4.3.2 HSL-3 Heavy Duty Expansion Anchor

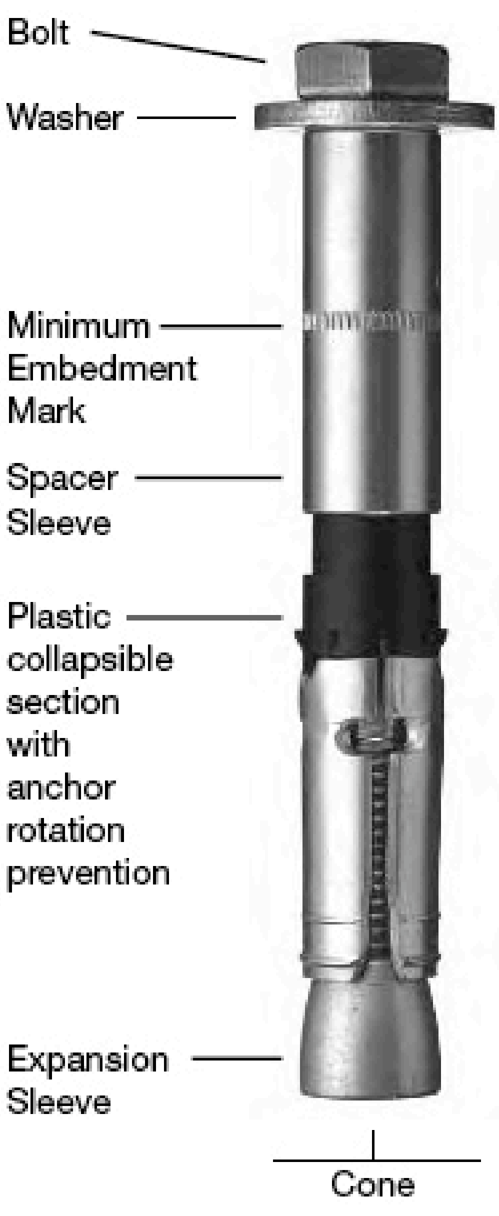
4.3.2.1 Product Description

4.3.2.2 Material Specifications

4.3.2.3 Technical Data

4.3.2.4 Installation Instructions

4.3.2.5 Ordering Information



Listings/Approvals

ICC-ES (International Code Council)
ESR-1545

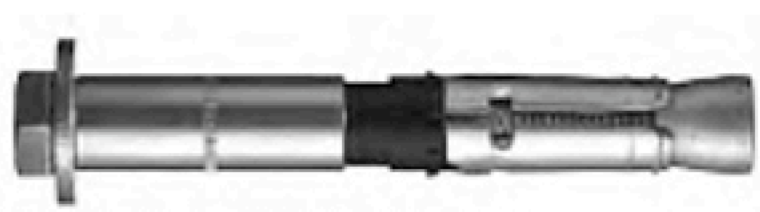
European Technical Approval (ETA)
ETA-02/0042

Qualified under NQA-1 Nuclear Quality Program

Building Code Compliance

IBC® 2006
IRC® 2006
UBC® 1997

4.3.2.1 HSL-3 Product Description



HSL-3 Heavy Duty Expansion Anchor

The Hilti HSL-3 Heavy Duty Expansion Anchor is a torque-controlled expansion bolt designed for high performance in static and dynamic application including the tension zone of concrete structures where cracking can be expected. HSL-3 anchors are available in metric sizes from M8 to M24. With a variety of head configurations, including bolt, stud and torque cap. All versions are available in zinc-plated carbon steel.

Product Features

- Approved for use in the concrete tension zone (cracked concrete)
- Data for use with the Strength Design provisions of ACI 318-05 Appendix D and ACI 349-01 Appendix B
- Allowable Stress Design data for use with ASD
- High load capacity
- Force-controlled expansion which allows for follow-up expansion
- Reliable clamping of part fastened to overcome gaps
- Suitable for dynamic loading, including seismic, fatigue and shock
- No spinning of the anchor in hole when tightening bolt or nut
- Seismic qualification per ICC-ES AC193 and the requirements of ACI 318-05 Appendix D

Guide Specifications

Expansion Anchors: Carbon steel anchor consists of hex head bolt (threaded stud), sleeve, expansion sleeve, expansion cone, collapsible plastic sleeve, (nut) and washer. Anchors shall be torque controlled expansion bolt as manufactured by Hilti.

4.3.2.2 Material Specifications

Carbon Steel Bolt or Threaded Rod for HSL-3 (Bolt), HSL-3 (Stud) and HSL-3-B conform to DIN EN ISO 898-1, Grade 8.8, f_y > 93 ksi, f_u > 116 ksi

Carbon Steel Nut conforms to DIN 934, Grade 8, f_u > 116 ksi

Carbon Steel Washer conforms to DIN 1544, Grade St37, f_u > 100 ksi

Carbon Steel Expansion Cone conforms to DIN 1654-4, f_u > 80 ksi

Carbon Steel Expansion Sleeve (M8-M16) conforms to DIN 10139 and (M20-M24) conforms to DIN 2393-2

Carbon Steel Spacing Sleeve conforms to DIN 2393 T1, f_u > 100 ksi

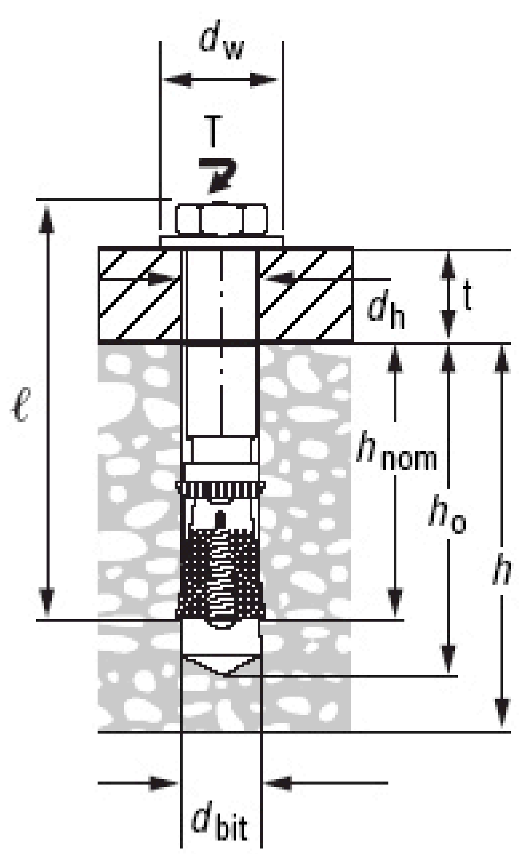
Collapsible Sleeve is made from acetal polyoxymethylene (POM) resin

4.3.2.3 Technical Data

Table 1 — HSL-3 Specifications

Details			HSL-3 Anchor Thread Diameter (mm)											
			M8		M10		M12		M16		M20		M24	
nominal drill bit diameter[1]	d_{bit}	mm	12		15		18		24		28		32	
Hilti matched-tolerance carbide-tipped drill bit	-	-	TE-CX 12/22 TE-YX 12/35		TE-CX 15/27 TE-YX 15/35		TE-C 18/22 TE-YX 18/32		TE-C-T 24/27 TE-YX 24/32		TE-C-T 28/27 TE-YX 28/32		TE-YX 32/37	
minimum base material thickness to obtain smallest critical edge distance	h_{min}	mm	110 (120)		120 (140)		135 (160)		160 (200)		190 (250)		225 (300)	
		(in.)	4 3/8 (4-3/4)		4 3/4 (5-1/2)		5 3/8 (6 1/4)		6 1/4 (7-7/8)		7 1/2 (9-7/8)		8 7/8 (11-7/8)	
minimum hole depth	h_0	mm	80		90		105		125		155		180	
		(in.)	(3-1/8)		(3-1/2)		(4-1/8)		(4-7/8)		(6-1/8)		(7-1/8)	
effective embedment depth	$h_{ef,min}$	mm	60		70		80		100		125		150	
		(in.)	(2-3/8)		(2-3/4)		(3-1/8)		(3-7/8)		(4-7/8)		(5-7/8)	
minimum clearance hole diameter in part being fastened	d_h	mm	14		17		20		26		31		35	
		(in.)	(9/16)		(11/16)		(13/16)		(1)		(1-1/4)		(1-3/8)	
max. cumulative gap between part(s) being fastened and concrete surface	-	mm	4		5		8		9		12		16	
		(in.)	(1/8)		(3/16)		(5/16)		(3/8)		(1/2)		(5/8)	
maximum thickness of part fastened HSL-3, HSL-3-B	t	mm	20	40	20	40	25	50	25	50	30	60	30	60
		(in.)	(3/4)	(1-1/2)	(3/4)	(1-1/2)	(1)	(2)	(1)	(2)	(1-1/8)	(2-1/4)	(1-1/8)	(2-1/4)
overall length of anchor HSL-3, HSL-3-B	-	mm	98	118	110	130	131	156	153	178	183	213	205	235
		(in.)	(3-7/8)	(4-5/8)	(4-3/8)	(5 1/8)	(5-1/8)	(6 1/8)	(6)	(7)	(7-1/4)	(8-3/8)	(8)	(9-1/4)
maximum thickness of part fastened HSL-3-G	t	mm	20		20		25	50	25	50	30	60		
		(in.)	(3/4)		(3/4)		(1)	(2)	(1)	(2)	(1-1/8)	(2-1/4)		
overall length of anchor HSL-3-G	-	mm	102		115		139	164	163	188	190	220		
		(in.)	(4)		(4-1/2)		(5-1/2)	(6-3/8)	(6-3/8)	(7-3/8)	(7-1/2)	(8-3/4)		
washer diameter	d_w	mm	20		25		30		40		45		50	
		(in.)	(3/4)		(1)		(1-1/8)		(1-9/16)		(1-3/4)		(2)	
installation torque HSL-3	T_{inst}	Nm	25		50		80		120		200		250	
		(ft-lb)	(18)		(37)		(59)		(89)		(148)		(185)	
installation torque HSL-3-G	T_{inst}	Nm	20		35		60		80		160			
		(ft-lb)	(15)		(26)		(44)		(59)		(118)			
wrench size HSL-3, HSL-3-G	-	mm	13		17		19		24		30		36	
wrench size HSL-3-B	-	mm					24		30		36		41	

1 Use metric bits only.



4.3.2 HSL-3 Heavy Duty Expansion Anchor

Table 2 — HSL-3 Strength Design Information

Design parameter	Symbol	Units	Nominal anchor diameter					
			M8	M10	M12	M16	M20	M24
Anchor O.D.	d_o	mm	12	15	18	24	28	32
		in.	0.47	0.59	0.71	0.94	1.10	1.26
Effective min. embedment depth[1]	$h_{ef,min}$	mm	60	70	80	100	125	150
		in.	2.36	2.76	3.15	3.94	4.92	5.91
Anchor category[2]	1,2 or 3	-	1	1	1	1	1	1
Strength reduction factor for tension, steel failure modes[3]	ϕ	-	0.75					
Strength reduction factor for shear, steel failure modes[3]	ϕ	-	0.65					
Strength reduction factor for tension, concrete failure modes[3]	ϕ	Cond.A	0.75					
		Cond.B	0.65					
Strength reduction factor for shear, concrete failure modes[3]	ϕ	Cond.A	0.75					
		Cond.B	0.70					
Yield strength of anchor steel	f_y	lb/in²	92,800					
Ultimate strength of anchor steel	f_{ut}	lb/in²	116,000					
Tensile stress area	A_{se}	in²	0.057	0.090	0.131	0.243	0.380	0.547
Steel strength in tension	N_{sa}	lb	6,612	10,440	15,196	28,188	44,080	63,452
Effectiveness factor uncracked concrete	k_{uncr}	-	24	24	24	24	24	24
Effectiveness factor cracked concrete[4]	k_{cr}	-	17	24	24	24	24	24
k_{uncr}/k_{cr}[5]	$\Psi_{c,N}$	-	1.41	1.00	1.00	1.00	1.00	1.00
Pullout strength uncracked concrete[6]	$N_{pn,uncr}$	lb	4,204	-	-	-	-	-
Pullout strength cracked concrete[6]	$N_{pn,cr}$	lb	2,810	4,496	-	-	-	-
Steel strength in shear HSL-3,-B	V_{sa}	lb	7,239	10,229	14,725	26,707	39,521	45,951
Steel strength in shear HSL-3-G	V_{sa}	lb	6,070	8,385	12,162	22,683	33,159	
Tension pullout strength seismic[7]	$N_{pn,seismic}$	lb	-	-	-	-	-	14,320
Steel strength in shear, seismic[7] HSL-3,-B,-SH,-SK	$V_{sa,seismic}$	lb	4,609	8,453	11,892	24,796	29,135	38,173
Steel strength in shear, seismic[7] HSL-3-G		lb	3,777	6,924	9,824	21,065	24,459	
Axial stiffness in service load range[8] — uncracked concrete	β_{uncr}	1000 lb/in.	300					
Axial stiffness in service load range[8] — cracked concrete	β_{cr}		30	70	130	130	130	130

1 See table 1.

2 See ACI 318-05 Section D.4.4.

3 For use with the load combinations of ACI 318-05 Section 9.2. 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.

4 See ACI 318-05 Section D.5.2.2.

5 See ACI 318-05 Section D.5.2.6.

6 See Section 4.1.3 of ICC ESR-1546.

7 See Section 4.1.6 of ICC ESR-1546.

8 Minimum axial stiffness values, maximum values may be 3 times larger due to high strength concrete.

Table 3 — Edge Distance, Spacing and Member Thickness Requirements[1,2]

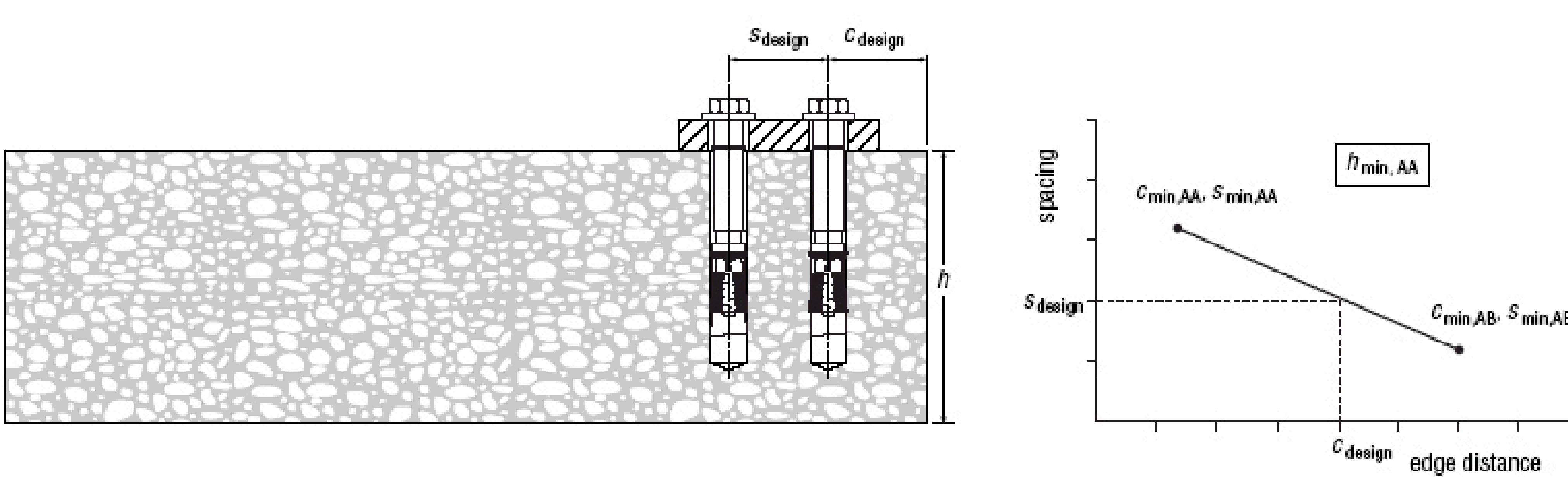
Case[3]	Dimensional parameter	Symbol	Units	Nominal anchor diameter					
				M8	M10	M12	M16	M20	M24
A	Minimum concrete thickness	$h_{min,A}$	in. (mm)	4-3/4 (120)	5-1/2 (140)	6-1/4 (160)	7-7/8 (200)	9-7/8 (250)	11-7/8 (300)
A	Critical edge distance[2]	$c_{cr,A}$	in. (mm)	4-3/8 (110)	4-3/8 (110)	4-3/4 (120)	5-7/8 (150)	8-7/8 (225)	8-7/8 (225)
A	Minimum edge distance[3]	$c_{min,AA}$	in. (mm)	2-3/8 (60)	2-3/4 (70)	3-1/2 (90)	4-3/4 (120)	5 (125)	5-7/8 (150)
A	Minimum anchor spacing[3]	$s_{min,AA}$	in. (mm)	5-1/2 (140)	9-1/2 (240)	11 (280)	12-5/8 (320)	13-3/4 (350)	11-7/8 (300)
A	Minimum edge distance[3]	$c_{min,AB}$	in. (mm)	3-3/8 (85)	5 (125)	6-1/8 (155)	7-7/8 (200)	8-1/4 (210)	8-1/4 (210)
A	Minimum anchor spacing[3]	$s_{min,AB}$	in. (mm)	2-3/8 (60)	2-3/4 (70)	3-1/8 (80)	4 (100)	5 (125)	5-7/8 (150)
B	Minimum concrete thickness	$h_{min,B}$	in. (mm)	4-3/8 (110)	4-3/4 (120)	5-3/8 (135)	6-1/4 (160)	7-1/2 (190)	8-7/8 (225)
B	Critical edge distance[2]	$c_{cr,B}$	in. (mm)	5-7/8 (150)	6-7/8 (175)	7-7/8 (200)	9-7/8 (250)	12-3/8 (312.5)	14-3/4 (375)
B	Minimum edge distance[3]	$c_{min,BA}$	in. (mm)	2-3/8 (60)	3-1/2 (90)	4-3/8 (110)	6-1/4 (160)	7-7/8 (200)	8-7/8 (225)
B	Minimum anchor spacing[3]	$s_{min,BA}$	in. (mm)	7 (180)	10-1/4 (260)	12-5/8 (320)	15 (380)	15-3/4 (400)	15 (380)
B	Minimum edge distance[3]	$c_{min,BB}$	in. (mm)	4 (100)	6-1/4 (160)	7-7/8 (200)	10-5/8 (270)	11-7/8 (300)	12-5/8 (320)
B	Minimum anchor spacing[3]	$s_{min,BB}$	in. (mm)	2-3/8 (60)	2-3/4 (70)	3-1/8 (80)	4 (100)	5 (125)	5-7/8 (150)

1 In lieu of ACI 318 D.3.3. minimum edge distance, spacing and member thickness shall comply with ESR-1545 Table 4.

2 The concrete breakout strength calculated according to ACI 318 D.5.2, shall be further multiplied by $\Psi_{ed,N}$. See ESR-1545 Section 4.1.2.

3 Denotes admissible combinations of h_{min}, c_{cr}, c_{min}, and s_{min}. For example, $h_{min,A} + c_{min,AA} + s_{min,AA}$ or $h_{min,A} + c_{cr,A} + c_{min,AB} + s_{min,AB}$ are admissible, but $h_{min,A} + c_{cr,B} + c_{min,AB} + s_{min,BB}$ is not. However, other admissible combinations for minimum edge distance c_{min} and spacing s_{min} for $h_{min,A}$ or $h_{min,B}$ may be derived by linear interpolation between boundary values (see example for $h_{min,A}$ below).

Example of allowable interpolation of minimum edge distance and minimum spacing



4.3.2 HSL-3 Heavy Duty Expansion Anchor

Table 4 - HSL-3 Allowable Static Tension (ASD), Normal Weight Uncracked Concrete (lb)[1,3,4]

Nominal Anchor Diameter	Embedment Depth hef mm	(in.)	Concrete Compressive Strength[2]							
			f'_c = 2000 psi		f'_c = 3000 psi		f'_c = 4000 psi		f'_c = 6000 psi	
			Condition A	Condition B	Condition A	Condition B	Condition A	Condition B	Condition A	Condition B
M8	60	2.36	1,746	1,746	2,139	2,139	2,470	2,470	3,025	3,025
M10	70	2.76	2,631	2,280	3,222	2,792	3,720	3,224	4,556	3,949
M12	80	3.15	3,214	2,785	3,936	3,411	4,545	3,939	5,567	4,825
M16	100	3.94	4,492	3,893	5,501	4,768	6,352	5,505	7,780	6,743
M20	125	4.92	6,277	5,440	7,688	6,663	8,877	7,694	10,873	9,423
M24	150	5.91	8,252	7,152	10,106	8,759	11,670	10,114	14,292	12,387

1 Values are for single anchors with no edge distance or spacing reduction. For other cases, see ESR-1545 Section 4.2 Eq. 5.

2 Values are for normal weight concrete. For sand-lightweight concrete, multiply values by 0.85. For all-lightweight concrete, multiply values by 0.75. See ACI 318-05 Section D.3.4.

3 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.

4 Allowable static tension loads for 2,500 psi are calculated by multiplying the concrete breakout strength N_b by the strength reduction ϕ factor of 0.65 and dividing by an α of 1.4 according to ICC ESR-1545 Section 4.2. N_b is calculated as per ACI 318-05 D.5.2.2. This load may be adjusted for other concrete strengths according to ICC ESR-1545 Section 4.1.3 by using the following equation.

$$N_{b,f'c} = N_b \sqrt{\frac{f'c}{2500}}$$

Table 5 - HSL-3 Allowable Static Tension (ASD), Normal Weight Cracked Concrete (lb)[1,3,4]

Nominal Anchor Diameter	Embedment Depth hef mm	(in.)	Concrete Compressive Strength[2]							
			f'_c = 2000 psi		f'_c = 3000 psi		f'_c = 4000 psi		f'_c = 6000 psi	
			Condition A	Condition B	Condition A	Condition B	Condition A	Condition B	Condition A	Condition B
M8	60	2.36	1,167	1,167	1,429	1,429	1,650	1,650	2,021	2,021
M10	70	2.76	1,867	1,867	2,286	2,286	2,640	2,640	3,233	3,233
M12	80	3.15	3,214	2,785	3,936	3,411	4,545	3,939	5,567	4,825
M16	100	3.94	4,492	3,893	5,501	4,768	6,352	5,505	7,780	6,743
M20	125	4.92	6,277	5,440	7,688	6,663	8,877	7,694	10,873	9,423
M24	150	5.91	8,252	7,152	10,106	8,759	11,670	10,114	14,292	12,387

1 Values are for single anchors with no edge distance or spacing reduction. For other cases, see ESR-1545 Section 4.2 Eq. 5.

2 Values are for normal weight concrete. For sand-lightweight concrete, multiply values by 0.85. For all-lightweight concrete, multiply values by 0.75. See ACI 318-05 Section D.3.4.

3 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.

4 Allowable static tension loads for 2,500 psi are calculated by multiplying the pullout strength N_{pn} by the strength reduction ϕ factor of 0.65 and dividing by an α of 1.4 according to ICC ESR-1545 Section 4.2. See Table 2 for N_{pn}. This load may be adjusted for other concrete strengths according to ICC ESR-1545 Section 4.1.3 by using the following equation.

$$N_{pn,cr,f'c} = N_{pn,cr} \sqrt{\frac{f'c}{2500}}$$

Table 6 - HSL-3 Allowable Static Shear (ASD), Steel (lb)[1,2]

Nominal Anchor Diameter	Allowable Steel Capacity, Shear	
	HSL-3, HSL-3-B	HSL-3-G
M8	3,361	2,818
M10	4,749	3,893
M12	6,837	5,647
M16	12,400	10,531
M20	18,349	15,395
M24	21,334	

1 Values are for single anchors with no edge distance or spacing reduction due to concrete failure.

2 Allowable static shear loads are calculated by multiplying V_{sa} by the strength reduction ϕ factor of 0.65 and dividing by an α of 1.4 according to ICC ESR-1545 Section 4.2. See Table 2 for V_{sa}.

HSL-3 Heavy Duty Expansion Anchor 4.3.2

Table 7 - HSL-3 Allowable Seismic Tension (ASD), Normal Weight Cracked Concrete (lb)[1,3,4]

Nominal Anchor Diameter	Embedment Depth h_{ef} mm	(in.)	Concrete Compressive Strength[2] f'_c = 2000 psi Condition A	Condition B	f'_c = 3000 psi Condition A	Condition B	f'_c = 4000 psi Condition A	Condition B	f'_c = 6000 psi Condition A	Condition B
M8	60	2.36	1,114	1,114	1,364	1,364	1,575	1,575	1,929	1,929
M10	70	2.76	1,782	1,782	2,182	2,182	2,520	2,520	3,086	3,086
M12	80	3.15	3,068	2,659	3,757	3,256	4,339	3,760	5,314	4,605
M16	100	3.94	4,288	3,716	5,251	4,551	6,063	5,255	7,426	6,436
M20	125	4.92	5,992	5,193	7,339	6,360	8,474	7,344	10,378	8,995
M24	150	5.91	6,550	5,676	8,022	6,952	9,263	8,028	11,344	9,832

1 Values are for single anchors with no edge distance or spacing reduction. For other cases, see ESR-1545 Section 4.2 Eq. 5.

2 Values are for normal weight concrete. For sand-lightweight concrete, multiply values by 0.85. For all-lightweight concrete, multiply values by 0.75. See ACI 318-05 Section D.3.4.

3 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.

4 Allowable seismic tension loads for 2,500 psi are calculated by multiplying the pullout strength N_{pn} by the strength reduction ϕ factor of 0.65, then multiplying by a 0.75 factor describe in ACI 318-05 D.3.3.3, and dividing by an α of 1.1 according to ICC ESR-1545 Section 4.2. See Table 2 for N_{pn}. This load may be adjusted for other concrete strengths according to ICC ESR-1545 Section 4.1.3 by using the following equation.

$$N_{pn,cr,f'c} = N_{pn,cr}\sqrt{\frac{f'c}{2500}}$$

Table 8 - HSL-3 Allowable Seismic Shear (ASD), Steel (lb)[1,2]

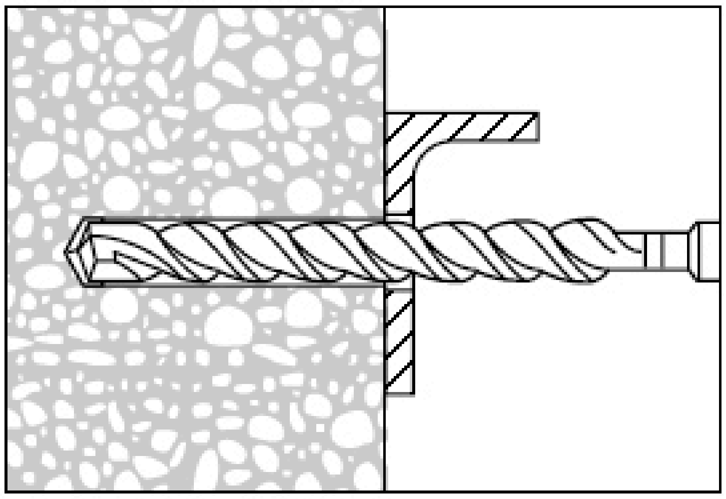
Nominal Anchor Diameter	Allowable Steel Capacity, Shear HSL-3, HSL-3-B	HSL-3-G
M8	2,043	1,674
M10	3,746	3,069
M12	5,270	4,354
M16	10,989	9,336
M20	12,912	10,840
M24	16,918	

1 Values are for single anchors with no edge distance or spacing reduction due to concrete failure.

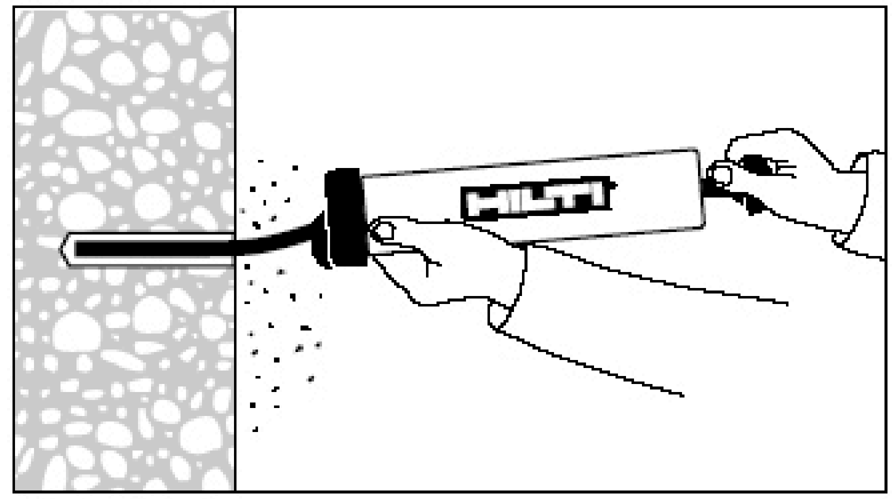
2 Allowable seismic shear loads are calculated by multiplying $V_{sa,seis}$ by the strength reduction ϕ factor of 0.65, then multiply by 0.75 as per ACI 318-05 D.3.3.3, and dividing by an α of 1.1 according to ICC ESR-1545 Section 4.2. See Table 2 for $V_{sa,seis}$.

4.3.2 HSL-3 Heavy Duty Expansion Anchor

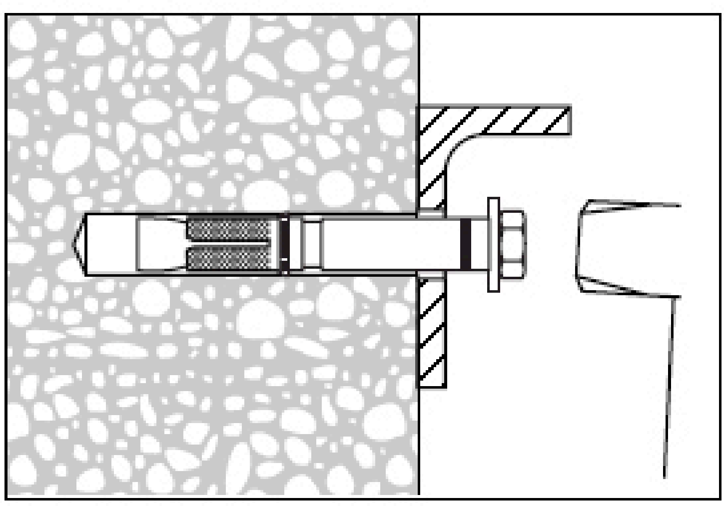
4.3.2.4 HSL-3 Installation Instructions



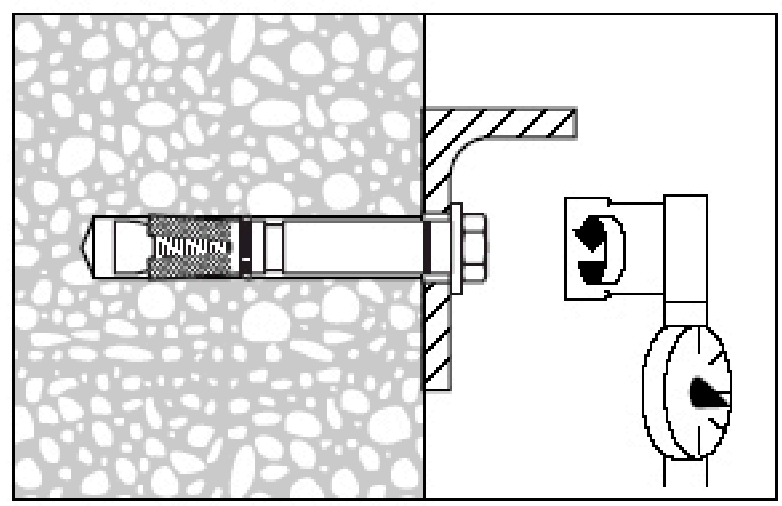
1. Using the correct diameter metric bit, drill hole to minimum required hole depth or deeper.



2. Remove drilling debris with a blowout bulb or with compressed air.



3. Using a hammer, tap the anchor through the part being fastened into the drilled hole until the washer is in contact with the fastened part. Do not expand anchor by hand prior to installation.



4. Using a torque wrench, apply the specified installation torque. HSL-3-B does not require use of a torque wrench. Tighten until torque cap shears off.