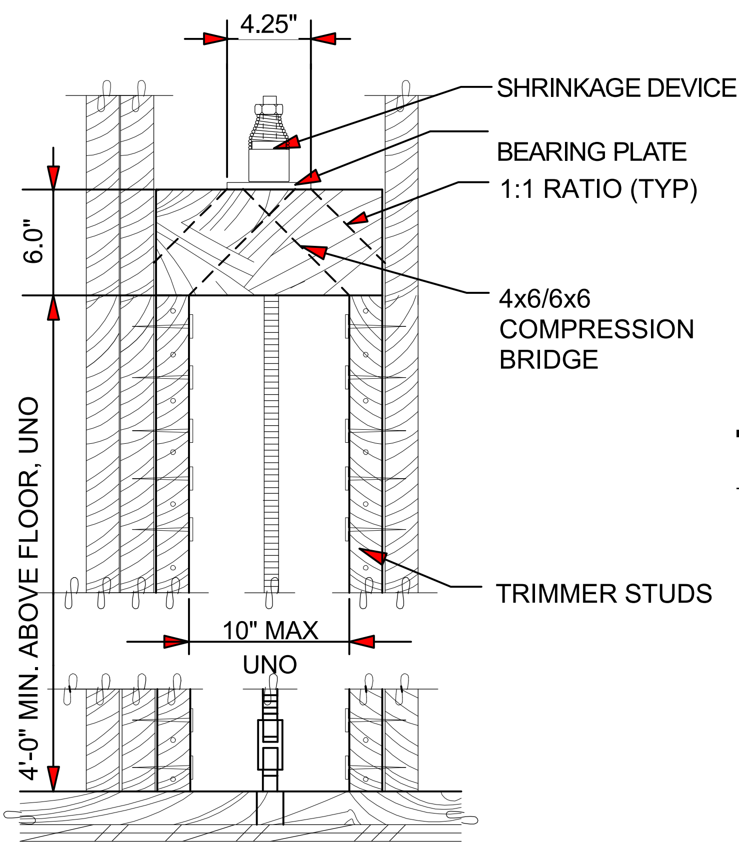
$\text{TotalNailCapacity} = 23392 \cdot \text{lbf}$

Nailing Capacity Summary: The above calculation is based on the trimmer stud height used and the spacing between rows of nails. Note that the Earthbound System does require 4" o.c. sheathing nailing on all trimmer members and 4" o.c. face nailing of the outermost trimmer to the full height stud members.

Calculation Summary:
For a given bearing load underneath the take up device, the required amount of cripple studs under the bridge is an even number of multiples of the above Allowable Stud Capacity. We use even numbers to balance the supporting under the 4x6 or 6x6 bridge.

This bearing load may be greater that the actual uplift load required for the top floor due to assignment of loads upward in the building using the threaded rod system. The face nailing portion of the cripple studs need to exist to transfer shear load that occurs above the bridge back underneath the bridge and into the threaded rod. The loads required for panel nailing calculations will be the uplift load for that floor only. The additional studs required are to take up the bearing loads from loads transferred from below.

Examine Shear at Bridge:
The figure at the left shows a worst case scenario of a bridge trimmer with our smallest plate (Part "P8" 3 1/4 x 4 1/4 x 3/8) and only two (2) trimmers total. By inspection we are within a 1:1 requirement per 2012 NDS 3.4.3 to ignore shear force. If the load under the shrinkage device exceeds 8,000 lbs, a larger bearing plate will used. Depending on the lumber species (Hem vs Doug Fir) of the trimmers and floor plates, we would also increase the number of trimmer members under the bridge.

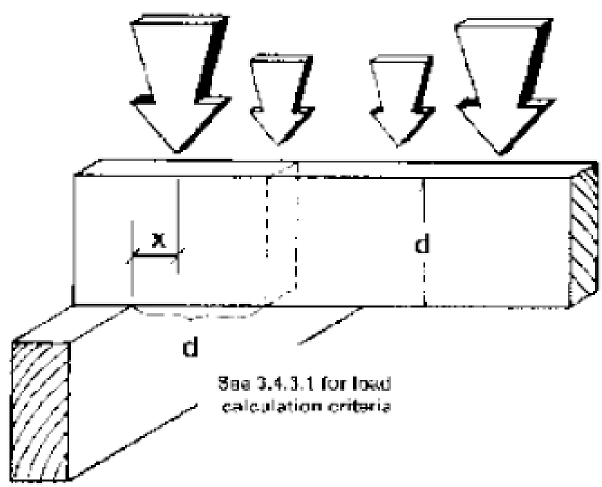


3.4.3 Shear Design

3.4.3.1 When calculating the shear force, V, in bending members:

(a) For beams supported by full bearing on one surface and loads applied to the opposite surface, uniformly distributed loads within a distance from supports equal to the depth of the bending member, d, shall be permitted to be ignored. For beams supported by full bearing on one surface and loads applied to the opposite surface, concentrated loads within a distance, d, from supports shall be permitted to be multiplied by x/d where x is the distance from the beam support face to the load (see Figure 3C).

Figure 3C Shear at Supports



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Wood-to-Wood Single Shear Connections

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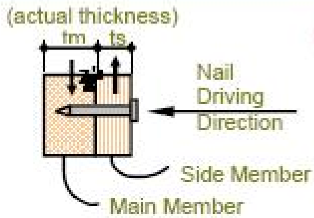

Main Member Species	Douglas Fir-Larch
Main Member Thickness (tm ")	1 1/2
Side Member Species	Douglas Fir-Larch
Side Member Thickness (ts ")	1 1/2
Loading Type	Seismic Load
End Grain Condition?	No

Type of Connector

- (●) **Box Nail**
- ( ) Common Wire Nail
- ( ) Sinker Nail
- ( ) Bolt
- ( ) Wood Screw
- ( ) Lag Screw

Connector Size		Length (in)		Shear Capacity		Controlling Mode
10d	x	3	=	**148**	lb each	**MODE IV**

Mode

Open Detailed Calculation Sheet

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Wood-to-Wood Single Shear Connections

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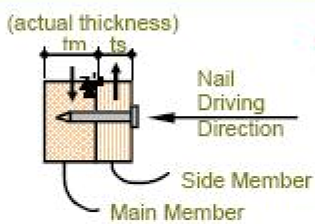

Main Member Species	Douglas Fir-Larch
Main Member Thickness (tm ")	3 1/2
Side Member Species	Plywood (Str. 1 or Marine Gr.)
Side Member Thickness (ts ")	7/16
Loading Type	Seismic Load
End Grain Condition?	No

Type of Connector

- (●) **Box Nail**
- ( ) Common Wire Nail
- ( ) Sinker Nail
- ( ) Bolt
- ( ) Wood Screw
- ( ) Lag Screw

Connector Size		Length (in)		Shear Capacity		Controlling Mode
10d	x	3	=	**112**	lb each	**MODE IIIs**

Mode

Open Detailed Calculation Sheet

NOTE: THIS CALCULATION MUST INCLUDE Cdl = 1.1 FOR DIAPHRAGM FACTOR.
THEREFORE 112 LBS x 1.1 = 123 lbs PER SHEAR NAIL.