

Technical Data [ข้อมูลทางเทคนิค] [อ้างอิงจาก ASTM A325M - 14]

ASTM A325M : Heavy Hex Structural Bolts

1. Materials [วัสดุ]

Type 1: Medium carbon steel, boron steel, or medium carbon alloy 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	A563M : 8S or 8S3	F436M : plain
1, zinc-coated	A563M : 10S, zinc-coated	F436M : zinc-coated
3, plain	A563M : 8S3	F436M : plain

2. Mechanical Properties [สมบัติทางกล]

2.1 Hardness [ค่าความแข็ง]

Table2 : Hardness Requirements for Bolts

Bolt Size [mm]	Bolt Length [mm]	Brinell		Rockwell C	
		Min	Max	Min	Max
M12 to M24, Inclusive	Less than 2D	253	319	25	34
	2D and over	...	319	...	34
M25 to M36, 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 [mm]	Stress Area [mm ²]	Tensile Load, min [MPa]	Proof Load, Length Measurement Method [kN]	Alternative Proof Load, Yield Strength Method [kN]
M12 x 1.75	84.3	70	50.6	55.6
M16 x 2.0	157	130	94.2	104
M20 x 2.5	245	203	147	162
M22 x 2.5	303	251	182	200
M24 x 3.0	353	293	212	233
M27 x 3.0	459	381	275	303
M30 x 3.5	561	466	337	370
M36 x 4.0	817	678	490	539

2.3 Tensile Strength [ค่าความแข็งแรงทางแรงดึง]

Table4 : Tensile Strength Requirements for Specimens Machined From Bolts

Bolt Size [mm]	Tensile Strength, min [MPa]	Yield Strength, min [MPa]	Elongation in 4D, min [%]	Reduction of Area, min [%]
M12 to M36, Inclusive	830	660	14	35

2.4 Rotational Capacity [ค่าความสามารถการขันน็อต]

Table5 : Rotational Capacity Test for Zinc-Coated Bolts

Bolt Length [mm]	Nut Rotation, degrees (turn), min
2D and shorter	180 [½]
Over 2D to 3D Inclusive	240 [2/3]
Over 3D to 4D Inclusive	300 [7/8]
Over 4D to 8D Inclusive	360 [1]
Over 8D	420 [1-1/8]

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

3.1 Basic Dimensions [ขนาดทั่วไปของ Bolts A325M]

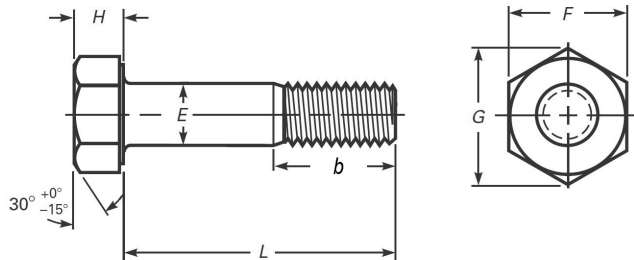


Table 6 : Dimensions of Heavy Hex Structural Bolts

Bolt Diameter [mm]	Body Diameter E, [mm]		Width Across Flats F, [mm]		Width Across Corners G, [mm]		Head Height H, [mm]		Thread Length, b, [mm]	
	Max	Min	Max	Min	Max	Min	Max	Min	Length ≤ 100	Length > 100
									Basic	
M16 x 2.0	16.70	15.30	27.00	26.16	31.18	29.56	10.75	9.25	31	38
M20 x 2.5	20.84	19.16	34.00	33.00	39.26	37.29	13.40	11.60	36	43
M22 x 2.5	22.84	21.16	36.00	35.00	41.57	39.55	14.90	13.10	38	45
M24 x 3.0	24.84	23.16	41.00	40.00	47.34	45.20	15.90	14.10	41	48
M27 x 3.0	27.84	26.16	46.00	45.00	53.12	50.85	17.90	16.10	44	51
M30 x 3.5	30.84	29.16	50.00	49.00	57.74	55.37	19.75	17.65	49	56
M36 x 4.0	37.00	35.00	60.00	58.80	69.28	66.44	23.55	21.45	56	63

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 5 mm length increments through 100 mm and 10 mm increments over 100 mm.

[ความยาวของ Bolts จะวัดระยะเริ่มจากส่วนหัวด้านในจนถึงปลายสุด โดยระยะที่น้อยกว่าหรือเท่ากับ 100 มิลลิเมตร จะเพิ่มความยาวขึ้นครั้งละ 5 มิลลิเมตร ส่วนระยะที่มากกว่า 100 มิลลิเมตร จะเพิ่มความยาวครั้งละ 10 มิลลิเมตร]

3.3 Length Tolerances [ค่าความคลาดเคลื่อนของความยาว]

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

Table 7 : Tolerance Requirements for Bolts Length

Bolt Length [mm]	M12	M16	M20	M22	M24	M27	M30	M36
Length > 150mm.	-4.0	-6.0	-6.0	-6.0	-6.0	-6.0	-6.0	-6.0
Length ≤ 150mm.	-3.0	-3.0	-4.0	-4.0	-4.0	-6.0	-6.0	-6.0

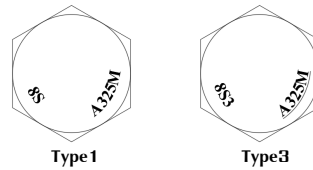
4. Surface and Marking [ผิวและสัญลักษณ์บน Bolts A325M]

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 “A325M” and “8S.”
2. Type 3 bolts shall be marked “A325M” [with the A325M underlined> and “8S3.”



5. Weight [น้ำหนัก Bolts A325M]

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

Body Length [mm]	45	50	55	60	65	70	75	80	85	90	95	100	110	120	130	140
M16x2.0	10.71	11.38	12.04	12.70	13.36	14.02	14.68	15.34	16.00	16.66	17.32	17.98	19.55	21.13	22.71	24.29
M20x2.5		18.85	20.10	21.40	22.60	23.87	25.13	26.40	27.69	28.90	30.15	31.50	34.00	36.44	38.95	41.50
M22x2.5			25.58	26.85	28.12	29.39	30.44	31.39	33.20	34.47	35.74	37.01	39.99	42.97	45.96	48.94
M24x3.0				33.76	35.21	36.66	38.11	39.56	41.01	42.46	43.91	45.36	48.91	52.46	56.01	59.56
M27x3.0					48.40	50.64	52.88	55.12	57.36	59.60	61.84	64.08	68.57	73.06	77.56	82.05
M30x3.5						60.66	63.43	66.21	68.98	71.76	74.53	77.30	82.84	88.39	93.94	99.49
M36x4.0								124.50	128.50	132.50	135.40	141.30	149.29	157.28	165.27	173.26

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

Body Length [mm]	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
M16x2.0	25.87	27.44	29.02	30.60	32.18	33.76	35.34	36.91	38.49	40.07	41.65	43.23	44.81	46.38	47.96	49.54
M20x2.5	44.00	46.50	49.02	51.53	54.40	56.60	59.10	61.70	64.11	66.65	69.20	71.70	74.20	76.70	79.25	81.90
M22x2.5	51.93	54.91	57.89	60.88	63.86	66.85	69.83	72.81	75.80	78.78	81.77	84.75	87.73	90.72	93.70	96.69
M24x3.0	63.11	66.66	70.21	73.77	77.32	80.87	84.42	87.97	91.52	95.07	98.62	102.18	105.73	109.25	112.83	116.38
M27x3.0	86.55	91.04	95.54	100.03	104.53	109.02	113.52	118.01	122.50	127.00	131.49	135.99	140.48	144.98	149.47	153.97
M30x3.5	105.04	110.59	116.15	121.69	127.23	132.78	138.32	143.87	149.42	154.97	160.52	166.07	171.62	177.17	182.71	188.26
M36x4.0	181.50	189.24	197.23	205.22	213.21	221.20	229.19	237.18	245.17	253.16	261.15	269.14	277.13	285.12	293.11	301.10

ASTM A563M : Heavy Hex Nuts Use With Structural Bolts[A325M]. [อ้างอิงจาก ASTM A563M - 07]

1. Materials [วัสดุ]

Table9 : Chemical Requirements for Nuts

Element	8S		10S		8S3	
	Heat Analysis	Product Analysis	Heat Analysis	Product Analysis	Heat Analysis	Product Analysis
Carbon	0.55max	0.58max	0.55max	0.58max	0.15 - 0.48	0.14 - 0.50
Manganese	...	...	0.30min	0.27min	0.40 - 1.35	0.36 - 1.39
Phosphorus	0.04max	0.048max	0.04max	0.048max	0.04max	0.045max
Sulfur	0.15max	...	0.05max	0.058max	0.05max	0.055max
Silicon	...	...	...	...	0.15 - 0.90	0.13 - 0.55
Copper	...	...	...	...	0.20 - 0.61	0.17 - 0.63
Nickel	...	...	...	...	1.00max	0.17 - 0.83
Chromium	...	...	...	...	0.30 - 1.25	0.27 - 1.05
Vanadium	...	...	...	...	0.02min	0.01min
Molybdenum	...	...	...	...	0.10max	0.11min
Titanium	...	...	...	...	0.05max	...

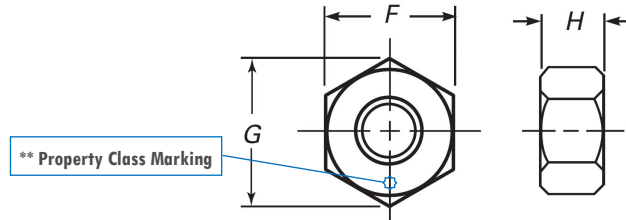
2. Mechanical Properties [สมบัติทางกล]

Table10 : Mechanical Properties Requirements for Nuts

Size [mm]	8S, 8S3			10S		
	Proof Load Values, [kN]	Proof Load Stress, [MPa]	Hardness, [Rockwell]	Proof Load Values, [kN]	Proof Load Stress, [MPa]	Hardness, [Rockwell]
M12 x 1.75	90.6			98.2		
M16 x 2.0	169			183		
M20 x 2.5	263			285		
M22 x 2.5	326			353		
M24 x 3.0	379	1075 MPa	B89 - C38	411	1165 MPa	C26 - C38
M27 x 3.0	493			535		
M30 x 3.5	603			654		
M36 x 4.0	878			952		

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

[รูปร่างและขนาด Nuts A563M + น้ำหนัก] [อ้างอิงจาก ANSI B18.2.6M]



*** Recommended ***
Finish/Coatings : Self Color/Black, HDG

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

Size	Width Across Flats F, [mm]		Width Across Corners G, [mm]		Head Height H, [mm]		Weight [Kg./100pcs.]
	Max	Min	Max	Min	Max	Min	
M12 x 1.75	21.00	20.16	24.25	22.78	12.30	11.90	2.80
M16 x 2.0	27.00	26.16	31.18	29.56	17.10	16.40	5.20
M20 x 2.5	34.00	33.00	39.26	37.29	20.70	19.40	7.99
M22 x 2.5	36.00	35.00	41.57	39.55	23.60	22.30	10.64
M24 x 3.0	41.00	40.00	47.34	45.20	24.20	22.90	17.65
M27 x 3.0	46.00	45.00	53.12	50.85	27.60	26.30	22.90
M30 x 3.5	50.00	49.00	57.74	55.37	30.70	29.10	29.39
M36 x 4.0	60.00	58.80	69.28	66.44	36.60	35.00	49.90

ASTM F436M : Metric Hardened Steel Washers. [อ้างอิงจาก ASTM F436M - 11]

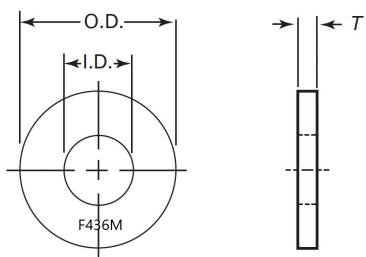


Table12 : Dimension and Weight of Washers for Use With Structural Bolts

Size	I.D., [mm]		O.D., [mm]		T, [mm]		[Kg./100pcs.]
	Max	Min	Max	Min	Max	Min	
M12	14.40	14.00	27.00	25.70	4.60	3.10	1.20
M16	18.40	18.00	34.00	32.40	4.60	3.10	2.15
M20	22.50	22.00	42.00	40.40	4.60	3.10	3.20
M22	24.50	24.00	44.00	42.40	4.60	3.40	4.55
M24	26.50	26.00	50.00	48.40	4.60	3.40	5.90
M27	30.50	30.00	56.00	54.10	4.60	3.40	6.60
M30	33.60	33.00	60.00	58.10	4.60	3.40	7.55
M36	39.60	39.00	72.00	70.10	4.60	3.40	13.30

Table13 : Chemical Requirements for Washers

Element	Composition, %	
	Heat Analysis	Product Analysis
Phosphorus	0.04max	0.05max
Sulfur	0.05max	0.00max

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