

HXN

Professional & High Quality Fasteners

KATALOG

HIGH STRENGTH STRUCTURAL BOLT, NUT, & WASHER

STANDARD ASTM JIS & DIN

HEAVY HEXAGON STRUCTURAL BOLT

HEAVY HEXAGON NUT

HIGH STRENGTH STEEL PLAIN WASHER

HIGH STRENGTH STEEL SPRING WASHER



ASTM A325

BOLT : ASTM A325 (HXN/HD)

NUT : ASTM A563 / A194 GRADE 2H/DH

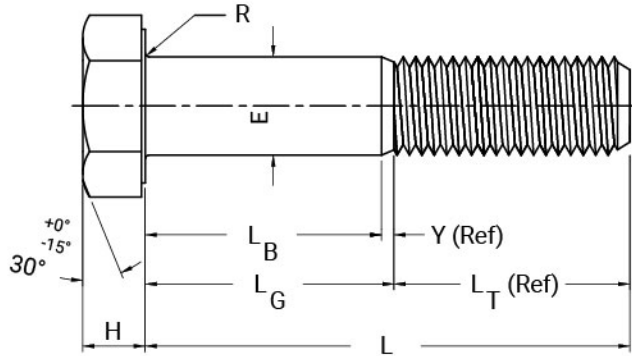
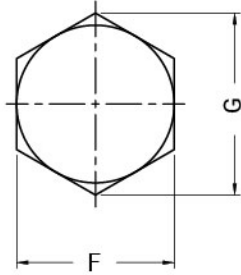
WASHER : ASTM F436



ASTM A325

DIMENSION AND TOLERANCES

ASTM A325 HEAVY HEXAGON STRUCTURAL BOLT



(Bolt Marking)

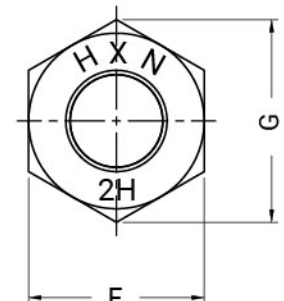
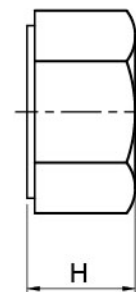
(Unit : Inchi)

Nominal Size or Basic Bolt Dia		E		F			G		H			R		L (Ref)		Y (Ref)
		Body Diameter		Width Across Flats			Width Across Corners		Height			Radius of Fillet		Thread Length		Transition Thread Length
		Max.	Min.	Basic	Max.	Min.	Max.	Min.	Basic	Max.	Min.	Max.	Min.	Basic	Max.	
1/2 - 13 UNC	0.5000	0.515	0.482	7/8	0.875	0.850	1.010	0.969	5/16	0.323	0.302	0.031	0.009	1.00		0.19
5/8 - 11 UNC	0.6250	0.642	0.605	1-1/16	1.062	1.031	1.227	1.175	25/64	0.403	0.378	0.062	0.021	1.25		0.22
3/4 - 10 UNC	0.7500	0.768	0.729	1-1/4	1.250	1.212	1.443	1.383	15/32	0.483	0.455	0.062	0.021	1.38		0.25
7/8 - 9 UNC	0.8750	0.895	0.852	1-7/16	1.438	1.394	1.660	1.589	35/64	0.563	0.531	0.062	0.031	1.50		0.28
1" - 8 UNC	1.0000	1.022	0.976	1-5/8	1.625	1.575	1.876	1.796	39/64	0.627	0.591	0.093	0.062	1.75		0.31
1-1/8 - 7 UNC	1.1250	1.149	1.098	1-13/16	1.812	1.756	2.093	2.002	11/16	0.718	0.658	0.093	0.062	2.00		0.34
1-1/4 - 7 UNC	1.2500	1.277	1.223	2"	2.000	1.938	2.309	2.209	25/32	0.813	0.749	0.093	0.062	2.00		0.38
1-3/8 - 6 UNC	1.3750	1.404	1.345	2-3/16	2.188	2.119	2.526	2.416	27/32	0.878	0.810	0.093	0.062	2.25		0.44
1-1/2 - 6 UNC	1.5000	1.531	1.470	2-3/8	2.375	2.300	2.742	2.622	15/16	0.974	0.902	0.093	0.062	2.25		0.44

HEAVY HEXAGON NUT GRADE 2H

(Unit : Inchi)

Nominal Size or Basic Major Dia Thread		F			G		H		
		Width Across Flats			Width Across Corners		Thickness Heavy Hex. Nuts		
		Basic	Max.	Min.	Max.	Min.	Basic	Max.	Min.
1/2 - 13 UNC	0.5000	7/8	0.875	0.850	1.010	0.969	31/64	0.504	0.464
5/8 - 11 UNC	0.6250	1-1/16	1.062	1.031	1.227	1.175	39/64	0.631	0.587
3/4 - 10 UNC	0.7500	1-1/4	1.250	1.212	1.443	1.382	47/64	0.758	0.710
7/8 - 9 UNC	0.8750	1-7/16	1.438	1.394	1.660	1.589	55/64	0.885	0.833
1" - 8 UNC	1.0000	1-5/8	1.625	1.575	1.876	1.796	63/64	1.012	0.956
1-1/8 - 7 UNC	1.1250	1-13/16	1.812	1.756	2.093	2.002	1-7/64	1.139	1.079
1-1/4 - 7 UNC	1.2500	2"	2.000	1.938	2.309	2.209	1-7/32	1.251	1.187
1-3/8 - 6 UNC	1.3750	2-3/16	2.188	2.119	2.526	2.416	1-11/32	1.378	1.310
1-1/2 - 6 UNC	1.5000	2-3/8	2.375	2.300	2.742	2.622	1-15/32	1.505	1.433

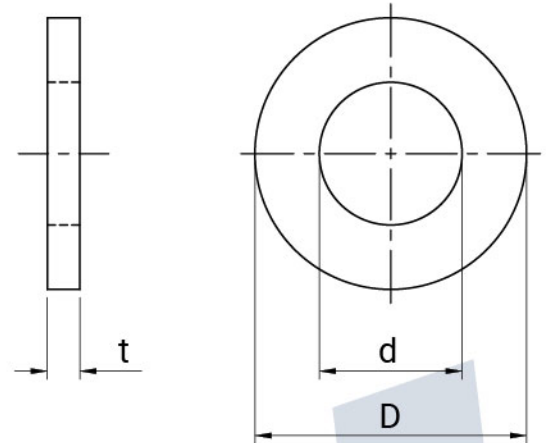


ASTM A325

HIGH STRENGTH STEEL PLAIN WASHER

(Unit : Inchi)

Bolt Size		d	D	t	
		Nominal Diameter of Hole	Nominal Diameter Diameter	Thickness Max.	Min.
1/2 - 13 UNC	12.700	17/32	1-1/16	0.097	0.177
5/8 - 11 UNC	15.875	11/16	1-5/16	0.122	0.177
3/4 - 10 UNC	19.050	13/16	1-15/32	0.112	0.177
7/8 - 9 UNC	22.225	15/16	1-3/4	0.136	0.177
1" - 8 UNC	25.400	1-1/8	2"	0.136	0.177
1-1/8 - 7 UNC	28.575	1-1/4	2-1/4	0.136	0.177
1-1/4 - 7 UNC	31.750	1-3/8	2-1/2	0.136	0.177
1-3/8 - 6 UNC	34.925	1-1/2	2-3/4	0.136	0.177
1-1/2 - 6 UNC	38.100	1-5/8	3"	0.136	0.177



MECHANICAL PROPERTIES

ASTM A325 HEAVY HEXAGON MECHANICAL BOLT

Bolt Size Threads per inch and Series Designation	Stress Area ^A in ²	Tensile Strength ^B lbf.	Proof Load ^B Length Measurement Method (lbf.)	Min. Alternate Proof Load ^B Yield Strength Method (lbf.)	Hardness Number			
		Min.			Brinell		Rockwell	
Column 1	Column 2	Column 3	Column 4	Column 5	Min	Max	Min	Max
1/2 - 13 UNC	0.142	17050	12050	13050	253	319	25	34
5/8 - 11 UNC	0.226	27100	19200	20800	253	319	25	34
3/4 - 10 UNC	0.334	40100	28400	30700	253	319	25	34
7/8 - 9 UNC	0.462	55450	39250	42500	253	319	25	34
1" - 8 UNC	0.606	72700	51500	55750	253	319	25	34
1-1/8 - 7 UNC	0.763	80100	56450	61800	223	256	19	30
1-1/4 - 7 UNC	0.969	101700	71700	78500	223	256	19	30
1-3/8 - 6 UNC	1.155	121300	85450	93550	223	256	19	30
1-1/2 - 6 UNC	1.405	147500	104000	113800	223	256	19	30

^A The stress area is calculate as follows :

$$A_s = 0.7854 [D - (0.9743/n)]^2$$

Where :

A_s = Stress area, in.²,

D = Nominal bolt size, and

n = Threads per inch.

^B Loads tabulated are based on the following :

Bolt Size	Column 3	Column 4	Column 5
1/2 to 1, incl.	120000 psi	85000 psi	92000 psi
	(825 Mpa)	(585 Mpa)	(635 Mpa)
1-1/8 to 1-1/2, incl.	105000 psi	74000 psi	81000 psi
	(725 Mpa)	(510 Mpa)	(560 Mpa)

ASTM A325

HEAVY HEXAGON NUT GRADE 2H

Bolt Size Threads per inch and Series Designation	Minimum Proof Load lb	Brinell Hardness Number		Rockwell C Hardness Number	
		Min	Max	Min	Max
1/2 - 13 UNC	24850	248	352	24	38
5/8 - 11 UNC	39550	248	352	24	38
3/4 - 10 UNC	58450	248	352	24	38
7/8 - 9 UNC	80850	248	352	24	38
1" - 8 UNC	106000	248	352	24	38
1-1/8 - 7 UNC	133500	248	352	24	38
1-1/4 - 7 UNC	169600	248	352	24	38
1-3/8 - 6 UNC	202100	248	352	24	38
1-1/2 - 6 UNC	245900	248	352	24	38

FINISHING OVERSIZE LIMIT OF NUT

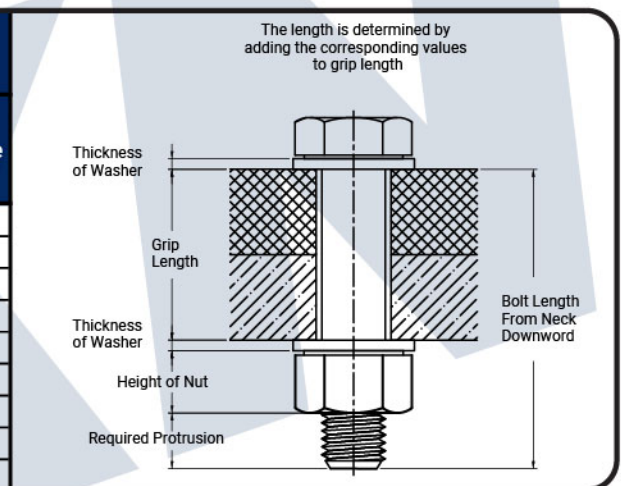
Nominal Bolt Diameter (in.)	Oversize Limit, in. ^A	
	Hot-Dip Zinc	Mechanical Zinc
1/2	0.018	0.012
9/16, 5/8, 3/4	0.020	0.013
7/8	0.022	0.015
1 to 1 1/4	0.024	0.016
1 3/8, 1 1/2	0.027	0.018

^A Hot-dip zinc nuts are tapped oversize after coating, and mechanical zinc coated nuts are tapped oversize before coating.

HIGH STRENGTH STEEL PLAIN WASHER

Bolt Size Threads per inch and Series Designation	Rockwell C Hardness Number	
	Min	Max
1/2 to 1 - 1/2, incl.	38	45

DETERMINATION OF BOLT LENGTH	
Nominal Diameter of Bolt	Additional Value
1/2 - 13 UNC	3/4
5/8 - 11 UNC	7/8
3/4 - 10 UNC	1"
7/8 - 9 UNC	1-1/8
1" - 8 UNC	1-1/4
1-1/8 - 7 UNC	1-3/8
1-1/4 - 7 UNC	1-1/2
1-3/8 - 6 UNC	1-5/8
1-1/2 - 6 UNC	1-3/4



CHEMICAL PROPERTIES

Element	Alloy Steel	
	Heat Analysis	Product Analysis
Carbon	0.30 - 0.52	0.28 - 0.55
Manganese, min	0.60	0.57
Phosphorus, max	0.035	0.040
Sulfur, max	0.040	0.045
Silicon	0.15 - 0.35	0.13 - 0.37
Alloying Elements	A	A

^A Steel, as defined by the American Iron and Steel Institute, Shall be considered to be alloy when the maximum of the range given for the content of alloying elements exceeds one or more of the following limits: Manganese, 1.65%; silicon, 0.60%; copper, 0.60% or in which a definite range or a definite minimum quantity of any of the following elements is specified or required within the limits of the recognized field of constructional alloy steels: aluminum, chromium up to 3.99%, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium, zirconium, or any other alloying elements added to obtain a desired alloying effect.

ASTM A325

WEIGHT

APPROXIMATE WEIGHT OF 100 BOLT AND NUTS IN POUNDS

ASTM A325 HEAVY HEXAGON STRUCTURAL BOLT

Diameter Length	1/2	5/8	3/4	7/8	1"	1-1/8	1-1/4	1-3/8	1-1/2
1	16.5	29.4	47.0	-	-	-	-	-	-
1 - 1/4	17.8	31.1	49.6	74.4	104	-	-	-	-
1 - 1/2	19.2	33.1	52.2	78.0	109	148	197	-	-
1 - 3/4	20.5	35.3	55.3	81.9	114	154	205	261	333
2	21.9	37.4	58.4	86.1	119	160	212	270	344
2 - 1/4	23.3	39.8	61.6	90.3	124	167	220	279	355
2 - 1/2	24.7	41.7	64.7	94.6	130	174	229	290	366
2 - 3/4	26.1	43.9	67.8	98.8	135	181	237	300	379
3	27.4	46.1	70.9	103.0	141	188	246	310	391
3 - 1/4	28.8	48.2	74.0	107.0	146	195	255	321	403
3 - 1/2	30.2	50.4	77.1	111.0	151	202	263	332	416
3 - 3/4	31.6	52.5	80.2	116.0	157	209	272	342	428
4	33.0	54.7	83.3	120.0	162	216	280	353	441
4 - 1/4	34.3	56.9	86.4	124.0	168	223	289	363	453
4 - 1/2	35.7	59.0	89.5	128.0	173	230	298	374	465
4 - 3/4	37.1	61.2	92.7	133.0	179	237	306	384	478
5	38.5	63.3	95.8	137.0	184	244	315	395	490
5 - 1/4	39.9	65.5	98.9	141.0	190	251	324	405	503
5 - 1/2	41.2	67.7	102.0	146.0	196	258	332	416	515
5 - 3/4	42.6	69.8	105.0	150.0	201	265	341	426	527
6	44.0	71.9	108.0	154.0	207	272	349	437	540
6 - 1/4	45.4	74.1	111.0	158.0	212	279	358	447	552
6 - 1/2	46.8	76.3	114.0	163.0	218	286	367	458	565
6 - 3/4	48.1	78.5	118.0	167.0	223	293	375	468	577
7	49.5	80.6	121.0	171.0	229	300	384	479	589
7 - 1/4	50.9	82.8	124.0	175.0	234	307	392	489	602
7 - 1/2	52.3	84.9	127.0	179.0	240	314	401	500	614
7 - 3/4	53.6	87.1	130.0	183.0	246	321	410	510	626
8	55.0	89.2	133.0	187.0	251	328	418	521	639
8 - 1/4	56.4	91.4	136.0	192.0	257	335	427	531	651
8 - 1/2	57.8	93.5	139.0	196.0	262	342	435	542	664
8 - 3/4	59.1	95.7	142.0	200.0	268	349	444	552	676
9	60.5	97.8	145.0	204.0	273	356	453	563	689
Per inch additional add	5.5	8.6	12.4	16.9	22.1	28.0	34.4	42.5	49.7
For each 100 plain round washers add	3.8	5.3	7.9	11.5	14.4	17.2	20.8	27.1	31.8

HEAVY HEXAGON NUT GRADE 2H

Nominal Size Type Nut	1/2	5/8	3/4	7/8	1"	1-1/8	1-1/4	1-3/8	1-1/2
Heavy Hex.	6.5	11.9	19.3	29.7	42.5	59.2	78.6	102.0	131.0

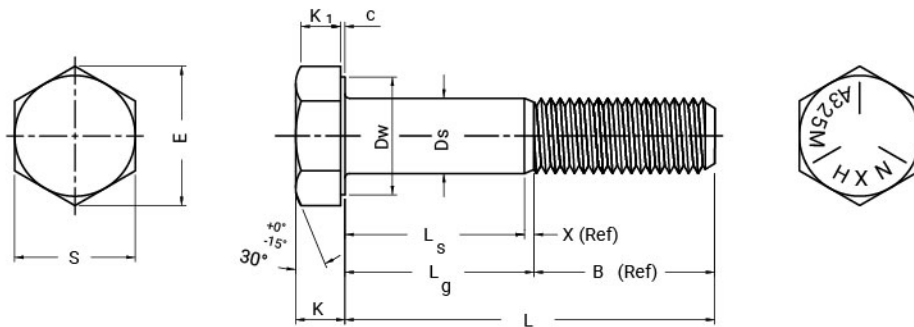
ASTM A325M

BOLT : ASTM A325M (HXN/HD)
NUT : ASTM A563 GRADE 2HM
WASHER : ASTM F436M



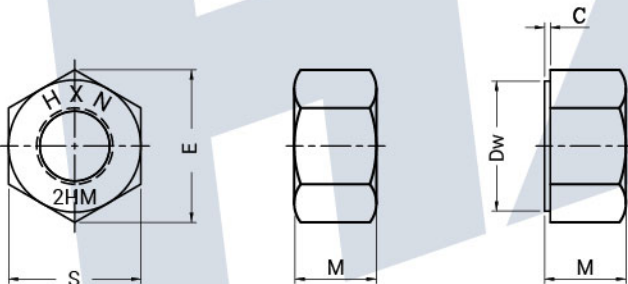
ASTM A325M

ASTM A325M HEAVY HEXAGON STRUCTURAL BOLT



Dia. D, and Thread Pitch	Body Diameter, D_s		Width Across Flats, S		Width Across Corners, E		Head Height, K		Wrenching Height K_1	Washer Face Dia., D_w	Washer Face Thickness, C		Thread Length, B (Ref)		Transition Thread Length, X (Ref)
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.			Max.	Min.	Lengths ≤ 100	Lengths > 100	
M16 x 2.00	16.70	15.30	27.00	26.16	31.18	29.56	10.75	9.25	6.5	24.9	0.8	0.4	31	38	6.0
M20 x 2.50	20.84	19.16	32.00	31.00	37.00	35.80	13.31	11.56	8.1	31.9	0.8	0.4	36	43	7.5
M22 x 2.50	22.84	21.16	36.00	35.00	41.57	39.55	14.90	13.10	9.2	33.3	0.8	0.4	38	45	7.5
M24 x 3.00	24.84	23.16	41.00	40.00	47.34	45.20	15.90	14.10	9.9	38.0	0.8	0.4	41	48	9.0
M27 x 3.00	27.84	26.16	46.00	45.00	53.12	50.85	17.90	16.10	11.3	42.8	0.8	0.4	44	51	9.0
M30 x 3.50	30.84	29.16	50.00	49.00	57.74	55.37	19.75	17.65	12.4	46.5	0.8	0.4	49	56	10.5

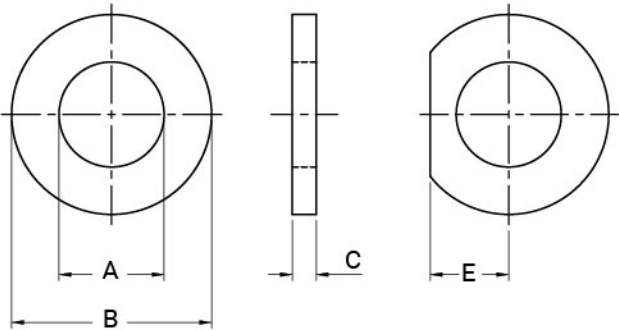
HEAVY HEXAGON NUT GRADE 2HM



Diameter and Thread Pitch	S		E		M		Dw	C	
	Width Across Flats		Width Across Corners		Thickness		Bearing Face Dia.	Washer Face Thickness	
	Max.	Min.	Approx.		Max.	Min.	Min.	Max.	Min.
M16 x 2.00	27.00	26.20	31.20		16.35	15.65	25.0	0.8	0.4
M20 x 2.50	32.00	31.00	37.00		20.40	19.60	29.0	0.8	0.4
M22 x 2.50	36.00	35.00	41.60		22.40	21.60	33.0	0.8	0.4
M24 x 3.00	41.00	40.00	47.30		24.40	23.60	38.0	0.8	0.4
M27 x 3.00	46.00	45.00	53.10		27.40	26.60	43.0	0.8	0.4
M30 x 3.50	50.00	49.00	57.70		30.40	29.60	47.0	0.8	0.4

ASTM A325M

HIGH STRENGTH STEEL PLAIN WASHER



Metric Series Nominal Washer Size, mm ^A	Inside Diameter (A), mm		Outside Diameter (B), mm		Thickness (C), mm		Clipped Width (E), mm, min ^B
	Max.	Min.	Max.	Min.	Max.	Min.	
M16-2.00	18.4	18.0	34.0	32.4	4.6	3.1	14.0
M20-2.50	22.5	22.0	42.0	40.4	4.6	3.1	17.5
M22-2.50	24.5	24.0	44.0	42.4	4.6	3.4	19.2
M24-3.00	26.5	26.0	50.0	48.4	4.6	3.4	21.0
M27-3.00	30.5	30.0	56.0	54.1	4.6	3.4	23.6
M30-3.50	33.6	33.0	60.0	58.1	4.6	3.4	31.5

ASTM A325M

MECHANICAL PROPERTIES

ASTM A325M HEAVY HEXAGON MECHANICAL BOLT

Nominal Bolt Diameter and Thread Pitch	Stress Area, mm ²	Proof Load Length Measurement Method (kN)	Proof Load Yield Strength Method (kN)	Tensile Strength , min, (kN)	Hardness Number			
					Rockwell, C		Vickers, V	
					Min	Max	Min	Max
M16-2.00	157	94.2	104	130	23	34	255	336
M20-2.50	245	147	162	203	23	34	255	336
M22-2.50	303	182	200	251	23	34	255	336
M24-3.00	353	212	233	293	23	34	255	336
M27-3.00	459	275	303	381	23	34	255	336
M30-3.50	561	337	370	466	23	34	255	336

HEAVY HEXAGON NUT GRADE 2HM

Nuts Size Threads Designation, Heavy Nuts Hex.	Proof Load Grade 2HM Heavy Nuts Hex. (kN) ^{A & D}	Stress Area, mm ²	Hardness Number		
			Brinell Hardness, min	Rockwell, C	
				Min	Max
M16-2.00	162.5	157.0	179	24	35
M20-2.50	253.6	245.0	179	24	35
M22-2.50	313.6	303.0	179	24	35
M24-3.00	365.4	353.0	179	24	35
M27-3.00	475.1	459.0	179	24	35
M30-3.50	580.6	561.0	179	24	35

^A The proof load for jam nuts shall be 46 % of the tabulated value.

^D Based on proof stress of 1035 MPa.

HIGH STRENGTH STEEL PLAIN WASHER

Bolt Size Threads per inch and Series Designation	Hardness Number	
	Rockwell, C	
	Min	Max
M16-2.00	26	45
M20-2.50	26	45
M22-2.50	26	45
M24-3.00	26	45
M27-3.00	26	45
M30-3.50	26	45

FINISHING OVERSIZE LIMIT OF NUT

Nominal Bolt Diameter	Oversize Limit, mm
M16-2.00	0.42
M20-2.50	0.53
M22-2.50	0.53
M24-3.00	0.64
M27-3.00	0.64
M30-3.50	0.75

JIS B1186 F10T

BOLT : JIS B1186 F10T (HXN/HD)

NUT : JIS B1186 F10

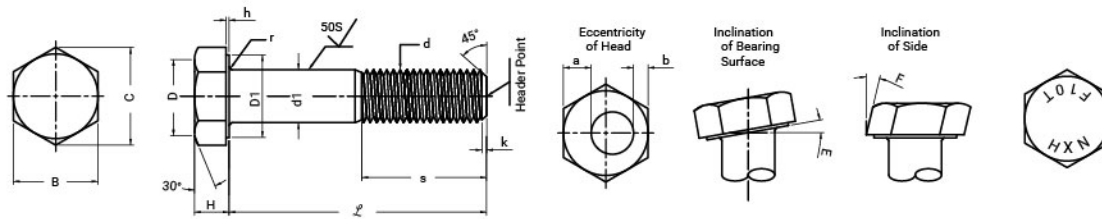
WASHER : JIS B1186 F35



JIS B1186 F10T

DIMENSION AND TOLERANCES

JIS B1186 F10T HEAVY HEXAGON STRUCTURAL BOLT

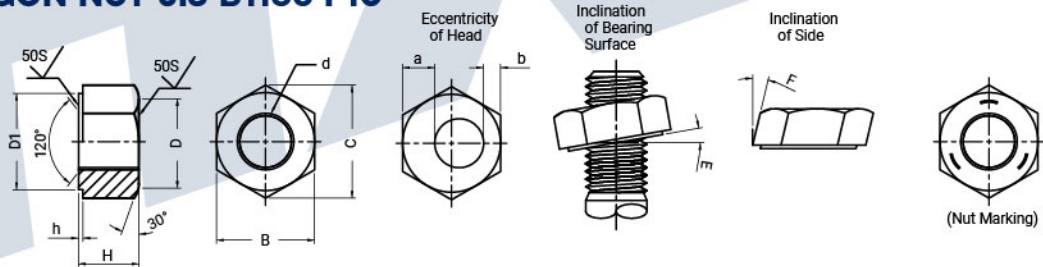


(Unit : mm)

Designation of Bolt (d)	d1		H		B		C	D	D1	r	k	a-b	E	F	h	S	
	Basic Dimension	Tolerance	Basic Dimension	Tolerance	Basic Dimension	Tolerance	Approx	Approx	Min.		Approx	Max.	Max.	Max.		Basic Dimension	Tolerance
M 12x1.75	12	+0.7 -0.2	8	±0.8	22	+0 -0.8	25.4	20	20	0.8 ~1.6	2	0.7				25	+5
M 16x2	16		10		27		31.2	25	25			0.8				30	-0
M 20x2.5	20		13		32		37	30	29	12		0.9				35	
M 22x2.5	22		14		36		41.6	34	33	~2.0	2.5	1.1				40	
M 24x3	24	+0.8 -0.4	15	±0.9	41	+0 -1	47.3	39	38	1.6	3	1.2	1°	2°	0.4 ~0.8	45	+6
M 27x3	27		17		46		53.1	44	43	~2.4		1.3				50	-0
M 30x3.5	30		19	±1.0	50		57.7	48	47	2.0 ~2.8	3.5	1.5				55	

ℓ	
Length	Tolerance
Under 55	±1.0
55 & Over - Under 125	±1.4
125 & Over	±1.8

HEAVY HEXAGON NUT JIS B1186 F10



(Unit : mm)

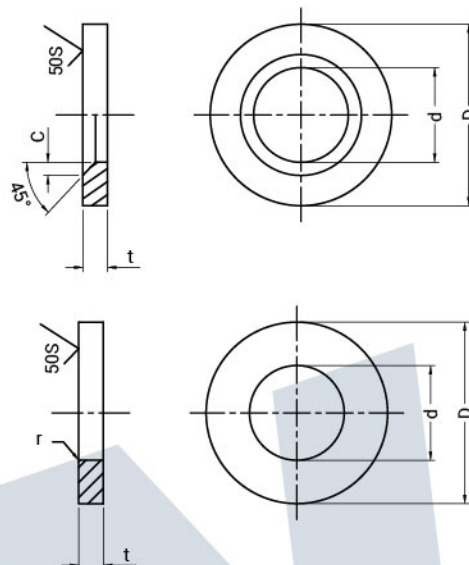
Nominal Size of Thread (d)	Outside Diameter External Thread	H		B		C	D	D1	a-b	E	F	h
		Basic Dimension	Tolerance	Basic Dimension	Tolerance	Approx.	Approx.	Min.	Max.	Max.	Max.	Approx.
M 12x1.75	12	12	±0.35	22	0 - 0.8	25.4	20	20	0.7			
M 16x2	16	16		27		31.2	25	25	0.8			
M 20x2.5	20	20		32		37	30	29	0.9			
M 22x2.5	22	22		36		41.6	34	33	1.1	1°	2°	0.4 - 0.8
M 24x3	24	24	±0.4	41	+0 -1	47.3	39	38	1.2			
M 27x3	27	27		46		53.1	44	43	1.3			
M 30x3.5	30	30		50		57.7	48	47	1.5			

JIS B1186 F10T

HIGH STRENGTH STEEL PLAIN WASHER

(Unit : mm)

Nominal Size of Washer	d		D		t		c or r
	Basic Dimension	Tolerance	Basic Dimension	Tolerance	Basic Dimension	Tolerance	Approx.
M 12x1.75	13	+0.7 0	26	+0 -0.8	3.2	± 0.4	1.5
M 16x2	17		32	+0 -1	4.5	0.5	2
M 20x2.5	21		40				
M 22x2.5	23	+0.8 0	44		6	0.7	2.4
M 24x3	25		48				
M 27x3	28	+1.0 0	56	+0 -1.2			
M 30x3.5	31		60		60		2.58



MECHANICAL PROPERTIES

JIS B1186 F10T HEAVY HEXAGON MECHANICAL BOLT

Grade of Bolt According to Mechanical Properties	Mechanical Properties of Test Piece Mechined from Bolt				Mechanical Properties of Full - size Bolt Minimum Tensile Load (kgf)							Hardness
	Yield Strenght (kg/mm ²)	Tensile Strenght (kg/mm ²)	Elongation (%)	Reduction of Area (%)	M 12	M 16	M 20	M 22	M 24	M 27	M 30	
F 10 T	90 Min.	100 - 120	14 Min.	40 Min.	8.430	15.700	24.500	30.300	35.300	45.900	56.100	HrC 27-38

HEAVY HEXAGON NUT JIS B1186 F10

Grade of Bolt According to Mechanical Properties	Hardness Test	Tension Test
	Hardness	Proof. Load
F 10	Hrb 95 - Hrc35	Same as Tensile Load (Min.) of Bolt

HIGH STRENGTH STEEL PLAIN WASHER

Grade of Bolt According to Mechanical Properties	Hardness
F 35	HrC 35-45

JIS B1186 F10T

TIGHTENING AXIAL STRENGTH AND TORQUE VALUE

The allowable tensile strength of a high strength friction grip bolted joint is calculated from the design tensile strength of the bolt. Because of tightening variations, the standard tensile strength is taken as 10 % more than the design tensile strength.

The design bolt **TIGHTENING AXIAL STRENGTH** is calculated using the following formula

$$N_o = 0.75 f_y A_e$$

N_o : Design bolt tensile strength
 f_y : Minimal bolt yield strength
 A_e : Effective cross section area

The design bolt **TIGHTENING TORQUE VALUE** is calculated using the following formula

$$T = K \times d \times N$$

T : Tightening torque value (kg-m)
 K : Torque coefficient
 d : Nominal bolt diameter (m)
 N : Bolt tensile strength (kg)

Grade	Nominal Size of Thread	Design Bolt Tensile Strength N_o (t)	Standard Bolt Tensile Strength N (t)	Standard Torque Coefficient K	Standard Tightening Torque value T (kg-m)
F 10 T	M 12x1.75	5.69	6.26	B 0.165	12
	M 16x2	10.6	11.7		31
	M 20x2.5	16.5	18.2		60
	M 22x2.5	20.5	22.6		82
	M 24x3	23.8	26.2		104
	M 27x3	31.0	34.1		152
	M 30x3.5	37.9	41.7		206

DESIGN DATA

Table of Allowable Yield Strength for High Strength Bolts

Type of High Strength bolt	Type of High Strength	Bolt Axial Diameter d (mm)	Bolt Hole Diameter d (mm)	Bolt Axial Cross-section Area A_t (cm ²)	Bolt Effective Cross-section Area A_e (cm ²)	Design Bolt Tensile Strength N_o (t)	Allowable Shear Strength (t)		Allowable Tensile Strength (t)
							1 Surface Friction	2 Surface Friction	
S 10 T	M 12x1.75	12	13.0	1.13	0.843	5.69	1.695	3.39	3.50
	M 16x2	16	17.0	2.01	1.57	10.6	3.02	6.03	6.23
	M 20x2.5	20	21.5	3.14	2.45	16.5	4.71	9.42	9.73
	M 22x2.5	22	23.5	3.80	3.03	20.5	5.70	11.4	11.8
	M 24x3	24	25.5	4.25	3.53	23.8	6.78	13.6	14.0
	M 27x3	27	28.5	5.73	4.59	31.0	8.60	17.2	17.8
	M 30x3.5	30	32.0	7.08	5.61	37.9	10.62	21.2	21.9

JIS B1186 F10T

UNIT WEIGHT AND PACKING

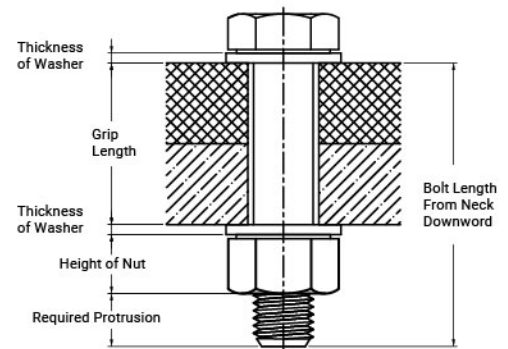
(Unit : gr)

Nominal Diameter	M 12		M 16		M 20		M 22		M 24		M 27		M 30	
Weight of Nut	30		57		97		137		201		275		356	
Weight of 2 Washer	20		40		64		104		124		174		260	
Bolt Length (mm)	Unit Weight of Set	Packing Sets per Box	Unit Weight of Set	Packing Sets per Box	Unit Weight of Set	Packing Sets per Box	Unit Weight of Set	Packing Sets per Box	Unit Weight of Set	Packing Sets per Box	Unit Weight of Set	Packing Sets per Box	Unit Weight of Set	Packing Sets per Box
40	107	300	202	160										
45	112	280	210	150	348	90								
50	116	280	217	150	361	80	496	65	648	45				
55	121	260	225	130	373	80	510	65	666	45				
60	125	260	233	130	385	80	525	60	683	45	953	25	1263	25
65	130	260	241	130	398	80	540	60	701	40				
70	134	230	249	125	410	75	555	55	719	40	999	25	1319	25
75	139	230	257	125	422	75	570	55	737	40				
80	143	210	265	110	435	65	585	50	754	40	1045	25	1375	20
85	148	210	273	110	447	65	600	50	772	35				
90	152	210	281	100	459	60	615	50	790	35	1091	25	1431	20
95	157	200	289	100	472	60	630	45	808	35				
100	161	200	296	100	484	60	645	45	825	35	1137	20	1487	20
105														
110			312	90	509	50	674	40	861	30	1183	20	1543	20
115														
120			327	90	533	50	704	40	896	25	1229	20	1599	20
125														
130			343	90	558	50	734	35	932	25	1275	20	1655	20
135														
140			358	80	582	45	764	35	967	25	1321	15	1711	15
145														
150			374	80	607	45	794	35	1003	25	1367	15	1767	15
155														
160									1038	25	1413	15	1823	15
165														
170									1074	20	1459	15	1879	10
175														
180									1109	20	1505	15	1935	10
190									1145	20	1551	15	1991	10
200									1180	20	1597	15	2047	10

DETERMINATION OF BOLT LENGTH

Nominal Diameter of Bolt	Additional Value
M 12x1.75	25
M 16x2	30
M 20x2.5	35
M 22x2.5	40
M 24x3	45
M 27x3	50
M 30x3.5	55

The length is determined by adding the corresponding values to grip length



DIN GRADE 8.8/10.9

BOLT : DIN931/DIN933 GRADE 8.8/10.9 (HXN/HD)
NUT : DIN934 CLASS 8/CLASS 10
WASHER* : PLAIN STEEL WASHER (DIN125A OPTIONAL)
SPRING WASHER** : PLAIN STEEL SPRING WASHER (DIN127 OPTIONAL)

**HIGH STRENGTH STEEL WASHER F436M/F35 OPTIONAL*

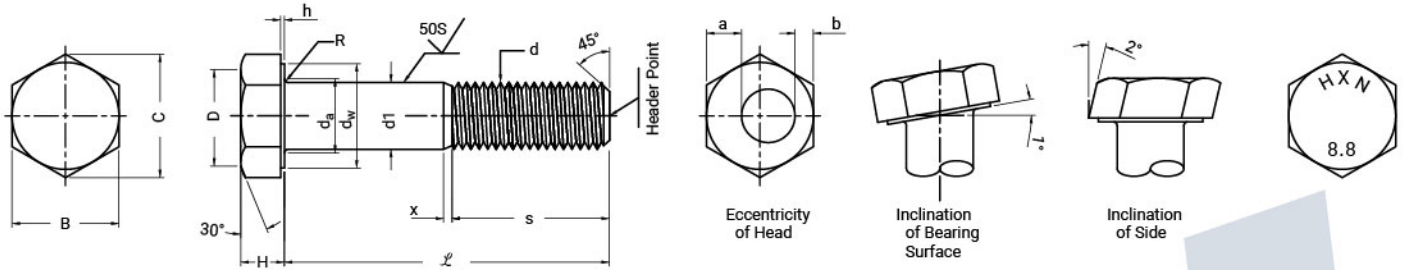
***HIGH STRENGTH STEEL SPRING WASHER OPTIONAL*



DIN GRADE 8.8/10.9

DIMENSION AND TOLERANCES

DIN GRADE 8.8/10.9 HEAVY HEXAGON STRUCTURAL BOLT



Nom. Size d x p	d1		H		B		C		D		R		da		k		a-b		h		dw		S	
	Max.	Min.	Basic	Max.	Min.	Max.	Min.	Approx.	Approx.	Min.	Max.	Approx.	Max.	Approx.	Max.	Approx.	Max.	Approx.	Min.	Max.	Min.	Max.	≤ 125	> 125
M 6x1	6.0	5.9	4	4.15	3.85	10.0	9.8	11.5	9.8	0.25	6.8	1	0.3	0.4	9	18	-	-	-	-	-	-	-	-
M 8x1.25	8.0	7.85	5.5	5.65	5.35	13.0	12.75	15	12.6	0.4	9.2	1.2	0.4	0.4	11.7	22	-	-	-	-	-	-	-	-
M 10x1.5	10.0	9.85	7	7.2	6.8	17.0	16.75	19.6	16.5	0.4	11.2	1.5	0.5	0.4	15.8	26	-	-	-	-	-	-	-	-
M 12x1.75	12.0	11.8	8	8.2	7.8	19.0	18.65	21.9	18.0	0.6	13.7	2	0.7	0.6	17.6	30	36	-	-	-	-	-	-	-
M 14x2	14.0	13.8	9	9.2	8.8	22.0	21.65	25.4	21.0	0.6	15.7	2	0.7	0.6	20.4	34	40	-	-	-	-	-	-	-
M 16x2	16.0	15.8	10	10.2	9.8	24.0	23.65	27.7	23.0	0.6	17.7	2	0.8	0.6	22.3	38	44	-	-	-	-	-	-	-
M 18x2.5	18.0	17.8	12	12.2	11.8	27.0	26.65	31.2	26.0	0.6	20.2	2.5	0.9	0.6	25.6	42	48	-	-	-	-	-	-	-
M 20x2.5	20.0	19.8	13	13.2	12.8	30.0	29.65	34.6	29.0	0.8	22.4	2.5	0.9	0.6	28.5	46	52	-	-	-	-	-	-	-
M 22x2.5	22.0	21.8	14	14.2	13.8	32.0	31.6	37	31	0.8	24.4	2.5	1.1	0.6	30.4	50	56	-	-	-	-	-	-	-
M 24x3	24.0	23.8	15	15.2	14.8	36.0	35.6	41.6	34.0	0.8	26.4	3	1.2	0.6	34.2	54	60	-	-	-	-	-	-	-

TOLERANCE ON ℓ

unit: mm

Division of	M6 to M24
L < 50	+0.5
50 < L < 120	+0.7
120 < L < 250	+0.8

TOLERANCE ON s

unit: mm

Division of s	Tolerance
s < 30	+3 -0
30 < s < 50	+4 -0
50 < s < 80	+5 -0

x=2p

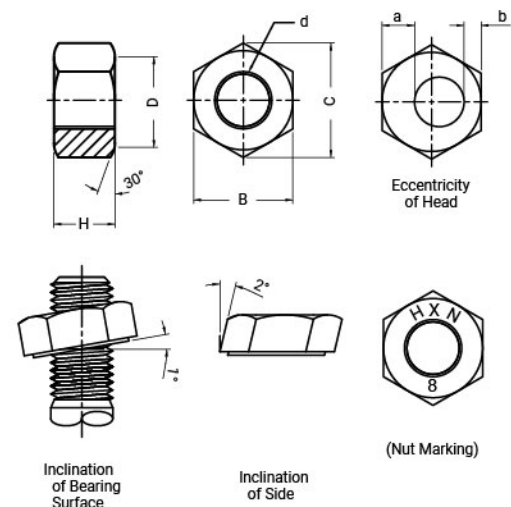
x=3p

Half Threaded Bolt

Fully Threaded Bolt

HEAVY HEXAGON NUT DIN934 CLASS 8/CLASS 10

Nominal Size d	Width Across Flats, B		Width Across Corner, C	Thickness H	
	Nom./Max	Min.	Min.	Nom./Max.	Min.
M 6x1	10.00	9.78	11.05	5.00	4.70
M 8x1.25	13.00	12.73	14.38	6.50	6.14
M 10x1.5	17.00	16.73	18.9	8.00	7.64
M 12x1.75	19.00	18.67	21.1	10.00	9.64
M 14x2	22.00	21.67	24.49	11.00	10.30
M 16x2	24.00	23.67	26.75	13.00	12.30
M 18x2.5	27.00	26.16	29.56	15.00	14.30
M 20x2.5	30.00	29.16	32.95	16.00	14.90
M 22x2.5	32.00	31.00	35.03	18.00	16.90
M 24x3	36.00	35.00	39.55	19.00	17.70



DIN GRADE 8.8/10.9

MECHANICAL PROPERTIES

DIN GRADE 8.8/10.9 HEAVY HEXAGON MECHANICAL BOLT

No.	Mechanical or physical property		d ≤ 16mm	d > 16mm
1	Tensile strength, R_m , Mpa	nom, ^c	800	
		min.	800	830
2	Lower yield strength, R_{eL} ^d , Mpa	nom, ^c	-	-
		min.	-	-
3	Stress under proof load, S_p ^f , Mpa	nom.	580	600
4	Percentage elongation after fracture for Machined test pieces, A , %	min.	12	12
5	Vickers hardness, HV $F \geq 98$ N	min.	250	255
		max.	320	335
6	Brinell hardness, HBW $F = 30 D^2$	min.	245	250
		max.	316	331
7	Rockwell hardness, HRB	min.	-	-
		max.	-	-
	Rockwell hardness, HRC	min.	22	23
		max.	32	34

Note:

- a: In case of dispute, the product analysis applies.
- b: Boron content can reach 0,005 %, provided non-effective boron is controlled by the addition of titanium and/or aluminium.
- e: In case of plain carbon boron steel with a carbon content below 0,25 % (cast analysis), the minimum manganese content shall be 0,6% for property class 8.8 and 0,7 % for property classes 9.8 and 10.9.
- f: For the materials of these property classes, there shall be a sufficient hardenability to ensure a structure consisting of approximately 90 % martensite in the core of the threaded sections for the fasteners in the "as-hardened" condition before tempering.
- g: This alloy steel shall contain at least one of the following elements in the minimum quantity given: chromium 0,30 %, nickel 0,30 %, molybdenum 0,20 %, vanadium 0,10 %. Where elements are specified in combinations of two, three or four and have alloy contents less than those given above, the limit value to be applied for steel class determination is 70 % of the sum of the individual limit values specified above for the two, three or four elements concerned.

HEAVY HEXAGON NUT DIN934 CLASS 8/CLASS 10

Thread D	Vickers Hardness, HV		Rockwell Hardness, HRC	
	Min.	Max.	Min.	Max.
M5 ≤ D ≤ M16	200	302	-	30
M16 ≤ D ≤ M39	233 ^a	353 ^b	-	36 ^b

DIN GRADE 8.8/10.9

PROOF LOAD VALUES FOR NUTS WITH COARSE THREAD

Thread D	Pitch P	Proof Load (N)	Nominal stress area
M6	1	17200	20.1
M8	1.25	31800	36.6
M10	1.5	50500	58
M12	1.75	74200	84.3
M14	2.0	101200	115
M16	2.0	138200	157
M18	2.5	176600	192
M20	2.5	225400	245
M22	2.5	278800	303
M24	3.0	324800	353

HIGH STRENGTH STEEL PLAIN WASHER

Properties class		300 HV
Vicker hardness, HV	Min.	300
	Max.	370
Rockwell hardness, HRC	Min.	30
	Max.	39

CHEMICAL PROPERTIES

MATERIAL FOR BOLTS

Class	Material and Treatment	C		P	S	B	Tempering Temp. [°C]
		Min.	Max.	Max.	Max.	Max.	
8.8	Carbon Steel with additives (E.G. B, MN or CR) Quenched and Tempered	0.15	0.4	0.025	0.025	0.003	425
	Carbon Steel Quenched and Tempered	0.25	0.55	0.035	0.025		
	Alloy steel quenched and tempered	0.20	0.55	0.025	0.025		

DIN GRADE 8.8/10.9

MATERIAL FOR NUTS

Property Class		Chemical composition limit (cast analysis,%)			
		C		P	S
		Min.	Max.	Max.	Max.
8	High nut	0.58	0.25	0.060	0.150
8	Regular nut D≤M16	0.58	0.55	0.060	0.150
8	Regular nut D≥M16	0.58	0.3	0.048	0.058

MATERIAL FOR WASHERS

Property Class		Chemical composition limit (cast analysis,%)				
		C		P	S	B
		Min.	Max.	Max.	Max.	Max.
HV100	Carbon steel	* Note				
HV200	Carbon steel	* Note				
HV300	Carbon steel, QT	0.80	0.17	0.035	0.035	0.003
HV380	Carbon steel, QT	0.80	0.40	0.035	0.035	0.003

METRIC BOLT TORQUE

Estimated with clamp load as 75% of proff load
as specified in ISO 898-1

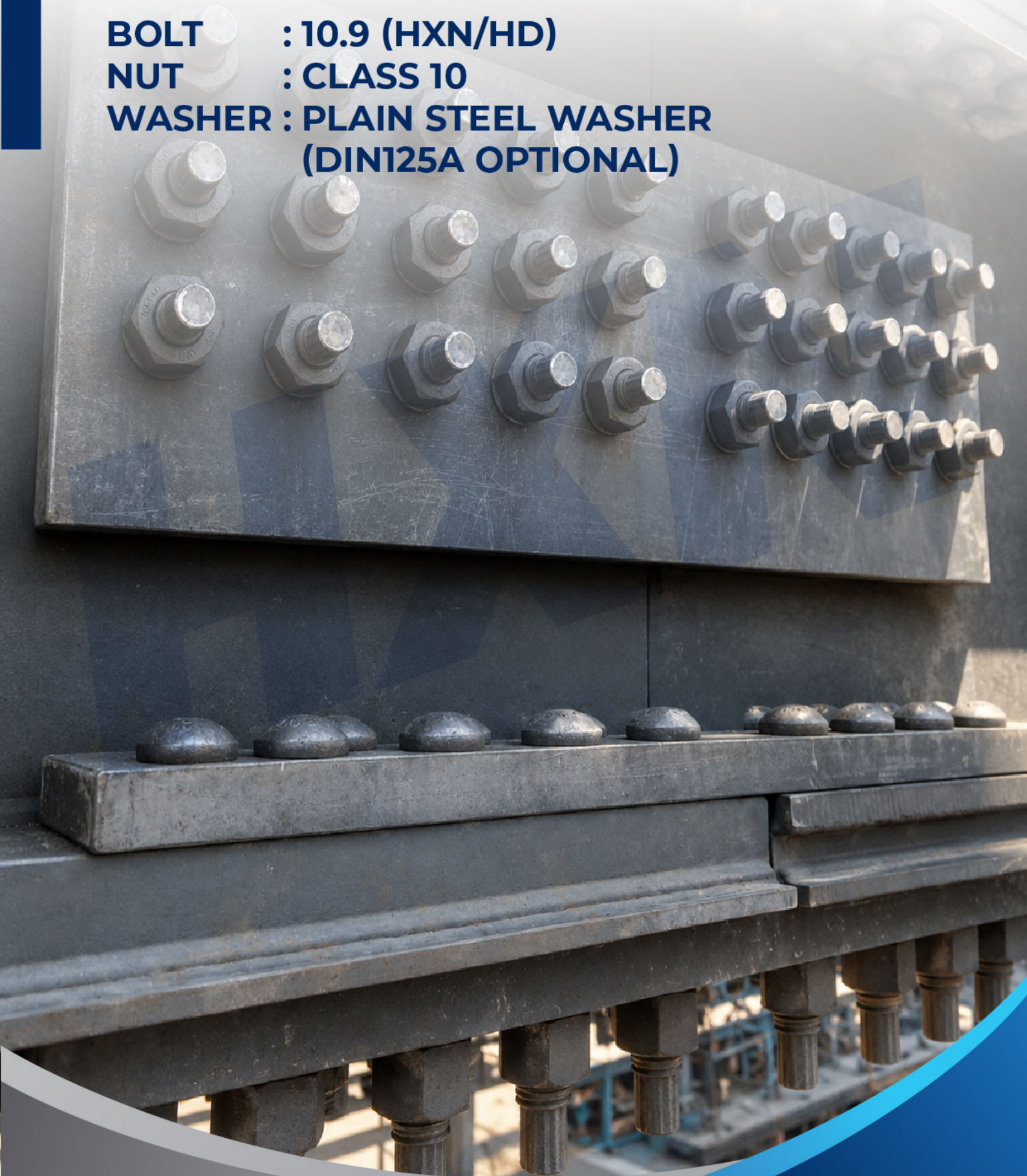
Property Class		
Minimum Tensile Strength Mpa	M6 - M16: 800	
	M20 - M30: 830	
Nominal Size and Theard Pitch	Bolt Torque Specs in Newton Meters - Nm	
	Dry	Lubed
M 6x1.00	10.4	7.8
M 8x1.25	25.4	19.1
M 10x1.5	50	38
M 12x1.75	88	66
M 14x2	141	106
M 16x2	218	164
M 18x2.5	301	226
M 20x2.5	426	319
M 22x2.5	580	435
M 24x3	736	552

TOR - CON BOLT

BOLT : 10.9 (HXN/HD)

NUT : CLASS 10

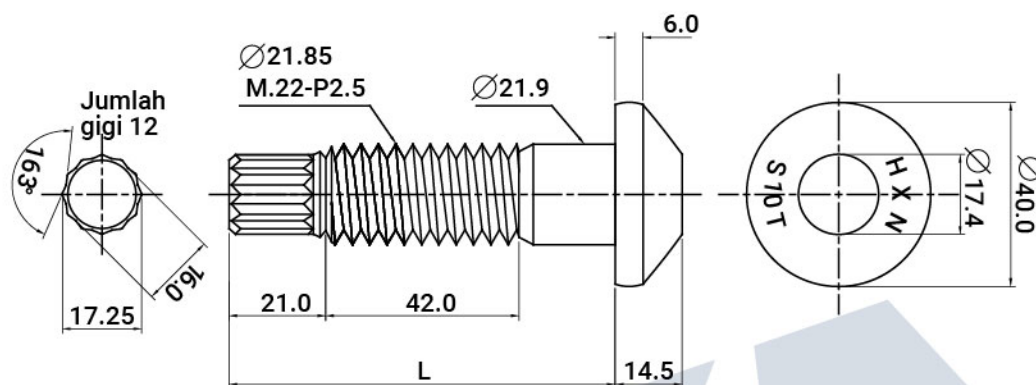
**WASHER : PLAIN STEEL WASHER
(DIN125A OPTIONAL)**



TC BOLTS

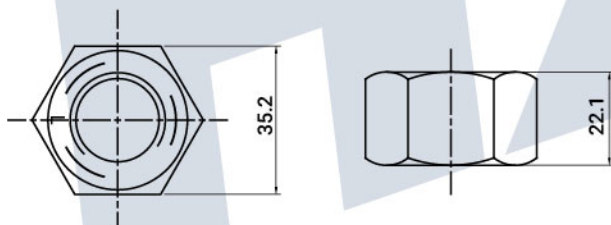
DIMENSION AND TOLERANCES

TC STRUCTURAL BOLT



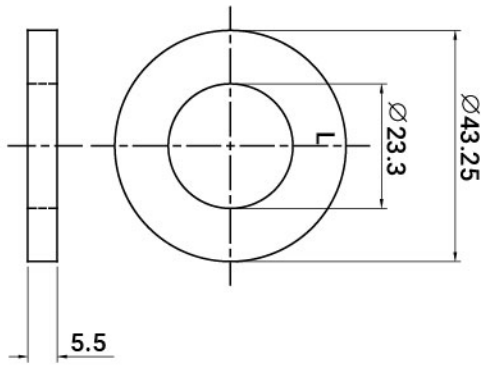
Designation of Bolt (d)	d1		D1	D	H		h	B		r	a-b	E	B	
	Basic Dimension	Tolerance	Min.	Min.	Basic Dimension	Tolerance	Approx.	Basic Dimension	Tolerance	Approx.	Max.	Max.	Basic Dimension	Tolerance
M 16	16	+0.7-0.2	26	27	10	±0.8	15	11.3	±0.3	1.2-2.0	0.8	1°	10	+5-0
M 20	20	+0.8 -0.4	33	34	13	±0.9	18	14.1			0.9		13	
M 22	22		37	38.5	14		19	15.4			1.1		14	+6-0
M 24	24		41	43	15		20	16.8			1.2		15	

HEAVY HEXAGON NUT GRADE 2HM



Nominal Size of Thread (d)	Outsider Diameter external Thread (d)	H		B		C	D	D1	a-b	E	F	H
		Basic Dimension	Tolerance	Basic Dimension	Tolerance	Approx.	Approx.	Min.	Max.	Max.	Max.	Approx.
M 16	16	16	± 0.35	27	0-0.8	31.2	25	25	0.8	1°	2°	0.4-0.8
M 20	20	20	± 0.4	32		37	30	30	0.9			
M 22	22	22		36	0-1	41.6	34	34	1.1			
M 24	24	24		41		47.3	39	39	1.2			

WASHER



Nominal Size of Washers	d		D		t		c or r
	Basic Dimension	Tolerance	Basic Dimension	Tolerance	Basic Dimension	Tolerance	Approx.
M 16	17	+0.7-0	32	0 -1	4.5	0.5	1.5
M 20	21	+0.8-0	40				2
M 22	23		44		6	0.7	2.4
M 24	25		48				

SPECIAL PROPERTY OF TOR-CON BOLTS

STABLE FASTENING TENSION

TMS TC Bolts are manufactured with a high level of quality control which ensure constant mechanical properties, especially the twisting shear strength of the pin tail. Therefore the axial tightening force for a group of bolts is constant.

STABLE TORQUE COEFFICIENT AT DIFFERENT TEMPERATURE

TMS nuts are manufactured with special surface treatment which minimize the effect of temperature variation on the axial tightening force :

Bolt tension is calculated using the formula below.

$$N = \frac{T}{K \times d}$$

N : Bolt axial force (kg)

T : Torque value at shear off of pin tail (kg,m)

K : Torque coefficient

d : Bolt nominal diameter (m)

STABLE TORQUE COEFFICIENT AT DIFFERENT TEMPERATURE

No special skill is required in using TMS TC Bolts. Fastening finish can be breakage of pin tail. Special control or inspection is also unnecessary. The breakage of pin stable fastening tension.

MECHANICAL PROPERTIES

BOLT

Grade of Bolt According to Mechanical Properties	Mechanical Properties of Test Piece Machined from Bolt				Mechanical Properties of Full - Size Bolt				Hardness
	Yield Hardness Strength (kg/mm²)	Tensile Strength (kg/mm²)	Elongation (%)	Reduction of Area (%)	Minimum Tensile Load (kgf)				
					M 16	M 20	M 22	M 24	
S 10 T	90 Min.	100 - 120	14 Min.	40 Min.	15.700	24.500	30.300	35.300	HrC 27-38

NUT

Grade of Bolt According to Mechanical Properties	Hardness Test	Tension Test
	Hardness	Proof. Load
F 10	HrB 95 HrC 35	Same as Tensile Load (Min.) of Bolt

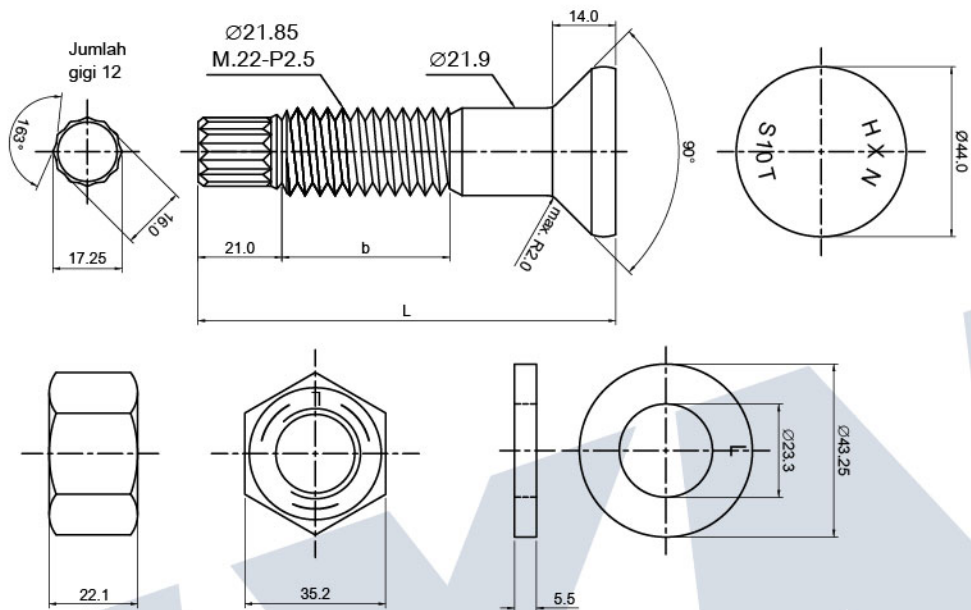
WASHER

Grade of Bolt According to Mechanical Properties	Hardness
F 35	HrC 35-45

GRIP AXIAL STRENGTH

Grade of Bolt According to Mechanical Properties	Designation of Bolt	Grip Axial Strength of The Set at Ambient Temperature (10° C - 30° C)		Grip Axial Strength of The Set Outside Ambient Temperature
		Average Tightening Axial Strength (t)	Standard Deviation of Tightening Axial Strength (t)	Average Tightening Axial Strength (t)
S 10 T	M 16	11.0 - 13.3	Max. 0.85	10.6 - 13.9
	M 20	17.2 - 20.7	Max. 1.30	16.5 - 21.7
	M 22	21.2 - 25.6	Max. 1.60	20.5 - 26.8
	M 24	24.7 - 29.8	Max. 1.90	23.8 - 31.2

BOLTING ASSEMBLIES



DIMENSIONS OF COUNTERSUNK HEAD BOLTS IN ACCORDANCE WITH BS EN 14399-10

Thread d		M12	M16	M20	M22	M24	M27	M30	M36
p		1.75	2.0	2.5	2.5	3.0	3.0	3.5	4.0
b	≤ 125mm	30	38	46	50	54	60	66	78
	> 125 ≤200mm	-	44	52	56	60	66	72	84
	> 200mm	-	-	65	69	73	79	85	97
ds	max	12.70	16.70	20.84	22.84	24.84	27.84	30.84	37.00
	min	11.30	15.30	19.16	21.16	23.16	26.16	29.16	35.00
dk	max	24	32	40	44	48	54	60	72
	min	23.16	31.16	39.00	43.00	47.00	53.00	58.80	70.80
k	nom	8.0	10.1	13.0	14.0	16.0	17.5	19.5	23.0
	max	8.80	10.75	13.90	14.90	16.90	18.40	20.55	24.05
	min	7.25	9.25	12.10	13.10	15.10	16.10	18.45	21.95
r	max	1.6	1.6	2.0	2.0	2.0	2.5	2.5	2.5
	min	1.2	1.2	1.5	1.5	1.5	2.0	2.0	2.0
F1	min	11.0	13.0	15.0	15.5	16.0	19.0	21.0	25.0
F2	max	16.0	18.0	20.0	21.0	21.5	24.0	26.0	31.0
Spline a/f S _b	max	8	11.6	14.4	15.7	17.1	19.3	21.4	25.7
	min	7.4	11.0	13.8	15.1	16.5	18.7	20.8	
Spline a/c e _b	min	8.36	12.43	15.60	17.06	18.65	21.13	23.50	28.50