Structural Calculations

6100 W Suburban Dr
Pinecrest, Fl 33156

Steel Stairs & Railings

Table of Contents

Carlos E Hoyos

Digitally signed by Carlos E Hoyos
Date: 2026.01.20 12:08:13 -05'00'

CARLOS E. HOYOS
LICENSE
No 81268
STATE OF
FLORIDA
PROFESSIONAL ENGINEER

Hoyos Engineering FL CA No. 32119
Registered Engineer FL No. 81268
12068 NW 83rd Place
Parkland, FL 33076
(954) 815 2941

Steel Beam

Project File: 6100 West Suburban.ec6

LIC# : KW-06011976, Build:20.25.11.05 Hoyos Engineering (c) ENERCALC, LLC 1982-2026

DESCRIPTION: Stair Landing Beam

Code References

Governing Code : IBC 2021
Referenced Design Standard(s) : AISC 360-22* *User-selected, not referenced by : IBC 2021
Load Combination Set : ASCE 7-22 / IBC 2024

Material Properties

Analysis Method :	Allowable Strength Design	Fy : Steel Yield :	46.0 ksi
Beam Bracing :	Completely Unbraced	E: Modulus :	29,000.0 ksi
Bending Axis :	Major Axis Bending		

Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight calculated and added to loading
Uniform Load : D = 0.20, L = 0.60 k/ft, Tributary Width = 1.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	**0.428** : 1	Maximum Shear Stress Ratio =	**0.077** : 1
Section used for this span	**HSS6x4x3/8**	Section used for this span	**HSS6x4x3/8**
Ma : Applied	11.702 k-ft	Va : Applied	4.387 k
Mn / Omega : Allowable	27.315 k-ft	Vn/Omega : Allowable	57.137 k
Load Combination	+D+L	Load Combination	+D+L
		Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	0.214 in Ratio =	597 >=360	Span: 1 : L Only
Max Upward Transient Deflection	0 in Ratio =	0 <360	n/a
Max Downward Total Deflection	0.294 in Ratio =	436 >=180	Span: 1 : +D+L
Max Upward Total Deflection	0 in Ratio =	0 <180	n/a

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios		Summary of Moment Values							Summary of Shear Values		
Segment Length	Span #	M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega
D Only													
Dsgn. L = 10.67 ft	1	0.116	0.021	3.16		3.16	45.62	27.32	1.14	1.00	1.19	95.42	57.14
+D+L													
Dsgn. L = 10.67 ft	1	0.428	0.077	11.70		11.70	45.62	27.32	1.14	1.00	4.39	95.42	57.14
+D+0.750L													
Dsgn. L = 10.67 ft	1	0.350	0.063	9.57		9.57	45.62	27.32	1.14	1.00	3.59	95.42	57.14
+0.60D													
Dsgn. L = 10.67 ft	1	0.069	0.012	1.90		1.90	45.62	27.32	1.14	1.00	0.71	95.42	57.14

Overall Maximum Deflections

Span	Load Combination	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
1	+D+L	0.2935	5.365		0.0000	0.000

Maximum Deflections for Load Combinations

Load Combination	Span	Max. Downward Defl	Location in Span	Span	Max. Upward Defl	Location in Span
D Only	1	0.0794	5.365		0.0000	0.000
+D+L	1	0.2935	5.365		0.0000	0.000
+D+0.750L	1	0.2400	5.365		0.0000	0.000
+0.60D	1	0.0476	5.365		0.0000	0.000
L Only	1	0.2142	5.365		0.0000	0.000

Steel Beam

Project File: 6100 West Suburban.ec6

LIC# : KW-06011976, Build:20.25.11.05 Hoyos Engineering (c) ENERCALC, LLC 1982-2026

DESCRIPTION: Stair Landing Beam

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	4.387	4.387
Max Upward from Load Combinations	4.387	4.387
Max Upward from Load Cases	3.201	3.201
D Only	1.186	1.186
+D+L	4.387	4.387
+D+0.750L	3.587	3.587
+0.60D	0.712	0.712
L Only	3.201	3.201

Steel Section Properties : HSS6x4x3/8

Depth	=	6.000 in	I xx	=	28.30	in^4	J	=	32.800 in^4
			S xx		9.43	in^3	Cw	=	14.20 in^6
Width	=	4.000 in	R xx	=	2.140	in			
Wall Thick	=	0.349 in	Zx	=	11.900	in^3			
Area	=	6.180 in^2	I yy	=	14.900	in^4	C	=	0.000 in^3
Weight	=	22.302 plf	S yy	=	7.470	in^3			
			R yy	=	1.550	in			
			Zy	=	8.940	in^3			
Ycg	=	3.000 in							

Steel Beam

Project File: 6100 West Suburban.ec6

LIC# : KW-06011976, Build:20.25.11.05 Hoyos Engineering (c) ENERCALC, LLC 1982-2026

DESCRIPTION: Stair Stringer

Code References

Governing Code : IBC 2021
Referenced Design Standard(s) : AISC 360-22*
Load Combination Set : ASCE 7-22 / IBC 2024

*User-selected, not referenced by : IBC 2021

Material Properties

Analysis Method :	Allowable Strength Design	Fy : Steel Yield :	46.0 ksi
Beam Bracing :	Completely Unbraced	E: Modulus :	29,000.0 ksi
Bending Axis :	Major Axis Bending		

Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight calculated and added to loading
Uniform Load : D = 0.090, L = 0.270 k/ft, Tributary Width = 1.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	**0.296** : 1	Maximum Shear Stress Ratio =	**0.043** : 1
Section used for this span	**HSS6x4x3/8**	Section used for this span	**HSS6x4x3/8**
Ma : Applied	8.076 k-ft	Va : Applied	2.485 k
Mn / Omega : Allowable	27.303 k-ft	Vn/Omega : Allowable	57.137 k
Load Combination	+D+L	Load Combination	+D+L
		Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	0.212 in	Ratio =	734 >=360	Span: 1 : L Only
Max Upward Transient Deflection	0 in	Ratio =	0 <360	n/a
Max Downward Total Deflection	0.301 in	Ratio =	519 >=180	Span: 1 : +D+L
Max Upward Total Deflection	0 in	Ratio =	0 <180	n/a

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios		Summary of Moment Values							Summary of Shear Values		
Segment Length	Span #	M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega
D Only													
Dsgn. L = 13.00 ft	1	0.087	0.013	2.37		2.37	45.60	27.30	1.14	1.00	0.73	95.42	57.14
+D+L													
Dsgn. L = 13.00 ft	1	0.296	0.043	8.08		8.08	45.60	27.30	1.14	1.00	2.48	95.42	57.14
+D+0.750L													
Dsgn. L = 13.00 ft	1	0.244	0.036	6.65		6.65	45.60	27.30	1.14	1.00	2.05	95.42	57.14
+0.60D													
Dsgn. L = 13.00 ft	1	0.052	0.008	1.42		1.42	45.60	27.30	1.14	1.00	0.44	95.42	57.14

Overall Maximum Deflections

Span	Load Combination	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
1	+D+L	0.3007	6.537		0.0000	0.000

Maximum Deflections for Load Combinations

Load Combination	Span	Max. Downward Defl	Location in Span	Span	Max. Upward Defl	Location in Span
D Only	1	0.0883	6.537		0.0000	0.000
+D+L	1	0.3007	6.537		0.0000	0.000
+D+0.750L	1	0.2476	6.537		0.0000	0.000
+0.60D	1	0.0530	6.537		0.0000	0.000
L Only	1	0.2124	6.537		0.0000	0.000

Steel Beam

Project File: 6100 West Suburban.ec6

LIC# : KW-06011976, Build:20.25.11.05 Hoyos Engineering (c) ENERCALC, LLC 1982-2026

DESCRIPTION: Stair Stringer

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	2.485	2.485
Max Upward from Load Combinations	2.485	2.485
Max Upward from Load Cases	1.755	1.755
D Only	0.730	0.730
+D+L	2.485	2.485
+D+0.750L	2.046	2.046
+0.60D	0.438	0.438
L Only	1.755	1.755

Steel Section Properties : HSS6x4x3/8

Depth	=	6.000 in	I xx	=	28.30 in^4	J	=	32.800 in^4
			S xx		9.43 in^3	Cw	=	14.20 in^6
Width	=	4.000 in	R xx	=	2.140 in			
Wall Thick	=	0.349 in	Zx	=	11.900 in^3			
Area	=	6.180 in^2	I yy	=	14.900 in^4	C	=	0.000 in^3
Weight	=	22.302 plf	S yy	=	7.470 in^3			
			R yy	=	1.550 in			
			Zy	=	8.940 in^3			
Ycg	=	3.000 in						

STEEL STAIR TREAD CALCULATION

1. Section properties (about horizontal bending axis)

Top plate: 11.5"×0.5"
Return: 2.25"×0.5"

Areas:

- $A_1 = 11.5(0.5) = 5.75 \text{ in}^2$
- $A_2 = 2.25(0.5) = 1.125 \text{ in}^2$

Centroid from top surface of plate:

- Plate centroid: $y_1 = 0.25\text{in}$
- Return centroid: $y_2 = 0.5 + \frac{2.25}{2} = 1.625\text{in}$

$$\bar{y} = \frac{A_1(0.25) + A_2(1.625)}{A_1 + A_2} = \frac{5.75(0.25) + 1.125(1.625)}{5.75 + 1.125} = 0.475 \text{ in}$$

Moment of inertia about centroidal x-axis:

- Plate: $I_1 = \frac{11.5(0.5)^3}{12} + A_1\,(0.475 - 0.25)^2 = 0.4109 \text{ in}^4$
- Return: $I_2 = \frac{0.5(2.25)^3}{12} + A_2\,(1.625 - 0.475)^2 = 1.9624 \text{ in}^4$

$$I_x = I_1 + I_2 = 2.3733 \text{ in}^4$$

2. Bending stress (cantilever with tip load)

$$M = Pa = 300(25) = 7{,}500 \text{ lb}\backslash\text{in}$$

Extreme fiber distance to bottom of return:
Total depth to bottom $= 0.5 + 2.25 = 2.75\text{in}$

$$c = 2.75 - \bar{y} = 2.75 - 0.475 = 2.275 \text{ in}$$

$$f_b = \frac{Mc}{I} = \frac{7{,}500(2.275)}{2.3733} = 7.19 \text{ ksi}$$

ASD allowable bending (A572 Grade 50): Fy / 1.67 ≈ 29.9 ksi

✅ **OK:** 7.19 < 29.9 ksi

Deflection

$$\Delta = \frac{Pa^3}{3EI} = \frac{300(25^3)}{3(29{,}000{,}000)(1.27)} = 0.042 \text{ in}$$

✅ **OK:** 0.042" < L/360

3. Weld check (3/16" continuous fillet around 3.5" square)

Perimeter weld length:

$$L = 4(3.5) = 14 \text{ in}$$

Fillet weld throat:

$$t_w = 0.707(3/16) = 0.707(0.1875) = 0.1326 \text{ in}$$

Forces on weld group from one-side tip load

- Shear: $V = P = 300\text{lb}$
- Moment at support: $M = 7{,}500\text{lb·in}$

For a closed square **line weld group** (side length $s = 3.5\text{in}$), the line polar "J" integral is:

$$J_{line} = \int r^2\, dL = \frac{4s^3}{3} = \frac{4(3.5^3)}{3} = 57.17 \text{ in}^3$$

Max radius (corner):

$$r_{max} = \sqrt{(s/2)^2 + (s/2)^2} = \frac{s}{\sqrt{2}} = 2.475 \text{ in}$$

Moment-induced shear flow (force per unit weld length):

$$q_M = \frac{Mr}{J_{line}} = \frac{7{,}500(2.475)}{57.17} = 325 \text{ lb/in}$$

Direct shear flow:

$$q_V = \frac{V}{L} = \frac{300}{14} = 21 \text{ lb/in}$$

Conservatively combine:

$$q_{max} \approx q_M + q_V \approx 346 \text{ lb/in}$$

Allowable weld strength per inch (ASD, E70)

AISC weld nominal shear:

$$R_n = 0.6F_{EXX}A_w$$

ASD allowable ($\Omega = 2.0$) $\Rightarrow R_{allow} = 0.3F_{EXX}A_w$

Per unit length, $A_w = t_w(1 \text{ in})$:

$$R_{allow}/\text{in} = 0.3(70{,}000)(0.1326) = 2{,}785 \text{ lb/in}$$

✅ **Weld OK:** $346 < 2{,}785$ lb/in

GUARDRAIL & HANDRAIL CALCULATION – 12 IN LOAD DISTRIBUTION

1. Code Basis and Assumptions (FBC Residential)

Guardrail designed per FBC Residential.
Top of guard serves as required handrail and is continuous.
Design loads (non-concurrent):
• 200 lb concentrated load applied at the handrail
• 50 lb per linear foot applied along the handrail

Load distribution assumption:
• Continuous, stiff handrail distributes the 200 lb load over 12 in of rail length.
• Vertical pickets spaced at 4 in o.c.; therefore, three pickets share the load.

2. Geometry and Material Properties

Handrail: solid flat bar 0.75 in × 2.5 in
Vertical pickets: solid square bar 0.75 in x 0.75 in
Picket spacing: 4 in o.c.
Picket height: 36 in (cantilever).
Steel material: ASTM A572.
Yield strength, Fy = 50 ksi.
Safety Factor, Ωb=1.67
Allowable bending stress (ASD): Fb,allow = Fy/ Ωb ≈ 29.9 ksi.
Modulus of elasticity: E = 29,000 ksi.

3. Load per Picket from 200 lb Concentrated Load (12 in Distribution)

Total handrail load: P = 200 lb
Assumed distribution length: 12 in
Tributary width per picket: 4 in

Load per picket:
P_picket = 200 × (4 / 12) = 66.7 lb

4. Bending Demand on Single Picket

Picket modeled as a cantilever with point load at top.
Picket height: L = 36 in

Base moment:
$M = P \times L = 66.7 \times 36 = 2{,}400$ lb·in

5. Required Plastic Section Modulus for Picket

Required section modulus:
$Z_{req} = M / F_{b,allow} = 2{,}400 / 29{,}900 = 0.080$ in^3

For a solid square bar:
$Z = bh^2/4 = d^3 / 4$

Solve for b:
$d = (4Z)^{(1/3)} = (0.32)^{(1/3)} = 0.68$ in

6. Picket Member Selection

Minimum Square picket size (strength-based): ¾ in side.

7. Handrail (Top Rail) Strength Check – 0.75 in × 2.5 in Solid Flat Bar

Handrail is modeled as a beam spanning between pickets.
Span between supports: L = 4 in (picket spacing).
Section properties (b = 0.75 in, h = 2.5 in, strong axis):
$Z = b h^2 / 4 = 0.75(2.5^2)/4 = 1.171$ in^3

A) 200 lb concentrated load at midspan (worst case):
$M_{max} = P L / 4 = 200(4)/4 = 200$ lb·in
$f_b = M/Z = 200$ lb·in / 1.171 in^3 = 0.170 ksi < 29.9 ksi → OK

B) 50 plf uniform load on rail:
$w = 50/12 = 4.167$ lb/in
$M_{max} = w L^2 / 8 = 4.167(4^2)/8 = 8.33$ lb·in
$f_b = M/Z = 8.33$ lb·in / 1.171 in^3 = 0.007 ksi < 29.9 ksi → OK

Designer: Carlos HOYOS	
Date: 01-08-2026	
Project: Project 1	
Component: 2x1 Top Rail	

PROPERTIES

INPUT DATA

Shape	RT1x2x0.125	**Member Type**	Beam	**Length**	4 ft
Rotate (deg)	0	**Material Type**	Aluminum		

MATERIAL PROPERTIES

Material	6061-T6 W	**E**	10100 ksi	**G**	3787.5 ksi
Table	Table B.4-1	**Ftu**	24 ksi	**Fcy**	15 ksi
Ct	141	**Density**	0.173 k/ft^3	**Nu**	0.33
Kt	1	**Fty**	15 ksi	**Fsu**	15 ksi

SHAPE PROPERTIES

A	0.688 in^2	**d**	2 in^1	**t**	0.125 in^1
b_f	1 in^1	I_{ZZ}	0.332 in^4	I_{YY}	0.105 in^4
S_{ZZ}	0.332 in^3	S_{YY}	0.21 in^3	**J**	0.245 in^4

DESIGN PROPERTIES

$L_{b\ out}$	4 ft	$L_{b\ in}$	4 ft	L_{torque}	4 ft
$L_{comp\ top}$	4 ft	$L_{comp\ bot}$	4 ft	K_{in}	1
C_b	Autocalc				

LOADS

POINT LOADS

Load Category	Magnitude (k, k-ft)	Location (ft, %)	Direction
LL	0.2	2	↓

LOAD COMBINATIONS

IBC 2021 Load combinations include self weight.

STRENGTH

	Equation	Code
1	1.4 DL	IBC 21/ASCE STRENGTH 1
2	1.2 DL + 1.6 LL	IBC 21/ASCE STRENGTH 2 (A)
3	1.2 DL + 0.5 LL	IBC 21/ASCE STRENGTH 3 (A)

ASD

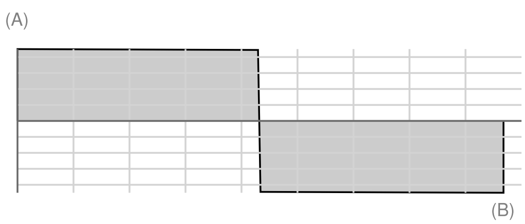
	Equation	Code
4	1 DL	IBC 21/ASCE ASD 1
5	1 DL + 1 LL	IBC 21/ASCE ASD 2
6	1 DL + 0.75 LL	IBC 21/ASCE ASD 4 (A)

DEFLECTION

	Equation
7	DL = DL
8	LL = LL
9	DL+LL = DL + LL
10	DL+LL = DL

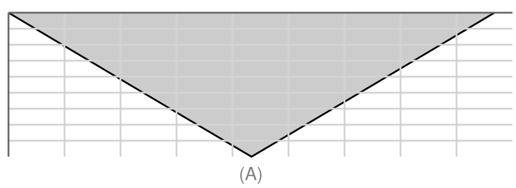
DIAGRAMS

All diagrams display the governing load combination.



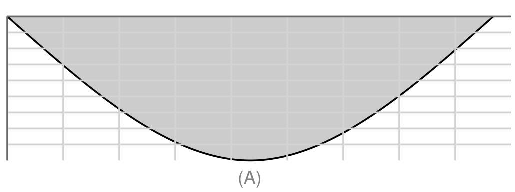
(A): 0.162 (max) at 0 ft (B): -0.162 (min) at 4 ft

Shear [k]
1.2 DL + 1.6 LL



(A): -0.322 (min) at 2 ft

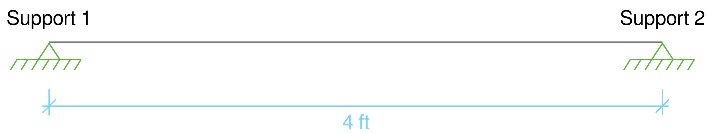
Moment [k-ft]
1.2 DL + 1.6 LL



(A): -0.222 (min) at 2 ft

Deflection [in]
1.2 DL + 1.6 LL

REACTIONS



Envelope Reactions

	Min/Max	Horizontal (k)	Vertical (k)	Moment (k-ft)
Support 1 (@ 0 ft)	Max	0 (IBC 21/ASCE STRENGTH 1)	0 (IBC 21/ASCE 4 (A))	0 (IBC 21/ASCE STRENGTH 1)
	Max	0 (IBC 21/ASCE STRENGTH 1)	-0.162 (IBC 21/ASCE STRENGTH 1 POST)	0 (IBC 21/ASCE STRENGTH 1)
Support 2 (@ 4 ft)	Max	0 (IBC 21/ASCE STRENGTH 1)	0 (IBC 21/ASCE 4 (A))	0 (IBC 21/ASCE STRENGTH 1)
	Max	0 (IBC 21/ASCE STRENGTH 1)	-0.162 (IBC 21/ASCE STRENGTH 1 POST)	0 (IBC 21/ASCE STRENGTH 1)

Load Category Reactions

	Load Category	Horizontal (k)	Vertical (k)	Moment (k-ft)
Support 1 (@ 0 ft)	DL	0	-0.002	0
	LL	0	-0.1	0
	LLS	0	0	0
	RLL	0	0	0
	SL	0	0	0
Support 2 (@ 4 ft)	DL	0	-0.002	0
	LL	0	-0.1	0
	LLS	0	0	0
	RLL	0	0	0
	SL	0	0	0

CALCULATIONS

Limit State	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	-	-	-	-
Applied Loading - Shear	-	-	-	-
Axial Tension Analysis	0 k	9.288 k	-	-
Axial Compression Analysis	0 k	3.473 k	-	-
Flexural Analysis	0.322 k-ft	0.373 k-ft	-	-
Shear Analysis	0.162 k	3.291 k	0.05	Pass
Bending & Axial Interaction Check (UC Bending Max)	-	-	0.86	Pass
Deflection Check	-	-	0.35	Pass

Deflection Check

	DL	LL	DL + LL
Deflection	0.001 in	0.137 in	0.139 in
Location	2 ft	2 ft	2 ft
L/Δ Ratio	33807	349.3	345.7
L/Δ Limit (user input)	120	120	120
Unity Check	0	0.34	0.35

PROPERTIES

INPUT DATA

Shape	RT2x2x0.250	**Member Type**	Beam	**Length**	3 ft
Rotate (deg)	0	**Material Type**	Aluminum		

MATERIAL PROPERTIES

Material	6061-T6 W	**E**	10100 ksi	**G**	3787.5 ksi
Table	Table B.4-1	**Ftu**	24 ksi	**Fcy**	15 ksi
Ct	141	**Density**	0.173 k/ft^3	**Nu**	0.33
Kt	1	**Fty**	15 ksi	**Fsu**	15 ksi

SHAPE PROPERTIES

A	1.75 in^2	**d**	2 in^1	**t**	0.25 in^1
b_f	2 in^1	**I_{ZZ}**	0.911 in^4	**I_{YY}**	0.911 in^4
S_{ZZ}	0.911 in^3	**S_{YY}**	0.911 in^3	**J**	1.34 in^4

DESIGN PROPERTIES

$L_{b\ out}$	3 ft	**$L_{b\ in}$**	3 ft	**L_{torque}**	3 ft
$L_{comp\ top}$	3 ft	**$L_{comp\ bot}$**	3 ft	**K_{in}**	1
C_b	Autocalc				

LOADS

POINT LOADS

Load Category	Magnitude (k, k-ft)	Location (ft, %)	Direction
LL	0.2	3	↓

LOAD COMBINATIONS

IBC 2021 Load combinations include self weight.

STRENGTH

	Equation	Code
1	1.4 DL	IBC 21/ASCE STRENGTH 1
2	1.2 DL + 1.6 LL	IBC 21/ASCE STRENGTH 2 (A)
3	1.2 DL + 0.5 LL	IBC 21/ASCE STRENGTH 3 (A)

ASD

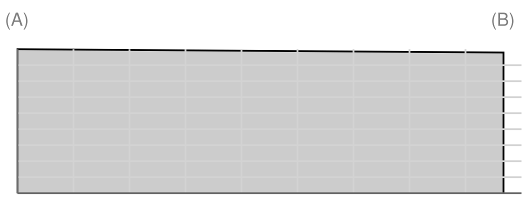
	Equation	Code
4	1 DL	IBC 21/ASCE ASD 1
5	1 DL + 1 LL	IBC 21/ASCE ASD 2
6	1 DL + 0.75 LL	IBC 21/ASCE ASD 4 (A)

DEFLECTION

	Equation
7	DL = DL
8	LL = LL
9	DL+LL = DL + LL
10	DL+LL = DL

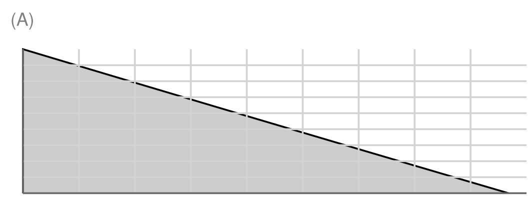
DIAGRAMS

All diagrams display the governing load combination.



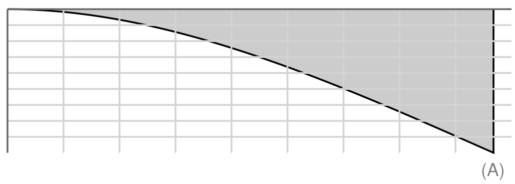
(A): 0.328 (max) at 0 ft (B): 0.32 (min) at 3 ft

Shear [k]
1.2 DL + 1.6 LL



(A): 0.971 (max) at 0 ft

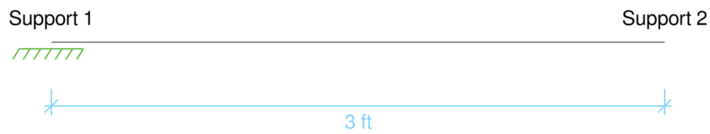
Moment [k-ft]
1.2 DL + 1.6 LL



(A): -0.546 (min) at 3 ft

Deflection [in]
1.2 DL + 1.6 LL

REACTIONS



Envelope Reactions

	Min/Max	Horizontal (k)	Vertical (k)	Moment (k-ft)
Support 1 (@ 0 ft)	Max	0 (IBC 21/ASCE STRENGTH 1)	0 (IBC 21/ASCE 4 (A))	0.971 (IBC 21/ASCE STRENGTH 1 POST)
	Max	0 (IBC 21/ASCE STRENGTH 1)	-0.328 (IBC 21/ASCE STRENGTH 1 POST)	0.971 (IBC 21/ASCE STRENGTH 1 POST)

Load Category Reactions

	Load Category	Horizontal (k)	Vertical (k)	Moment (k-ft)
Support 1 (@ 0 ft)	DL	0	-0.006	0.009
	LL	0	-0.2	0.6
	LLS	0	0	0
	RLL	0	0	0
	SL	0	0	0

CALCULATIONS

Limit State	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	-	-	-	-
Applied Loading - Shear	-	-	-	-
Axial Tension Analysis	0 k	23.625 k	-	-
Axial Compression Analysis	0 k	19.15 k	-	-
Flexural Analysis	0.971 k-ft	1.025 k-ft	-	-
Shear Analysis	0.328 k	5.063 k	0.06	Pass
Bending & Axial Interaction Check (UC Bending Max)	-	-	0.95	Pass
Deflection Check	-	-	0.57	Pass

Deflection Check

	DL	LL	DL + LL
Deflection	0.004 in	0.338 in	0.342 in
Location	3 ft	3 ft	3 ft
2L/Δ Ratio	18009.9	213	210.5
L/Δ Limit (user input)	120	120	120
Unity Check	0.01	0.56	0.57

PROPERTIES

INPUT DATA

Shape	RT1x1x0.095	**Member Type**	Beam	**Length**	4 ft
Rotate (deg)	0	**Material Type**	Aluminum		

MATERIAL PROPERTIES

Material	6061-T6 W	**E**	10100 ksi	**G**	3787.5 ksi
Table	Table B.4-1	**Ftu**	24 ksi	**Fcy**	15 ksi
Ct	141	**Density**	0.173 k/ft^3	**Nu**	0.33
Kt	1	**Fty**	15 ksi	**Fsu**	15 ksi

SHAPE PROPERTIES

A	0.344 in^2	**d**	1 in^1	**t**	0.095 in^1
b_f	1 in^1	I_{ZZ}	0.0475 in^4	I_{YY}	0.0475 in^4
S_{ZZ}	0.0949 in^3	S_{YY}	0.0949 in^3	**J**	0.0704 in^4

DESIGN PROPERTIES

$L_{b\ out}$	4 ft	$L_{b\ in}$	4 ft	L_{torque}	4 ft
$L_{comp\ top}$	4 ft	$L_{comp\ bot}$	4 ft	K_{in}	1
C_b	Autocalc				

LOADS

POINT LOADS

Load Category	Magnitude (k, k-ft)	Location (ft, %)	Direction
LL	0.05	2	↓

LOAD COMBINATIONS

IBC 2021 Load combinations include self weight.

STRENGTH

	Equation	Code
1	1.4 DL	IBC 21/ASCE STRENGTH 1
2	1.2 DL + 1.6 LL	IBC 21/ASCE STRENGTH 2 (A)
3	1.2 DL + 0.5 LL	IBC 21/ASCE STRENGTH 3 (A)

ASD

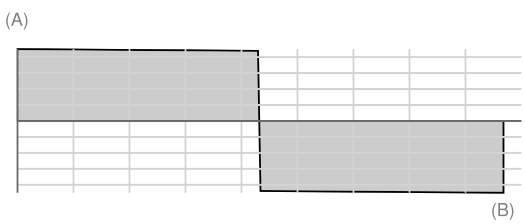
	Equation	Code
4	1 DL	IBC 21/ASCE ASD 1
5	1 DL + 1 LL	IBC 21/ASCE ASD 2
6	1 DL + 0.75 LL	IBC 21/ASCE ASD 4 (A)

DEFLECTION

	Equation
7	DL = DL
8	LL = LL
9	DL+LL = DL + LL
10	DL+LL = DL

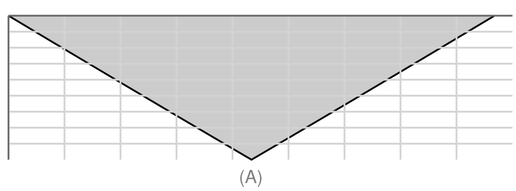
DIAGRAMS

All diagrams display the governing load combination.



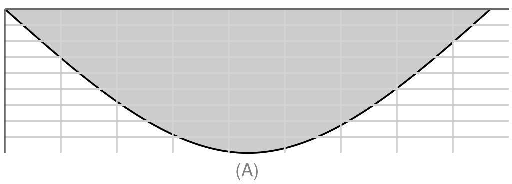
(A): 0.041 (max) at 0 ft (B): -0.041 (min) at 4 ft

Shear [k]
1.2 DL + 1.6 LL



(A): -0.081 (min) at 2 ft

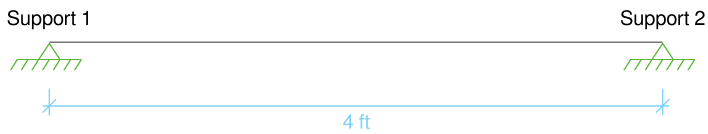
Moment [k-ft]
1.2 DL + 1.6 LL



(A): -0.39 (min) at 2 ft

Deflection [in]
1.2 DL + 1.6 LL

REACTIONS



Envelope Reactions

	Min/Max	Horizontal (k)	Vertical (k)	Moment (k-ft)
Support 1 (@ 0 ft)	Max	0 (IBC 21/ASCE STRENGTH 1)	0 (IBC 21/ASCE 4 (A))	0 (IBC 21/ASCE STRENGTH 1)
	Max	0 (IBC 21/ASCE STRENGTH 1)	-0.041 (IBC 21/ASCE STRENGTH 1 POST)	0 (IBC 21/ASCE STRENGTH 1)
Support 2 (@ 4 ft)	Max	0 (IBC 21/ASCE STRENGTH 1)	0 (IBC 21/ASCE 4 (A))	0 (IBC 21/ASCE STRENGTH 1)
	Max	0 (IBC 21/ASCE STRENGTH 1)	-0.041 (IBC 21/ASCE STRENGTH 1 POST)	0 (IBC 21/ASCE STRENGTH 1)

Load Category Reactions

	Load Category	Horizontal (k)	Vertical (k)	Moment (k-ft)
Support 1 (@ 0 ft)	DL	0	-0.001	0
	LL	0	-0.025	0
	LLS	0	0	0
	RLL	0	0	0
	SL	0	0	0
Support 2 (@ 4 ft)	DL	0	-0.001	0
	LL	0	-0.025	0
	LLS	0	0	0
	RLL	0	0	0
	SL	0	0	0

CALCULATIONS

Limit State	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	-	-	-	-
Applied Loading - Shear	-	-	-	-
Axial Tension Analysis	0 k	4.644 k	-	-
Axial Compression Analysis	0 k	1.579 k	-	-
Flexural Analysis	0.081 k-ft	0.107 k-ft	-	-
Shear Analysis	0.041 k	1.1 k	0.04	Pass
Bending & Axial Interaction Check (UC Bending Max)	-	-	0.76	Pass
Deflection Check	-	-	0.61	Pass

Deflection Check

	DL	LL	DL + LL
Deflection	0.005 in	0.24 in	0.245 in
Location	2 ft	2 ft	2 ft
L/Δ Ratio	9673.7	199.9	195.8
L/Δ Limit (user input)	120	120	120
Unity Check	0.01	0.6	0.61

www.hilti.com

Company:		Page:	
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Masonry - Jan 7, 2026	Date:	1/8/2026
Fastening point:			

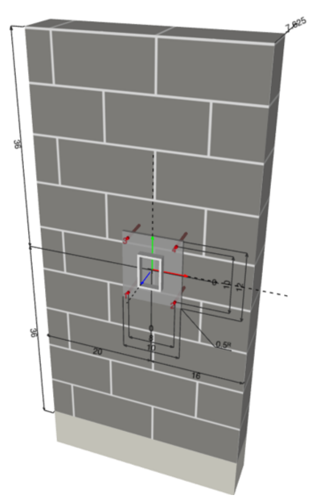
Specifier's comments:

1 Input data

Anchor type and diameter:	**KWIK HUS-EZ (KH-EZ) (Carbon Steel) 1/2 (4 1/4)**
Item number:	418076 KH-EZ 1/2"x5"
Specification text:	Hilti ∅ 1/2 (4 1/4) KWIK HUS-EZ (KH-EZ) (Carbon Steel) with 4.25 in nominal embedment depth per Technical data , Hammer drilled installation per MPII
Effective embedment depth:	h_{ef} = 4.250 in.
Material:	Carbon Steel
Evaluation Service Report:	Hilti Technical Data
Issued I Valid:	- | -
Proof:	Design Method ASD Masonry
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.500 in.
Anchor plate^R :	l_x x l_y x t = 10.000 in. x 12.000 in. x 0.500 in.; (Recommended plate thickness: not calculated)
Profile:	Rectangular HSS (AISC), HSS6X4X.375; (L x W x T) = 6.000 in. x 4.000 in. x 0.375 in.
Base material:	Grout-filled CMU, L x W x H: 16.000 in. x 8.000 in. x 8.000 in.;
	Joints: vertical: 0.375 in.; horizontal: 0.375 in.
	Base material temperature: 68 °F
Installation:	Face installation
Seismic loads	no

^{R} - The anchor calculation is based on a rigid anchor plate assumption.

Geometry [in.]

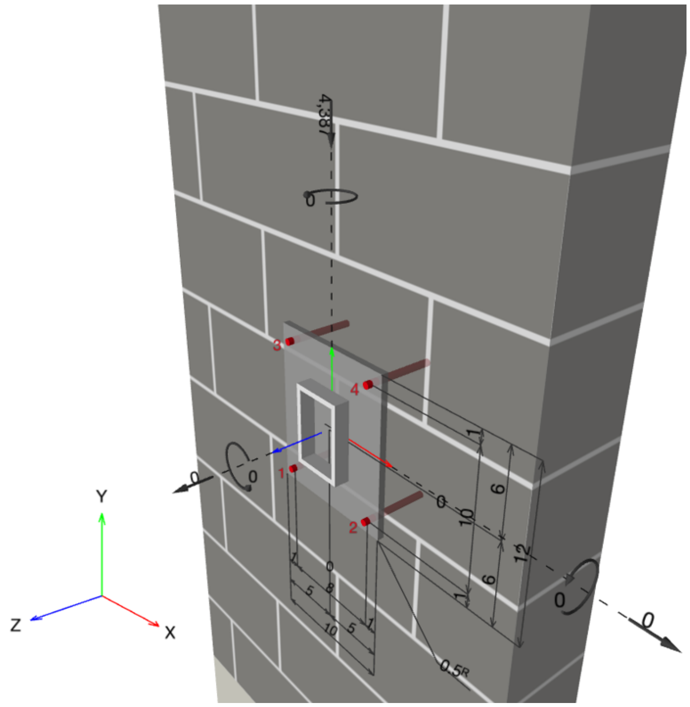


PROFIS Engineering (c) 2003-2026 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

www.hilti.com

Company:		Page:	
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Masonry - Jan 7, 2026	Date:	1/8/2026
Fastening point:			

Geometry [in.] & Loading [lb, in.lb]



1.1 Design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 0; V_x = 0; V_y = -4,387; M_x = 0; M_y = 0; M_z = 0;	no	56

2 Load case/Resulting anchor forces

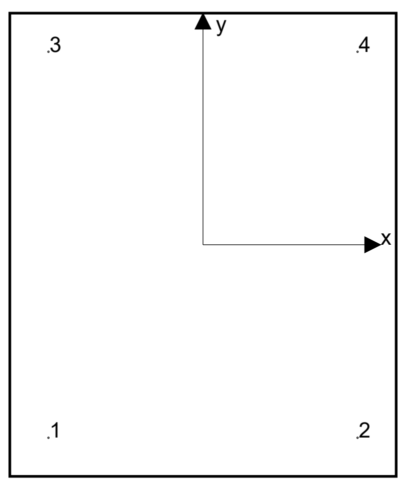
Load case: Service loads

Anchor reactions [lb]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	0	1,097	0	-1,097
2	0	1,097	0	-1,097
3	0	1,097	0	-1,097
4	0	1,097	0	-1,097

max. compressive strain: - [‰]
max. compressive stress: - [psi]
Resulting tension force in (x/y)=(-/-): 0 [lb]
Resulting compression force in (x/y)=(-/-): 0 [lb]



Anchor forces are calculated based on the assumption of a rigid anchor plate.

PROFIS Engineering (c) 2003-2026 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

Company:		Page:	
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Masonry - Jan 7, 2026	Date:	1/8/2026
Fastening point:			

3 Tension load (Most utilized anchor 1)

	Load P_s [lb]	Capacity P_t [lb]	Utilization $\beta_P = P_s/P_t$ [%]	Status
Overall strength	N/A	N/A	N/A	N/A

PROFIS Engineering (c) 2003-2026 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

4 Shear load (Most utilized anchor 1)

	Load V_s [lb]	Capacity V_t [lb]	Utilization $\beta_V = V_s/V_t$ [%]	Status
Overall strength para and perp, (Dir. x-)[1]	-	-	56	OK

[1]Shear utilization may result from parallel and perpendicular shear (see details)

4.1 Overall strength parallel

$V_{t,Base,||}$ = Value refer to Hilti Technical Data

$V_{t,||} = V_{t,Base,||} \cdot f_{red,E,||} \cdot f_{red,s,||} \cdot f_{red,Temp}$

$V_{t,||} \geq V_{s,||}$

Variables

c_{min} [in.]	c_{cr} [in.]	s_{min} [in.]	s_{cr} [in.]	Temperature [°F]
4.000	8.000	4.000	8.000	68

Results

$V_{t,||}$ [lb]	$V_{t,Base,||}$ [lb]	$V_{s,||}$ [lb]	$f_{red,E,||}$	$f_{red,S,||}$	$f_{red,Temp}$	Utilization $\beta_{V,||}$ [%]
1,959	1,959	-1,097	1.000	1.000	1.000	56

4.2 Overall strength perpendicular

$V_{t,Base,\perp}$ = Value refer to Hilti Technical Data

$V_{t,\perp} = V_{t,Base,\perp} \cdot f_{red,E,\perp} \cdot f_{red,s,\perp} \cdot f_{red,Temp}$

$V_{t,\perp} \geq V_{s,\perp}$

Variables

c_{min} [in.]	c_{cr} [in.]	s_{min} [in.]	s_{cr} [in.]	Temperature [°F]
4.000	8.000	4.000	8.000	68

Results

$V_{t,\perp}$ [lb]	$V_{t,Base,\perp}$ [lb]	$V_{s,\perp}$ [lb]	$f_{red,E,\perp}$	$f_{red,S,\perp}$	$f_{red,Temp}$	Utilization $\beta_{V,\perp}$ [%]
0	1,959	0	0.000	0.000	1.000	0

4.3 Shear interaction

$\beta_{V,||} = \frac{V_{s,||}}{V_{t,||}}$	$\beta_{V,\perp} = \frac{V_{s,\perp}}{V_{t,\perp}}$	δ	Utilization β_V [%]	Status
0.560	0.000	1.667	56	OK

$\beta_V = \beta_{V,||}^{\delta} + \beta_{V,\perp}^{\delta} <= 1.0$

Input data and results must be checked for conformity with the existing conditions and for plausibility!
PROFIS Engineering (c) 2003-2026 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

5 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (EN1992-4, AS5216, etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with FEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- The equations presented in this report are based on imperial units. When inputs are displayed in metric units, the user should be aware that the equations remain in their imperial format.
- Refer to the manufacturer's product literature for cleaning and installation instructions.
- The min. sizes of the bricks, the masonry compressive strength, the type / strength of the mortar and the grout (in case of fully grouted CMU walls) has to fulfill the requirements given in the relevant ESR-approval or in the PTG.
- Only the local load transfer from the anchor(s) to the wall is considered, a further load transfer in the wall is not covered by PROFIS!
- Wall is assumed as being perfectly aligned vertically – checking required(!): Noncompliance can lead to significantly different distribution of forces and higher tension loads than those calculated by PROFIS. Masonry wall must not have any damages (neither visible nor not visible)! While installation, the positioning of the anchors needs to be maintained as in the design phase i.e. either relative to the brick or relative to the mortar joints.
- The effect of the joints on the compressive stress distribution on the plate / bricks was not taken into consideration.
- If no significant resistance is felt over the entire depth of the hole when drilling (e.g. in unfilled butt joints), the anchor should not be set at this position or the area should be assessed and reinforced. Hilti recommends the anchoring in masonry always with sieve sleeve. Anchors can only be installed without sieve sleeves in solid bricks when it is guaranteed that it has not any hole or void.
- The accessories and installation remarks listed on this report are for the information of the user only. In any case, the instructions for use provided with the product have to be followed to ensure a proper installation.
- The compliance with current standards (e.g. 2018, 2015, 2012, 2009 and 2006 IBC) is the responsibility of the user.
- Drilling method (hammer, rotary) to be in accordance with the approval!
- Masonry should be built according to industry standards.

Fastening meets the design criteria!

PROFIS Engineering (c) 2003-2026 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

Company:		Page:	
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Masonry - Jan 7, 2026	Date:	1/8/2026
Fastening point:			

6 Installation data

Profile: Rectangular HSS (AISC), HSS6X4X.375; (L x W x T) = 6.000 in. x 4.000 in. x 0.375 in.

Hole diameter in the fixture: d_f = - in.

Plate thickness (input): 0.500 in.

Drilling method: Drilled in hammer mode

Anchor type and diameter: KWIK HUS-EZ (KH-EZ) (Carbon Steel) 1/2 (4 1/4)

Item number: 418076 KH-EZ 1/2"x5"

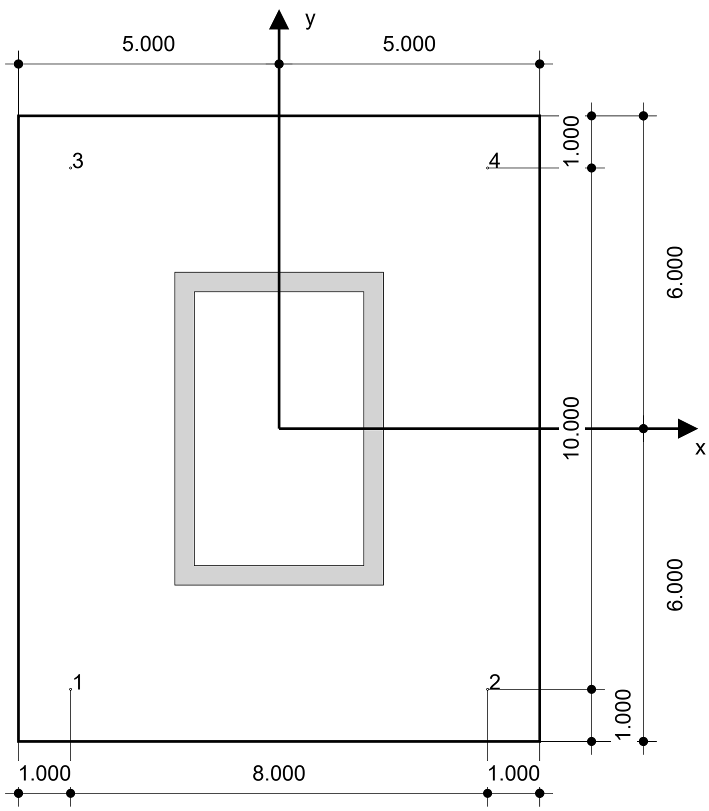
Maximum installation torque: 408 in.lb

Hole diameter in the base material: 0.500 in.

Hole depth in the base material: 4.625 in.

Minimum thickness of the base material: 7.625 in.

Hilti ∅ 1/2 (4 1/4) KWIK HUS-EZ (KH-EZ) (Carbon Steel) with 4.25 in nominal embedment depth per Technical data , Hammer drilled installation per MPII



Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-4.000	-5.000	16.000	20.000	31.000	41.000
2	4.000	-5.000	24.000	12.000	31.000	41.000
3	-4.000	5.000	16.000	20.000	41.000	31.000
4	4.000	5.000	24.000	12.000	41.000	31.000

PROFIS Engineering (c) 2003-2026 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

Company:		Page:	
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - Jan 7, 2026	Date:	1/7/2026
Fastening point:			

Specifier's comments:

1 Input data

Anchor type and diameter:	**KWIK HUS-EZ (KH-EZ) (Carbon Steel) 1/2 (5 1/2)**
Item number:	418077 KH-EZ 1/2"x6"
Specification text:	Hilti ∅ 1/2 in KWIK HUS-EZ (KH-EZ) (Carbon Steel) with 5.5 in nominal embedment depth per ICC-ES ESR-3027 , Hammer drill bit installation per MPII
Effective embedment depth:	$h_{ef,act}$ = 4.280 in., h_{nom} = 5.500 in.
Material:	Carbon Steel
Evaluation Service Report:	ESR-3027
Issued I Valid:	12/1/2023 | 12/1/2025
Proof:	Design Method ACI 318-19 / Mech
Shear edge breakout verification:	Row closest to edge (Case 3 only from ACI 318-19 Fig. R.17.7.2.1b)
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.375 in.
Anchor plate^R :	l_x x l_y x t = 24.000 in. x 4.000 in. x 0.375 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 3000, f_c' = 3,000 psi; h = 420.000 in.
Installation:	**Hammer drilled hole, Installation condition: Dry**
Reinforcement:	tension: not present, shear: not present; no supplemental splitting reinforcement present
	edge reinforcement: none or < No. 4 bar

Application also possible with KWIK-X (Carbon Steel) 1/2 (4 1/4) hnom2 under the selected boundary conditions.
More information in section Alternative fastening data of this report.

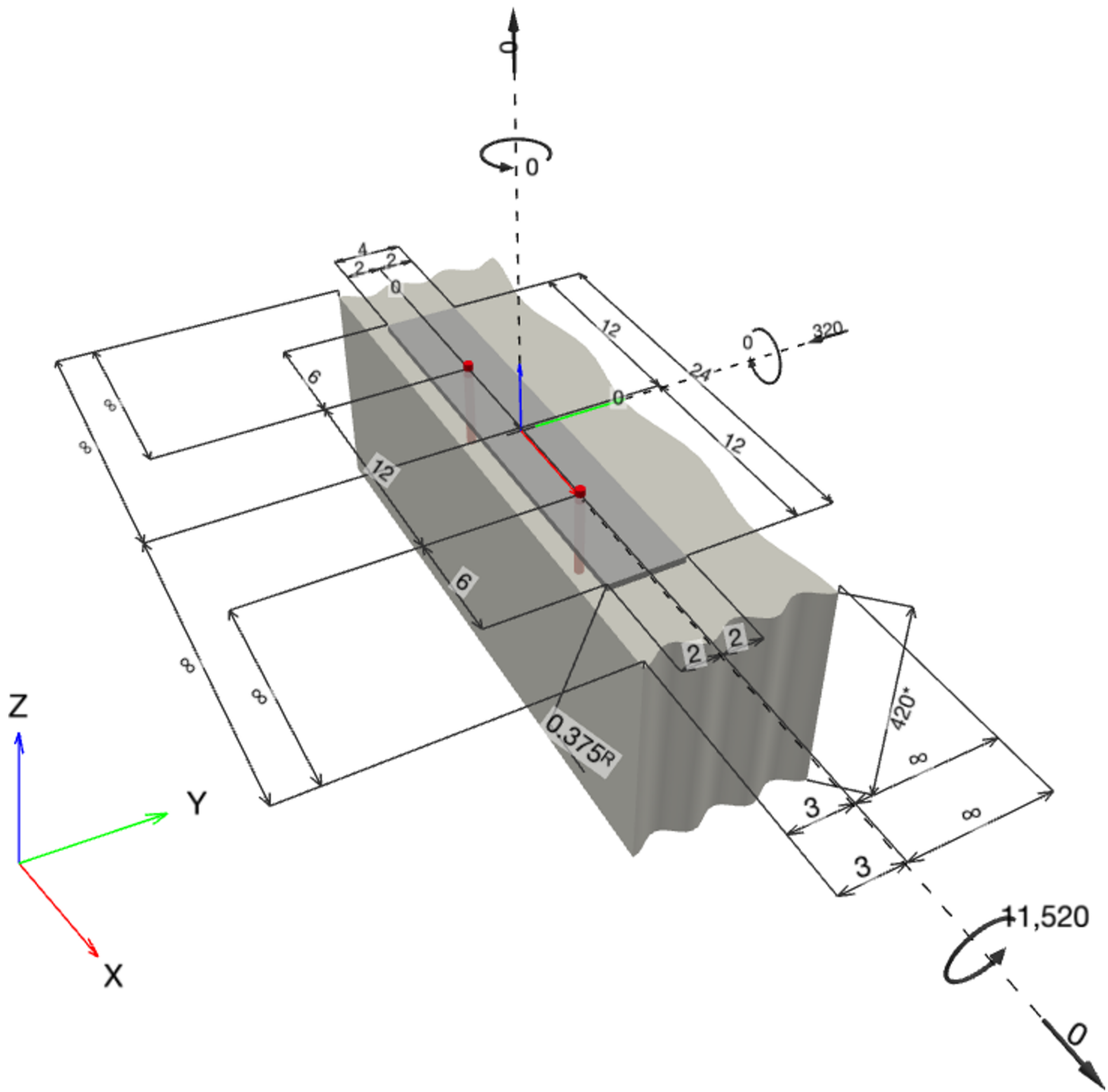
^{R} - The anchor calculation is based on a rigid anchor plate assumption.

Input data and results must be checked for conformity with the existing conditions and for plausibility!
PROFIS Engineering (c) 2003-2026 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

www.hilti.com

Company:		Page:	
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - Jan 7, 2026	Date:	1/7/2026
Fastening point:			

Geometry [in.] & Loading [lb, in.lb]



1.1 Design results

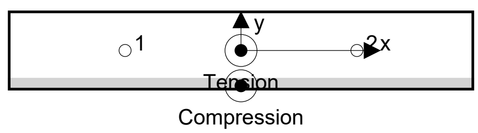
Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 0; V_x = 0; V_y = -320; M_x = 11,520; M_y = 0; M_z = 0;	no	99

2 Load case/Resulting anchor forces

Anchor reactions [lb]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	3,151	160	0	-160
2	3,151	160	0	-160



Max. concrete compressive strain: 0.23 [‰]
Max. concrete compressive stress: 1,019 [psi]
Resulting tension force in (x/y)=(-0.000/0.000): 6,301 [lb]
Resulting compression force in (x/y)=(-0.000/-1.828): 6,301 [lb]

Anchor forces are calculated based on the assumption of a rigid anchor plate.

3 Tension load

	Load N_{ua} [lb]	**Capacity ϕ N_n [lb]**	**Utilization $\beta_N = N_{ua}/\phi$ N_n**	**Status**
Steel Strength*	3,151	11,778	27	OK
Pullout Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Failure**	6,301	6,391	99	OK

* highest loaded anchor **anchor group (anchors in tension)

Input data and results must be checked for conformity with the existing conditions and for plausibility!
PROFIS Engineering (c) 2003-2026 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

3.1 Steel Strength

N_{sa} = ESR value — refer to ICC-ES ESR-3027

$\phi\ N_{sa} \geq N_{ua}$ — ACI 318-19 Table 17.5.2

Variables

$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
0.16	112,540

Calculations

N_{sa} [lb]
18,120

Results

N_{sa} [lb]	ϕ_{steel}	$\phi\ N_{sa}$ [lb]	N_{ua} [lb]
18,120	0.650	11,778	3,151

3.2 Concrete Breakout Failure

$N_{cbg} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ec,N}\ \psi_{ed,N}\ \psi_{c,N}\ \psi_{cp,N}\ N_b$ — ACI 318-19 Eq. (17.6.2.1b)

$\phi\ N_{cbg} \geq N_{ua}$ — ACI 318-19 Table 17.5.2

A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$A_{Nc0} = 9\ h_{ef}^2$ — ACI 318-19 Eq. (17.6.2.1.4)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\ e_N'}{3\ h_{ef}}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.3.1)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5h_{ef}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.4.1b)

$\psi_{cp,N} = \mathrm{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5h_{ef}}{c_{ac}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.6.1b)

$N_b = k_c\ \lambda_a\ \sqrt{f_c'}\ h_{ef}^{1.5}$ — ACI 318-19 Eq. (17.6.2.2.1)

Variables

h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
4.280	0.000	0.000	3.000	1.000

c_{ac} [in.]	k_c	λ_a	f_c' [psi]
17.100	17	1.000	3,000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
233.99	164.87	1.000	1.000	0.840	1.000	8,245

Results

N_{cbg} [lb]	$\phi_{concrete}$	$\phi\ N_{cbg}$ [lb]	N_{ua} [lb]
9,832	0.650	6,391	6,301

Input data and results must be checked for conformity with the existing conditions and for plausibility!
PROFIS Engineering (c) 2003-2026 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

4 Shear load

	Load V_{ua} [lb]	Capacity ϕ V_n [lb]	Utilization $\beta_V = V_{ua}/\phi\ V_n$	Status
Steel Strength*	160	5,547	3	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength**	320	13,764	3	OK
Concrete edge failure in direction y-**	320	2,989	11	OK

* highest loaded anchor **anchor group (relevant anchors)
When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

4.1 Steel Strength

V_{sa} = ESR value refer to ICC-ES ESR-3027
$\phi\ V_{steel} \geq V_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,V}$ [in.^{2}]	f_{uta} [psi]
0.16	112,540

Calculations

V_{sa} [lb]
9,245

Results

V_{sa} [lb]	ϕ_{steel}	$\phi\ V_{sa}$ [lb]	V_{ua} [lb]
9,245	0.600	5,547	160

PROFIS Engineering (c) 2003-2026 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

4.2 Pryout Strength

$V_{cpg} = k_{cp} \left[\left(\frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ec,N}\ \psi_{ed,N}\ \psi_{c,N}\ \psi_{cp,N}\ N_b \right]$ ACI 318-19 Eq. (17.7.3.1b)

$\phi\ V_{cpg} \geq V_{ua}$ ACI 318-19 Table 17.5.2

A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$A_{Nc0} = 9\ h_{ef}^2$ ACI 318-19 Eq. (17.6.2.1.4)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\ e'_N}{3\ h_{ef}}} \right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.3.1)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.4.1b)

$\psi_{cp,N} = \mathrm{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.6.1b)

$N_b = k_c\ \lambda_a\ \sqrt{f'_c}\ h_{ef}^{1.5}$ ACI 318-19 Eq. (17.6.2.2.1)

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
2	4.280	0.000	0.000	3.000

$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f'_c [psi]
1.000	17.100	17	1.000	3,000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
233.99	164.87	1.000	1.000	0.840	1.000	8,245

Results

V_{cpg} [lb]	$\phi_{concrete}$	$\phi\ V_{cpg}$ [lb]	V_{ua} [lb]
19,663	0.700	13,764	320

PROFIS Engineering (c) 2003-2026 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

4.3 Concrete edge failure in direction y-

$V_{cbg} = \left(\frac{A_{Vc}}{A_{Vc0}}\right) \psi_{ec,V}\ \psi_{ed,V}\ \psi_{c,V}\ \psi_{h,V}\ \psi_{parallel,V}\ V_b$ ACI 318-19 Eq. (17.7.2.1b)

$\phi\ V_{cbg} \geq V_{ua}$ ACI 318-19 Table 17.5.2

A_{Vc} see ACI 318-19, Section 17.7.2.1, Fig. R 17.7.2.1(b)*

$A_{Vc0} = 4.5\ c_{a1}^2$ ACI 318-19 Eq. (17.7.2.1.3)

$\psi_{ec,V} = \left(\frac{1}{1 + \frac{e_V'}{1.5c_{a1}}}\right) \leq 1.0$ ACI 318-19 Eq. (17.7.2.3.1)

$\psi_{ed,V} = 0.7 + 0.3\left(\frac{c_{a2}}{1.5c_{a1}}\right) \leq 1.0$ ACI 318-19 Eq. (17.7.2.4.1b)

$\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0$ ACI 318-19 Eq. (17.7.2.6.1)

$V_b = \left(7 \left(\frac{l_e}{d_a}\right)^{0.2} \sqrt{d_a}\right) \lambda_a \sqrt{f_c'}\ c_{a1}^{1.5}$ ACI 318-19 Eq. (17.7.2.2.1a)

Variables

c_{a1} [in.]	c_{a2} [in.]	e_{cV} [in.]	$\psi_{c,V}$	h_a [in.]
3.000	-	0.000	1.000	420.000

l_e [in.]	λ_a	d_a [in.]	f_c' [psi]	$\psi_{parallel,V}$
4.000	1.000	0.500	3,000	1.000

Calculations

A_{Vc} [in.^{2}]	A_{Vc0} [in.^{2}]	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{h,V}$	V_b [lb]
81.00	40.50	1.000	1.000	1.000	2,135

Results

V_{cbg} [lb]	$\phi_{concrete}$	$\phi\ V_{cbg}$ [lb]	V_{ua} [lb]
4,270	0.700	2,989	320

*Anchor row defined by: Anchor 1, 2; Case 3 controls

When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

5 Combined tension and shear loads, per ACI 318-19 section 17.8

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.986	0.107	1.000	92	OK

$\beta_{NV} = (\beta_N + \beta_V) / 1.2 <= 1$

Input data and results must be checked for conformity with the existing conditions and for plausibility!
PROFIS Engineering (c) 2003-2026 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

www.hilti.com

Company:		Page:	
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - Jan 7, 2026	Date:	1/7/2026
Fastening point:			

6 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (EN1992-4, AS5216, etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with FEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- The equations presented in this report are based on imperial units. When inputs are displayed in metric units, the user should be aware that the equations remain in their imperial format.
- Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.
- Refer to the manufacturer's product literature for cleaning and installation instructions.
- For additional information about ACI 318 strength design provisions, please go to https://viewer.joomag.com/profis-design-guide-us-en-summer-2021/0841849001625154758?short&/
- Hilti post-installed anchors shall be installed in accordance with the Hilti Manufacturer's Printed Installation Instructions (MPII). Reference ACI 318-19, Section 26.7.

Fastening meets the design criteria!

PROFIS Engineering (c) 2003-2026 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

7 Installation data

Anchor type and diameter: KWIK HUS-EZ (KH-EZ) (Carbon Steel) 1/2 (5 1/2)

Item number: 418077 KH-EZ 1/2"x6"

Maximum installation torque: 600 in.lb

Hole diameter in the base material: 0.500 in.

Hole depth in the base material: 5.875 in.

Minimum thickness of the base material: 8.750 in.

Profile: no profile

Hole diameter in the fixture: d_f = 0.625 in.

Plate thickness (input): 0.375 in.

Recommended plate thickness: not calculated

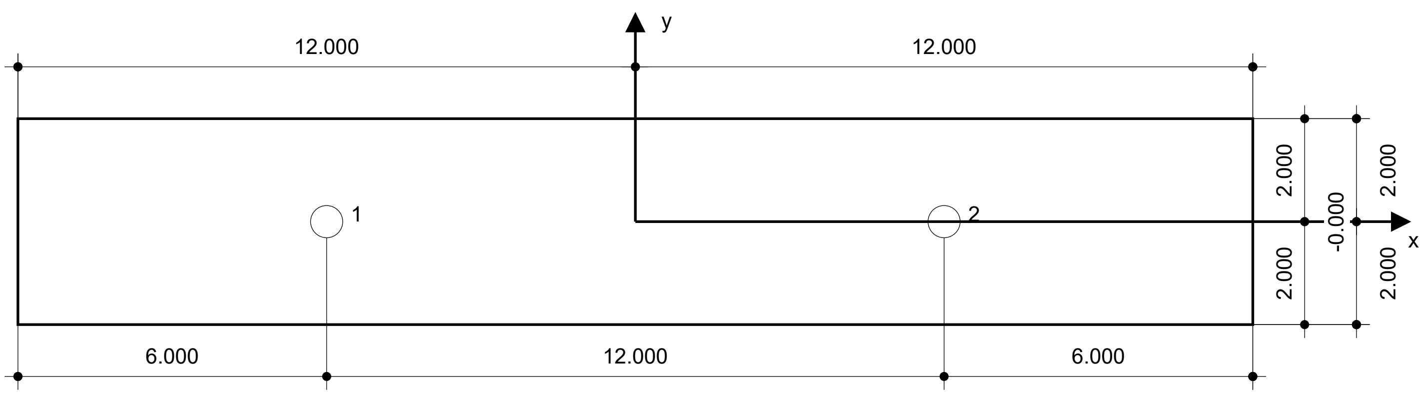
Drilling method: Hammer drilled

Cleaning: Manual cleaning of the drilled hole according to instructions for use is required.

Hilti ∅ 1/2 in KWIK HUS-EZ (KH-EZ) (Carbon Steel) with 5.5 in nominal embedment depth per ICC-ES ESR-3027 , Hammer drill bit installation per MPII

7.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit	• Manual blow-out pump	• Torque wrench



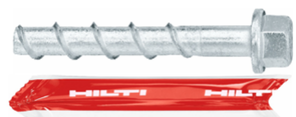
Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-6.000	0.000	-	-	3.000	-
2	6.000	-0.000	-	-	3.000	-

Input data and results must be checked for conformity with the existing conditions and for plausibility!
PROFIS Engineering (c) 2003-2026 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

8 Alternative fastening

8.1 Alternative fastening data



Anchor type and diameter:	**KWIK-X (Carbon Steel) 1/2 (4 1/4) hnom2**
Item number:	418076 KH-EZ 1/2"x5" (element) / 2362252 KHC 1/2" LARGE (capsule)
Specification text:	Hilti ∅ 1/2 in KWIK HUS-EZ (KH-EZ) (Carbon Steel) with 5.5 in nominal embedment depth per ICC-ES ESR-3027 , Hammer drill bit installation per MPII
Effective embedment depth:	$h_{ef,act}$ = 4.280 in. ($h_{ef,limit}$ = - in.), h_{nom} = 4.280 in.
Material:	Carbon Steel
Evaluation Service Report:	ESR-5065
Issued I Valid:	10/1/2025 | 12/1/2025
Proof:	Design Method ACI 318-19 / Chem
Shear edge breakout verification:	Row closest to edge (Case 3 only from ACI 318-19 Fig. R.17.7.2.1b)
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.375 in.
Anchor plate^R :	l_x x l_y x t = 24.000 in. x 4.000 in. x 0.375 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 3000, f_c' = 3,000 psi; h = 420.000 in., Temp. short/long: 32/32 °F
Installation:	**Hammer drilled hole, Installation condition: Dry**
Reinforcement:	tension: not present, shear: not present; no supplemental splitting reinforcement present
	edge reinforcement: none or < No. 4 bar

Max. Utilization with KWIK-X (Carbon Steel) 1/2 (4 1/4) hnom2: 99 %
Fastening meets the design criteria!

PROFIS Engineering (c) 2003-2026 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

8.2 Installation data

Profile: no profile	Anchor type and diameter: KWIK-X (Carbon Steel) 1/2 (4 1/4) hnom2 Item number: 418076 KH-EZ 1/2"x5" (element) / 2362252 KHC 1/2" LARGE (capsule)
Hole diameter in the fixture: d_f = 0.625 in.	Maximum installation torque: -
Plate thickness (input): 0.375 in.	Hole diameter in the base material: 0.500 in.
Recommended plate thickness: not calculated	Hole depth in the base material: 5.280 in.
Drilling method: Hammer drilled	Minimum thickness of the base material: 6.530 in.
Cleaning: No cleaning of the drilled hole is required	

Hilti ∅ 1/2 in KWIK-X (Carbon Steel) with KH-EZ with KHC 1/2" LARGE with 4.28 in nominal embedment depth per ICC-ES ESR-5065, Hammer drill bit installation per MPII

8.2.1 Recommended accessories

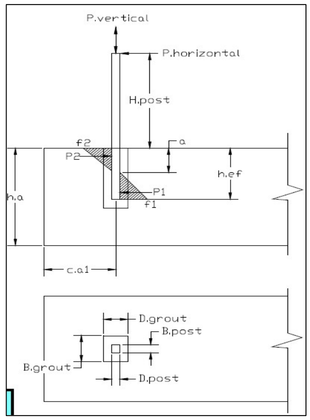
Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit	• No accessory required	• SIW 6-A22 Impact Screw Driver

PROFIS Engineering (c) 2003-2026 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

STRUCTURAL ANALYSIS

DESIGN CRITERIA : 2023 FLORIDA BUILDING CODE

POST ANCHORAGE TO CONCRETE



P	200	lbs
H_{post}	36	in
M	7200	lbs-in
V	200	lbs

POST DATA

B_{post}	1.66	Post Width (in)
D_{post}	1.66	Post Depth (in)
h_{ef}	4.50	Post Embedment (in)
C_{al}	4.00	Minimum Edge Distance (in)

GROUP SIZE DATA

B_{grout}	3.5	Equivalent Grout Width (in)
D_{grout}	4	Equivalent Grout Depth (in)
$f'c_{grout}$	5000.00	Group strength (psi)

CONCRETE SLAB DATA

$f'c_{concrete}$	3000.00	Concrete strength (psi)
d_0	4.00	Hold diameter (Grout diameter) (in)
h_a	8.00	Concrete Slab Deep (in)

EQUIVALENT ACTUAL HORIZONTAL LOAD AT TOP TOP RAILING HEIGHT (Pd)

$$Pd = \frac{M_{PT}}{H_{post}}$$

P_d	=	200	lbs

Arm Effect:

$$a = \frac{2.h_{ef}^2 + 3.H_{post}.h_{ef}}{3.h_{ef} + 6.H_{post}}$$

a	=	2.294	in

$$P_2 = \frac{Pd.a^2}{h_{ef}.(2.a - h_{ef})}$$

P_2	=	2650.98	lbs

$$P_1 = P_2 - P_d$$

P_1	=	2450.98	lbs

$$M_{external} = P_d.(H_{post} + a)$$

$M_{external}$	=	7658.82	lbs-in

$$M_{internal} = P_2.\frac{2}{3}.a + P_1.\frac{2}{3}.(h_{ef} - a)$$

$M_{internal}$	=	7658.82	lbs-in

$$V_u = 1.6 * (\max(P_1, P_2))$$

V_u	=	4241.57	lbs

STRESS ANALYSIS BETWEEN POST AND GROUT

$$f_{2.grout} = 1.6 * \frac{2 * P_2}{a * B_{post}}$$

$f_{2.grout}$	=	2227.58	psi

$$f_{1.grout} = 1.6 * \frac{2.P_1}{(h_{ef} - a) * B_{post}}$$

$f_{1.grout}$	=	2141.90	psi

BEARING STRESS FOR GROUT

$$F_{Pgrout} = \left[0.65 * \left(0.85 f'_{cgrout}\right)\right] * 1.5$$

F_{pgrout}	=	4143.75	psi

$$Stress_{grout} = \left| \begin{matrix} "N.G." \\ "O.K." \end{matrix} \right. \; if \max(f_{1.grout}, f_{2.grout}) \le F_{Pgrout}$$

$Stress_{grout}$	=	O.K.

STRESS ANALYSIS BETWEEN GROUT AND CONCRETE

$$f_{2.concrete} = 1.6 * \frac{2 * P_2}{a * B_{grout}}$$

$f_{2.concrete}$	1056.51	psi

$$f_{1.concrete} = 1.6 * \frac{2 * P_2}{(h_{ef} - a) * B_{grout}}$$

$f_{1.concrete}$	1015.87	psi

BEARING STRESS FOR CONCRETE

$$F_{Pconcrete} = \left[0.65 * \left(0.85 f'_{cconcrete}\right)\right] * 1.5$$

$F_{pconcrete}$	2486.25	psi

$$Stress_{concrete} = \left| \begin{matrix} "N.G." \\ "O.K." \; if \max(f_{1grout}, f_{2grout}) \le F_{Pgrout} \end{matrix} \right.$$

$Stress_{concrete}$	=	O.K.

SHEAR ANALYSIS-CONCRETE BREAKOUT STRENGTH

$Av_{CO} = 4.5 * C_{al}^2$ | Avco = 72 in^2

$$Av_c = \begin{vmatrix} 2.(1.5 * C_{al}) * h_a \; if \; h_a < 1.5 * C_{al} \\ 2.(1.5 * C_{al}) * (1.5 * C_{al}) \; if \; h_a \geq 1.5 * C_{al} \end{vmatrix}$$

Avc = 72 in^2

$\psi_{ed,V} = 1.00$ Modification factor for edge effect

$\psi_{c,V} = 1.20$ Modification factor in No cracked concrete at service loads

$\psi_{c,V} = 1.40$

Modification factor in cracked concrete with

$\psi_{c,V} = 1.0$ w/ No supplementary reinforcement

$\psi_{c,V} = 1.2$ w/ supplementary reinforcement of a No 4 bar between the anchor and the edge.

$\psi_{c,V} = 1.4$ w/supplementary reinforcement of No bar and stirrups spaced at no more than 4 in.

$l_e = if(h_{ef} > 8 * d_0, 8 * d_0, h_{ef})$ | le = 4.5 in

$V_b = 7 * \left[(\frac{l_e}{d_0})^{0.2} \sqrt{d_0} * \sqrt{f'_{Cconcrete}} * C_{al}^{1.5} \right]$ | Vb = 6280.72 lbs

$V_{cb} = \frac{A_{Vc}}{A_{Vco}} * \psi_{ed.V} * \psi_{c.V} * V_b$ | Vcb = 7536.86 lbs

$\phi = 0.75$

Conditions: | ΦVcb= 5652.64 lbs

$\phi = 0.75$ w/ supplementary reinforcement are crossing concrete failure prism.

$\phi = 0.70$ w/ No supplementary reinforcement are crossing concrete failure prism

$BREAKOUT_{shear} = if(Vu > \phi * V_{cb}, \text{"N.G"}, \text{"OK"})$ | BREAKOUTshear = OK