APPENDIX C: Strength Design Performance values in accordance to 2006 and 2009 IBC

ITW RED HEAD TRUBOLT+ and OVERHEAD TRUBOLT+ EDGE ANCHOR DESIGN INFORMATION TESTED TO ICC-ES AC 193 AND ACI 355.2, IN ACCORDANCE WITH 2006 and 2009 IBC

TRUBOLT+ AND OVERHEAD TRUBOLT+ WEDGE ANCHOR DESIGN INFORMATION[1]

Characteristic	Symbol	Units	Nominal Anchor Diameter (inch)[4]									
			3/8"		1/2"				5/8"		3/4"	
Anchor category	1, 2 or 3	—	1		1				1		1	
Minimum effective embedment depth	h_{ef}	in	1-5/8		2		3-1/4		2-3/4	4-1/4	3-3/4	
Minimum concrete member thickness	h_{min}	in	4	5	4	6	6	8	6	6-1/4	7	8
Critical edge distance	c_{ac}	in	5	3	6	6	7-1/2	6	7-1/2	6-1/2	12	10
Data for Steel Strengths – Tension and Shear												
Minimum specified yield strength	f_y	psi	60,000		55,000				55,000		55,000	
Minimum specified ultimate strength	f_{uta}	psi	75,000		75,000				75,000		75,000	
Effective tensile stress area (neck)	A_{se}	in^2	0.056		0.119				0.183		0.266	
Effective tensile stress area (thread)	A_{se}	in^2	0.075		0.142				0.217		0.332	
Steel strength in tension	N_{sa}	lbf	4,200		8,925				13,725		19,950	
Steel strength in shear, uncracked or cracked concrete[6]	V_{sa}	lbf	1,830		5,175				8,955		14,970	
Steel strength in shear – seismic loads	V_{eq}	lbf	1,545		5,175				8,955		11,775	
Strength reduction factor f for tension, steel failure modes[2]			0.75		0.75				0.75		0.75	
Strength reduction factor f for shear, steel failure modes[2]			0.60		0.65				0.65		0.65	
Data for Concrete Breakout Concrete Pryout Strengths in Tension and Shear												
Effectiveness factor – uncracked concrete	k_{uncr}	—	24		24				24		24	
Effectiveness factor – cracked concrete	k_{cr}	—	17		17				17		17	
Modification factor for cracked and uncracked concrete[3]	$\Psi_{c,N}$	—	1.0		1.0				1.0		1.0	
Coefficient for pryout strength	k_{cp}	—	1.0		1.0		2.0		2.0		2.0	
Load-bearing length of anchor	l_e	in	1.625		2.0		3.25		2.75	4.25	3.75	
Strength reduction factor ϕ for tension, concrete failure modes, Condition B[2]			0.65		0.65				0.65		0.65	
Strength reduction factor ϕ for shear, concrete failure modes, Condition B[2]			0.70		0.70				0.70		0.70	
Data for Pullout Strengths												
Pullout strength, uncracked concrete	$N_{p,uncr}$	lbf	See Footnote[5]		See Footnote[5]		6,540		5,430	8,900	See Footnote[5]	
Pullout strength, cracked concrete	$N_{p,cr}$	lbf	See Footnote[5]		See Footnote[5]				See Footnote[5]		See Footnote[5]	
Pullout strength for seismic loads	N_{eq}	lbf	See Footnote[5]		See Footnote[5]				See Footnote[5]	6,715	See Footnote[5]	
Strength reduction factor f for tension, pullout failure modes, Condition B[2]			See Footnote[5]		0.65				0.65		See Footnote[5]	
Additional Anchor Data												
Axial stiffness in service load range in uncracked concrete	b_{uncr}	lbf/in	100,000		250,000				250,000		250,000	
Axial stiffness in service load range in cracked concrete	b_{cr}	lbf/in	40,000		20,000				20,000		20,000	

For SI: 1 inch = 25.4 mm, 1 in2 = 645.16mm2, 1 lbf = 4.45 N, 1 psi = 0.006895 MPa, 1 lbf • 102/in - 17,500 N/m.

[1] The 1/2", 5/8" and 3/4" diameter Trubolt+ Wedge Anchors are ductile steel elements as defined by ACI 318 D.1. The 3/8" diameter Trubolt+ is considered ductile under tension loading and brittle under shear loading.

[2] All values of ϕ apply to the load combinations of IBC Section 1605.2, ACI 318 Section 9.2 or UBC Section 1612.2. If the load combinations of Appendix C or UBC Section 1909.2 are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.5. For installations where reinforcement that complies with ACI 318 Appendix D requirements for Condition A is present, the appropriate ϕ factor must be determined in accordance with ACI 318 D.4.4.

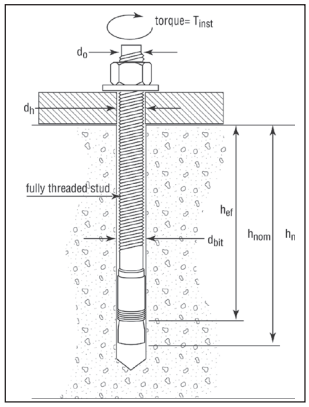
[3] For all design cases $\Psi_{c,N} = 1.0$. The appropriate effectiveness factor for cracked concrete (k_{cr}) or uncracked concrete (k_{uncr}) must be used.

[4] The actual diameter for the 3/8" diameter anchor is 0.361" for the 5/8" diameter anchor is 0.615" and the 3/4" diameter anchor is 0.7482".

[5] Anchor pullout strength does not control anchor design. Determine steel and concrete capacity only.

[6] Steel strength in shear values are based on test results per ACI 355.2, Section 9.4 and must be used for design.

TRUBOLT+ WEDGE ANCHOR (INSTALLED)



TRUBOLT+ AND OVERHEAD TRUBOLT+ WEDGE INSTALLATION INFORMATION

Parameter	Notation	Units	Nominal Achor Diameter (inch)									
			3/8		1/2				5/8		3/4	
Anchor outer diameter	d_o	inches	0.361		0.5				0.615		0.7482	
Nominal carbide bit diameter	d_{bit}	inches	3/8		1/2				5/8		3/4	
Effective embedment depth	h_{ef}	inches	1-5/8		2		3-1/4		2-3/4	4-1/4	3-3/4	
Minimum anchor embedment depth	h_{nom}	inches	2		2-1/2		3-3/4		3-1/4	4-3/4	4-3/8	
Minimum hole depth[1]	h_o	inches	2-1/4		2-3/4		4		3-1/2	5	4-5/8	
Minimum concrete member thickness[1]	h_{min}	inches	4	5	4	6	6	8	6	6-1/4	7	8
Critical edge distance[1]	c_{ac}	In.	5	3	6	6	7-1/2	6	7-1/2	6-1/2	12	10
Minimum anchor spacing[1]	s_{min}	In.	3-1/2	2-1/2	6	5-3/4	4	5-3/4	8	6	6	6
Minimum edge distance[1]	c_{min}	In.	3		6				7-1/2	5	7-1/2	7-1/2
Minimum overall anchor length	l	inches	2-1/2		3-3/4		4-1/2		4-1/4	6	5-1/2	
Installation torque	T_{inst}	ft-lb	30		45				90		110	
Minimum diameter of hole in fastened part	d_h	inches	1/2		5/8				3/4		7/8	

For SI: 1 inch = 25.4 mm, 1 ft-lb = 1.356 N-m.

APPENDIX C: Strength Design Performance values in accordance to 2006 and 2009 IBC

TRUBOLT+ AND *OVERHEAD* TRUBOLT+ WEDGE ANCHOR ALLOWABLE STRESS DESIGN (ASD) VALUES FOR ILLUSTRATIVE PURPOSES

Anchor Notation	Anchor Embedment Depth	Effective Embedment Depth	Allowable Tension Load
	(inches), h_{nom}	(inches), h_{ef}	(lbs)
3/8	2	1-5/8	1,090
1/2	2-1/2	2	1,490
	3-3/4	3-1/4	2,870
5/8	3-1/4	2-3/4	2,385
	4-3/4	4-1/4	3,910
3/4	4-3/8	3-3/4	3,825

For SI: 1 inch = 25.4 mm, 1 ft-lb = 4.45N.
Design Assumptions:
1 Single anchor with static shear load only.
[2] Load combinations from 2006 IBC, Sections 1605.2.1 and 1605.3.1 (no seismic loading).
[3] Thirty percent dead load and 70 percent live load, controlling load combination 1.2D + 1.6L
[4] Calculation of weighted average: 1.2D + 1.6L = 1.2 (0.3) + 1.6 (0.7) = 1.48
[5] Values do not include edge distance or spacing reductions.

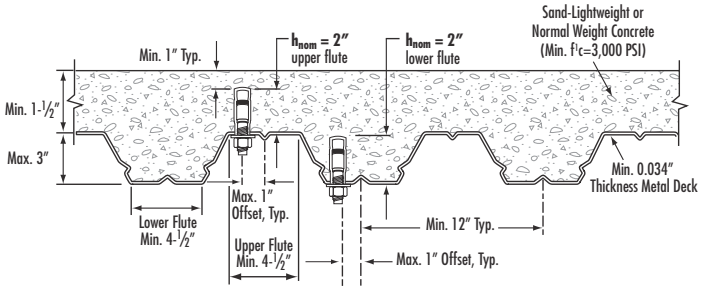
ITW RED HEAD TRUBOLT+ and *OVERHEAD* TRUBOLT+ WEDGE ANCHOR DESIGN INFORMATION FOR INSTALLATION IN THE SOFFIT OF CONCRETE FILL ON METAL DECK FLOOR AND ROOF ASSEMBLIES

TRUBOLT+ AND *OVERHEAD* TRUBOLT+ WEDGE ANCHOR DESIGN INFORMATION

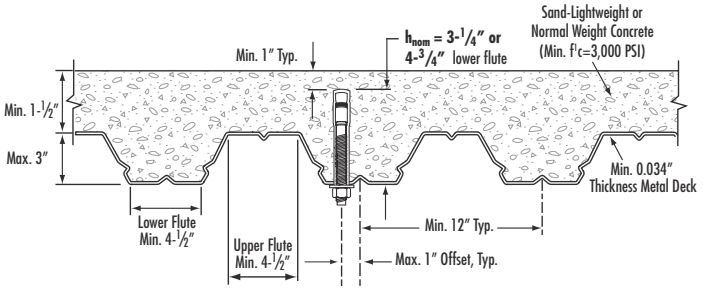
Characteristic	Symbol	Units	Nominal Anchor Diameter				
			3/8"	1/2"		5/8"	
			Upper /Lower	Upper /Lower	Lower Only	Lower Only	Lower Only
			h_{ef} = 1-5/8"	h_{ef} = 2"	h_{ef} = 3-1/4"	h_{ef} = 2-3/4"	h_{ef} = 4-1/4"
Pullout strength, uncracked concrete over metal deck	$N_{p, deck, uncr}$	lbf	2,170	2,515	5,285	3,365	6,005
Pullout strength, cracked concrete over metal deck	$N_{p, deck, cr}$	lbf	1,650	1,780	4,025	2,405	5,025
Reduction factor for pullout strength in tension, Condition B	ϕ	––	0.65				
Shear strength, uncracked concrete over metal deck	$V_{p, deck, uncr}$	lbf	1,640	2,200	3,790	2,890	6,560
Reduction factor for steel strength in shear	ϕ	––	0.60	0.65			
Anchor embedment depth	h_{nom}	in	2.0	2.5	3.75	3.25	4.75

For SI: 1 inch = 25.4 mm, 1 lbf = 4.45 N

Nominal Anchor Diameter = 3/8″



Nominal Anchor Diameter = 5/8″



Nominal Anchor Diameter = 1/2″