Technical Data [ข้อมูลทางเทคนิค] [อ้างอิงจาก ASTM A325 - 14]

ASTM A325 : Heavy Hex Structural Bolts

1. Materials [วัสดุ]

Type 1: Medium carbon steel, boron steel, or medium carbon alloy steel

Type 3: Weathering steel

Table1 : Chemical Requirements for Bolts

Element	Type : 1				Type : 3					
	Carbon Steel	Carbon Boron Steel	Alloy Steel	Alloy Boron Steel	A	B	C	D	E	F
Carbon	0.28-0.55	0.28-0.55	0.28-0.55	0.28-0.55	0.31-0.42	0.36-0.50	0.14-0.26	0.14-0.26	0.18-0.27	0.19-0.26
Manganese	0.57min	0.57min	0.57min	0.57min	0.86-1.24	0.67-0.93	0.76-1.39	0.36-1.24	0.56-1.04	0.86-1.24
Phosphorus	0.048max	0.048max	0.040max	0.040max	0.040max	0.040max	0.040max	0.040max	0.040max	0.040max
Sulfur	0.058max	0.058max	0.045max	0.045max	0.045max	0.045max	0.045max	0.045max	0.045max	0.045max
Silicon	0.13-0.32	0.08-0.32	0.13-0.37	0.13-0.37	0.13-0.37	0.25-0.55	0.13-0.37	0.20-0.55	0.13-0.37	0.13-0.37
Boron	...	0.0005-0.003	...	0.0005-0.003	...	...	...	...	...	...
Copper	...	...	...	...	0.22-0.48	0.17-0.43	0.17-0.53	0.27-0.53	0.27-0.63	0.17-0.43
Nickel	...	...	...	...	0.22-0.48	0.47-0.83	0.22-0.53	0.47-0.83	0.27-0.63	0.17-0.43
Chromium	...	...	...	...	0.42-0.68	0.47-0.83	0.27-0.53	0.45-1.05	0.55-0.95	0.42-0.68
Vanadium	...	...	...	...	...	...	0.010min	...	...	...
Molybdenum	...	...	...	...	...	0.07max	...	0.11max	...	...
Titanium	...	...	...	...	...	...	...	0.06max	...	...

*** Recommended Nuts and Washers

Bolt Type and Finish	Nuts Class and Finish Specification	Washer Finish
1, plain	A563 : C, D, DH, DH3, plain	F436 : plain
1, zinc-coated	A563 : DH, zinc-coated	F436 : zinc-coated
3, plain	A563 : C3, DH3, plain	F436 : plain

2. Mechanical Properties [สมบัติทางกล]

2.1 Hardness [ค่าความแข็ง]

Table2 : Hardness Requirements for Bolts

Bolt Size [in]	Bolt Length [in]	Brinell		Rockwell C	
		Min	Max	Min	Max
1/2 to 1, Inclusive	Less than 2D	253	319	25	34
	2D and over	...	319	...	34
1.1/8 to 1.1/2", Inclusive	Less than 3D	253	319	25	34
	3D and over	...	319	...	34

2.2 Tensile Load and Proof Load [ค่าแรงดึงและแรงดึงพิสูจน์]

Table3 : Tensile Load and Proof Load Requirements for Bolts Tested Full-Size

Bolt Size [in.]	Stress Area [in^2]	Tensile Load, min [lbf]	Proof Load, Length Measurement Method [lbf]	Alternative Proof Load, Yield Strength Method [lbf]
1/2 - 13 UNC	0.142	17,050	12,050	13,050
5/8 - 11 UNC	0.226	27,100	19,200	20,800
3/4 - 10 UNC	0.334	40,100	28,400	30,700
7/8 - 9 UNC	0.462	55,450	39,250	42,500
1 - 8 UNC	0.606	72,700	51,500	55,750
1.1/8 - 7 UNC	0.763	80,100	56,450	61,800
1.1/4 - 7 UNC	0.969	101,700	71,700	78,500
1.3/8 - 6 UNC	1.155	121,300	85,450	93,550
1.1/2 - 6 UNC	1.405	147,500	104,000	113,800

2.3 Tensile Strength [ค่าความแข็งแรงทางแรงดึง]

Table4 : Tensile Strength Requirements for Specimens Machined From Bolts

Bolt Size [in]	Tensile Strength, min [psi (MPa)]	Yield Strength, min [psi (MPa)]	Elongation in 4D, min [%]	Reduction of Area, min [%]
1/2 to 1, Inclusive	120,000 (825)	92,000 (635)	14	35
Over 1 to 1.1/2	105,000 (725)	81,000 (560)	14	35

2.4 Rotational Capacity [ค่าความสามารถการขันน๊อต]

Table5 : Rotational Capacity Test for Zinc-Coated Bolts

Bolt Length [in]	Nut Rotation, degrees (turn), min
Up to and including 4 x dia	240 [⅔]
Over 4 x dia, but not exceeding 8 x dia	360 [1]
Over 8 x dia, but not exceeding 12 x dia	420 [1-1/6]
Over 12 x dia	Test not applicable

3. Dimension [รูปร่างและขนาด Bolt A325M] [อ้างอิงจาก ANSI B18.2.6M]

3.1 Basic Dimensions [ขนาดทั่วไปของ Bolts A325M]

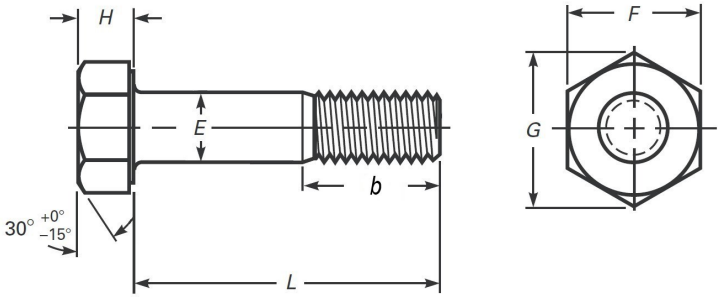


Table5 : Dimensions of Heavy Hex Structural Bolts

Bolt Size [in]	Body Diameter E, [in]		Width Across Flats F, [in]		Width Across Corners G, [in]		Head Height H, [in]		Thread Length, b	
									Bolt Length ≤ 6	Bolt Length > 6
	Max	Min	Max	Min	Max	Min	Max	Min	in [mm]	in [mm]
1/2	0.515	0.482	0.875	0.850	1.010	0.969	0.323	0.302	1.00 25.40	1.19 30.23
5/8	0.642	0.605	1.062	1.031	1.227	1.175	0.403	0.378	1.25 31.75	1.47 37.34
3/4	0.768	0.729	1.250	1.212	1.443	1.383	0.483	0.455	1.38 35.05	1.63 41.40
7/8	0.895	0.852	1.438	1.394	1.660	1.589	0.563	0.531	1.50 38.10	1.78 45.21
1	1.022	0.976	1.625	1.575	1.876	1.796	0.627	0.591	1.75 44.45	2.06 52.32
1.1/8	1.149	1.098	1.812	1.756	2.093	2.002	0.718	0.658	2.00 50.80	2.34 59.44
1.1/4	1.277	1.223	2.000	1.938	2.309	2.209	0.813	0.749	2.00 50.80	2.38 60.45
1.3/8	1.404	1.345	2.188	2.119	2.526	2.416	0.878	0.810	2.25 57.15	2.69 68.33
1.1/2	1.531	1.470	2.375	2.300	2.742	2.622	0.974	0.902	2.25 57.15	2.69 68.33

3.2 Body Length, L [ความยาวของ Bolts]

The bolt length shall be the distance measured parallel to the axis of the product from the bearing surface of the head to the extreme end of the bolt including point. Bolts are normally furnished in ¼ in. length increments.

[ความยาวของ Bolts จะวัดระยะเริ่มจากส่วนหัวด้านในจนถึงปลายสุด โดยระยะจะเพิ่มความยาวครั้งละ ¼ นิ้ว]

3.3 Length Tolerances [ค่าความคลาดเคลื่อนของความยาว]

Bolt length tolerances shall be as tabulated below. [ค่าความคลาดเคลื่อนของความยาว Bolts กำหนดตามตารางด้านล่าง]

Table7 : Tolerance Requirements for Bolts Length

Bolt Length [in]	1/2	5/8	3/4	7/8	1	1.1/8	1.1/4	1.3/8	1.1/2
Length ≤ 6 in.	-0.12	-0.12	-0.19	-0.19	-0.19	-0.25	-0.25	-0.25	-0.25
Length >6 in.	-0.19	-0.25	-0.25	-0.25	-0.25	-0.25	-0.25	-0.25	-0.25

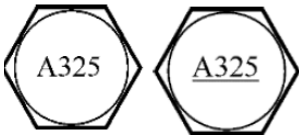
4. Surface and Marking [ผิวและสัญลักษณ์บน Bolts A325]

4.1 Finish/Coatings

1. Plain / Black
2. Hot-Dip Galvanized [ASTM A153/153M]

4.2 Product Marking

1. Type 1 bolts shall be marked “A325”
2. Type 3 bolts shall be marked “A325” [with the A325] underlined]



5. Weight [น้ำหนัก Bolts A325]

Table8 : Weight (Kg. / 100 pcs.) of Heavy Hex Structural Bolts

Body Lengths [in]	1.1/2	1.3/4	2	2.1/4	2.1/2	2.3/4	3	3.1/4	3.1/2	3.3/4	4	4.1/4	4.1/2	4.3/4
1/2	5.81	6.40	7.03	7.62	8.26	8.85	9.48	10.07	10.70	11.29	11.88	12.52	13.11	13.74
5/8	9.84	10.66	11.61	12.56	13.52	14.47	15.42	16.33	17.28	18.23	19.19	20.14	21.09	22.04
3/4	15.38	16.56	17.69	19.05	20.41	21.82	23.18	24.54	25.90	27.26	28.67	30.03	31.39	32.75
7/8	-	24.04	25.67	27.26	29.12	30.98	32.84	34.75	36.60	38.46	40.32	42.18	44.45	46.27
1	-	-	35.74	37.83	39.92	42.64	44.91	47.17	49.90	52.16	54.43	57.15	59.42	62.14
1.1/8	-	-	-	-	-	-	58.06	60.78	63.96	67.13	70.31	73.48	76.20	79.38
1.1/4	-	-	-	-	-	-	75.75	79.38	83.01	87.09	90.72	94.80	98.43	102.06
1.1/2	-	-	-	-	-	-	118.84	123.83	129.73	135.17	141.07	146.51	151.95	157.85

Table8 : Weight (Kg. / 100 pcs.) of Heavy Hex Structural Bolts [Continued]

Body Lengths [in]	5	5.1/4	5.1/2	5.3/4	6	6.1/2	7	7.1/2	8	8.1/2	9	9.1/2	10
1/2	14.33	-	14.56	-	16.78	17.87	19.10	20.32	21.55	-	-	-	-
5/8	23.00	23.95	24.90	25.85	26.81	28.53	30.44	32.34	34.25	36.15	-	-	-
3/4	34.11	35.52	36.88	38.24	39.60	42.14	44.91	47.63	52.16	53.07	55.79	58.51	61.23
7/8	48.08	49.90	51.71	53.52	55.34	58.97	62.60	66.22	70.31	73.94	77.56	81.19	85.28
1	64.41	66.68	69.40	71.67	73.94	78.47	83.46	88.45	93.44	97.98	102.97	109.54	112.94
1.1/8	82.55	85.73	88.90	-	94.80	100.70	106.59	112.94	119.29	125.19	131.54	137.44	143.79
1.1/4	106.14	-	113.85	-	121.11	128.37	136.08	143.79	151.05	158.76	166.47	174.18	185.43
1.1/2	163.29	169.19	174.63	180.08	185.97	197.31	208.20	219.54	230.88	242.22	253.56	256.28	267.17

ASTM A563M : Heavy Hex Nuts Use With Structural Bolts[A325M]. [อ้างอิงจาก ASTM A563 - 15]

1. Materials [วัสดุ]

Table9 : Chemical Requirements for Nuts

Element	C		D		DH		DH3	
	Heat Analysis	Product Analysis	Heat Analysis	Product Analysis	Heat Analysis	Product Analysis	Heat Analysis	Product Analysis
Carbon	0.55max	0.58max	0.55max	0.58max	0.20 - 0.55	0.18 - 0.58	0.20 - 0.53	0.19 - 0.55
Manganese	…	…	0.30min	0.27min	0.60min	0.57min	0.40min	0.37min
Phosphorus	0.12max	0.13max	0.040max	0.048max	0.040max	0.048max	0.046max	0.052max
Sulfur	0.15max	…	0.050max	0.058max	0.050max	0.058max	0.050max	0.055max
Silicon	…	…	…	…	…	…	…	…
Copper	…	…	…	…	…	…	0.20min	0.17min
Nickel	…	…	…	…	…	…	0.20min	0.17min
Chromium	…	…	…	…	…	…	0.45min	0.42min
Vanadium	…	…	…	…	…	…	…	…
Molybdenum	…	…	…	…	…	…	0.15min	0.14min
Titanium	…	…	…	…	…	…	…	…

2. Mechanical Properties [สมบัติทางกล]

Table10 : Mechanical Properties Requirements for Heavy Hex Nuts

Size [in]	C		D		DH		DH3	
	Proof Load Stress, [ksi]	Hardness, [Rockwell]	Proof Load Stress, [ksi]	Hardness, [Rockwell]	Proof Load Stress, [ksi] [Plain, HDG]	Hardness, [Rockwell]	Proof Load Stress, [ksi] [Plain, HDG]	Hardness, [Rockwell]
1/4 to 4	144	B78 - C38	150	B84 - C38	175, 150	C24 - C38	175, 150	C24 - C38

3. Dimension and Weight of Metric Heavy Hex Nuts for Use With Structural Bolts

[รูปร่างและขนาด Nuts A563 + น้ำหนัก] [อ้างอิงจาก ANSI B18.2.6]

*** Recommended ***

Finish/Coatings : Self Color/Black, HDG

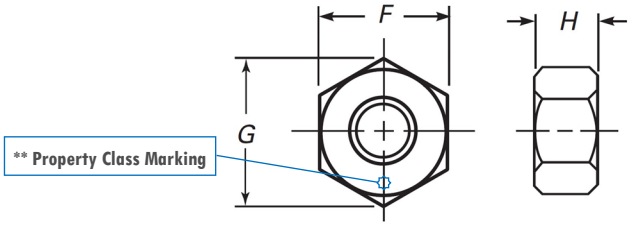


Table11 : Dimension and Weight of Metric Heavy Hex Nuts for Use With Structural Bolts

Nuts Size [in]	Width Across Flats F, [in]		Width Across Corners G, [in]		Head Height H, [in]		Weight [Kg./100pcs.]
	Max	Min	Max	Min	Max	Min	
1/2	0.875	0.850	1.010	0.969	0.504	0.464	3.21
5/8	1.062	1.031	1.227	1.175	0.631	0.587	5.09
3/4	1.250	1.212	1.443	1.382	0.758	0.710	8.82
7/8	1.438	1.394	1.660	1.589	0.885	0.833	12.95
1	1.625	1.575	1.876	1.796	1.012	0.956	18.45
1.1/8	1.812	1.756	2.093	2.002	1.139	1.079	25.42
1.1/4	2.000	1.938	2.309	2.209	1.251	1.187	33.09
1.3/8	2.188	2.119	2.526	2.416	1.378	1.310	43.18
1.1/2	2.375	2.300	2.742	2.622	1.505	1.433	55.10

ASTM F436 : Metric Hardened Steel Washers. [อ้างอิงจาก ASTM F436 - 11]

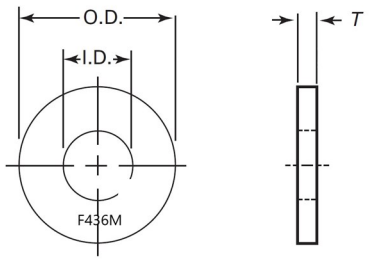


Table12 : Dimension and Weight of Washers for Use With Structural Bolts

Size [in]	I.D., [in]		O.D., [in]		T, [in]		[Kg./1,000pcs.]
	Min	Max	Min	Max	Min	Max	
1/2	0.531	0.563	1.031	1.095	0.097	0.177	10.11
5/8	0.688	0.720	1.281	1.345	0.122	0.177	19.00
3/4	0.813	0.845	1.437	1.501	0.122	0.177	22.61
7/8	0.938	0.970	1.718	1.782	0.136	0.177	34.75
1	1.063	1.085	1.937	2.063	0.136	0.177	42.50
1.1/8	1.188	1.251	2.187	2.313	0.136	0.177	55.59
1.1/4	1.375	1.438	2.437	2.563	0.136	0.177	69.35
1.3/8	1.500	1.563	2.687	2.813	0.136	0.177	76.70
1.1/2	1.625	1.688	2.937	3.063	0.136	0.177	101.80

Table13 : Chemical Requirements for Washers

Element	Composition,%	
	Heat Analysis	Product Analysis
Phosphorus	0.040max	0.050max
Sulfur	0.050max	0.060max

**Hardness for Plain Washers = 38 to 45 HRC. **Hardness for HDG Washers = 26 to 45 HRC.