



Nord-Lock Washer Technical Details

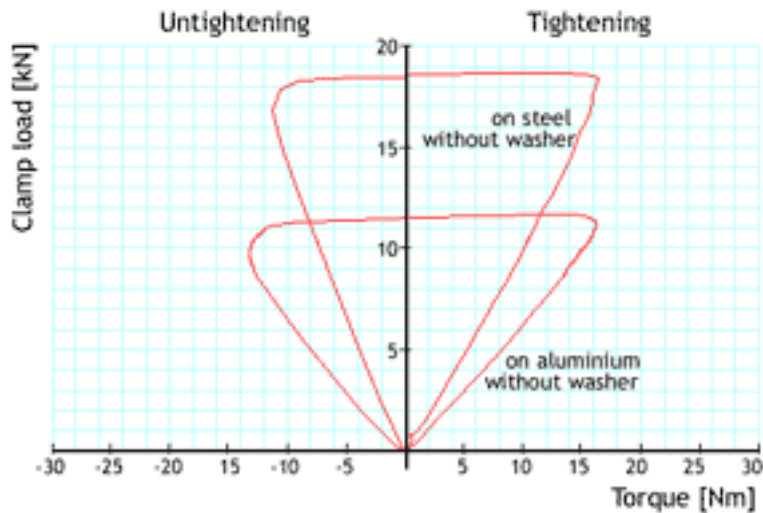


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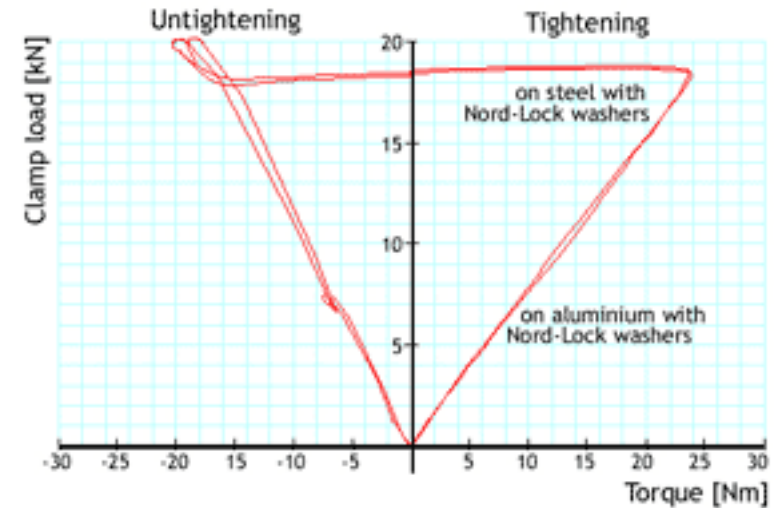
Torque Load Diagrams

It has become more and more important to have good control of the torque-clamp load relationship when tightening a joint. To optimize the design of the joint and utilize as much of the capacity of each dimension as possible, you need to know the required tightening torque to obtain the desired clamp load with a minimum of deviation.

In our test laboratory we perform torque load tests that are corresponding to our customers specific design conditions. Due to the fact that the clamp load of the joint depends on the friction between the sliding surfaces, you will receive different clamp loads depending on the surface conditions.



This diagram shows the deviation in clamp load when not using any washer. When applying the same tightening torque you will receive different clamp load values depending on the material you are tightening against (aluminium or steel). Because of the higher friction when tightening against aluminium the clamp load will be much lower.

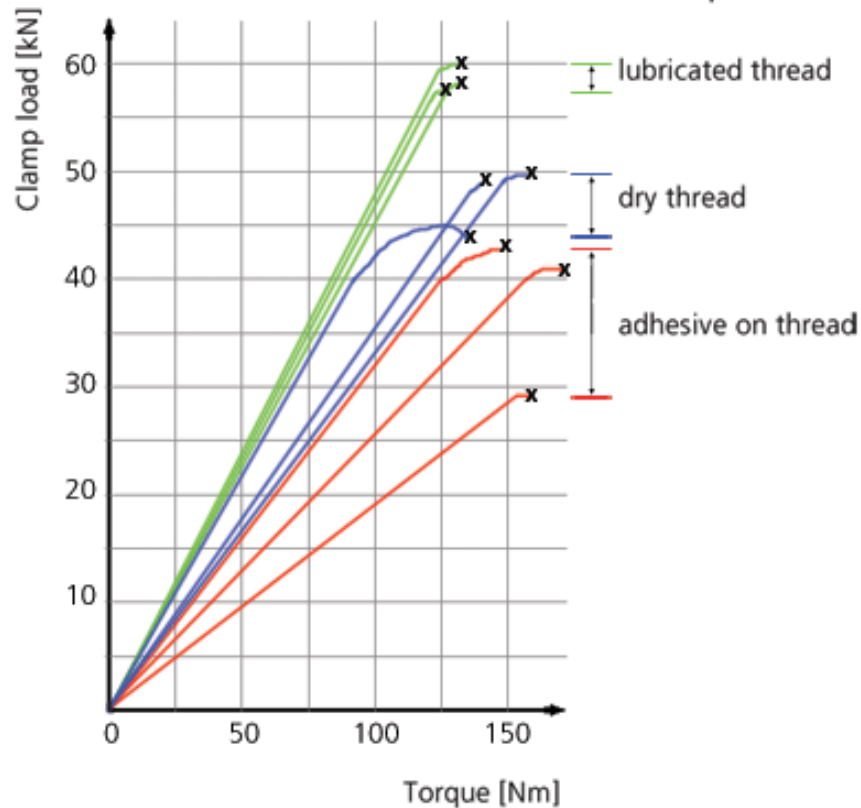


When using NORD-LOCK washers sliding will always occur between the same surfaces, i.e. between the washer and the head of the bolt, with the same surface conditions. You will receive a clamp load with a minimum of deviation.

Minimize Torsion Stress

During tightening, bolts are subjected to both tensile and torsional stress. The desired tensile stress (clamp load) is achieved when the bolt is stretched. Unwanted torsional stress (twisting) in bolts arises during tightening due to friction between the contact surfaces in the threads. High thread friction increases twisting of the bolts and causes yielding at lower clamp load levels than normal.

Yield points:



Applying an adhesive significantly increases thread friction during tightening. The graph to the right shows that when tightening bolts with adhesives on the threads, only half as much clamp load was obtained before reaching the yield points compared to when tightening similar lubricated bolts.

Since NORD-LOCK's unique wedge-locking technique is not affected by lubrication, the thread friction, and thereby also the torsional stress, can be minimized.

In addition, the diagram shows that at any given torque value the clamp load deviation for lubricated bolts is very low. Using NORD-LOCK washers together with a lubricant ensures that bolted joints will be safely locked at the highest possible clamp load level.

Example of a torque-load diagram for M12 bolt (8.8)

Torque Guidelines For Steel Washers (Metric)

Nord-Lock zinc flake coated (DP = Delta Protekt®) washers with electro zinc plated bolt 8.8

Washer Size	Bolt Size	Pitch (mm)	Oil, $G_F=0,75$		GTP600, $G_F=0,75$		Dry, $G_F=0,62$	
			Torque (Nm)	Clamp Load (kN)	Torque (Nm)	Clamp Load (kN)	Torque (Nm)	Clamp Load (kN)
NL3	M3	0,5	1,3	2,4	1,2	2,4	1,3	2,0
NL4	M4	0,7	3,1	4,2	2,8	4,2	3,1	3,5
NL5	M5	0,8	6,0	6,8	5,4	6,8	6,0	5,6
NL6	M6	1,0	10,5	9,7	9,5	9,7	10,5	8,0
NL8	M8	1,25	25	18	23	18	25	15
NL10	M10	1,5	49	28	45	28	50	23
NL12	M12	1,75	85	40	77	40	85	33
NL14	M14	2,0	135	55	122	55	136	46
NL16	M16	2,0	205	75	185	75	208	62
NL18	M18	2,5	288	92	260	92	291	76
NL20	M20	2,5	402	118	363	118	408	97
NL22	M22	2,5	548	146	494	146	557	120
NL24	M24	3,0	693	169	625	169	703	140
NL27	M27	3,0	1010	221	910	221	1028	182
NL30	M30	3,5	1379	269	1243	269	1401	222
NL33	M33	3,5	1855	333	1669	333	1889	275
NL36	M36	4,0	2394	392	2156	392	2436	324
NL39	M39	4,0	3087	468	2777	468	3145	387
NL42	M42	4,5	3820	538	3439	538	3890	445

GTP600 = graphite lubricant
 G_F = ratio of yield point
 μ_g = thread friction
 μ_w = washer friction

Nord-Lock zinc flake coated (DP) (with non-plated bolt 10.9)

Washer Size	Bolts Size	Pitch (mm)	Oil, $G_F=0,71$		GTP600, $G_F=0,75$	
			Torque (Nm)	Clamp Load (kN)	Torque (Nm)	Clamp Load (kN)
NL3	M3	0,5	1,8	3,2	1,6	3,4
NL4	M4	0,7	4,1	5,6	3,6	5,9
NL5	M5	0,8	8,1	9,1	7,0	9,6
NL6	M6	1,0	14,1	12,9	12,3	13,6
NL8	M8	1,25	34	23	30	25
NL10	M10	1,5	67	37	58	39
NL12	M12	1,75	115	54	99	57
NL14	M14	2,0	183	74	158	78
NL16	M16	2,0	279	100	240	106
NL18	M18	2,5	391	123	337	130
NL20	M20	2,5	547	156	470	165
NL22	M22	2,5	745	194	639	205
NL24	M24	3,0	942	225	809	238
NL27	M27	3,0	1375	294	1176	310
NL30	M30	3,5	1875	358	1608	378
NL33	M33	3,5	2526	443	2157	468
NL36	M36	4,0	3259	522	2788	551
NL39	M39	4,0	4203	624	3588	659
NL42	M42	4,5	5202	716	4445	757

Nord-Lock zinc flake coated (DP) with non-plated bolt 12.9

Washer Size	Bolt Size	Pitch (mm)	Oil, $G_F=0,71$		GTP600, $G_F=0,75$	
			Torque (Nm)	Clamp Load (kN)	Torque (Nm)	Clamp Load (kN)
NL3	M3	0,5	2,0	3,9	1,7	4,1
NL4	M4	0,7	4,6	6,7	4,0	7,1
NL5	M5	0,8	9,1	10,9	7,7	11,5
NL6	M6	1,0	15,8	15,4	13,5	16,3
NL8	M8	1,25	38	28	32	30
NL10	M10	1,5	75	44	64	47
NL12	M12	1,75	128	65	109	68
NL14	M14	2,0	204	89	174	94
NL16	M16	2,0	311	120	263	127
NL18	M18	2,5	437	148	370	156
NL20	M20	2,5	610	188	515	198
NL22	M22	2,5	831	233	699	246
NL24	M24	3,0	1052	270	887	286
NL27	M27	3,0	1533	352	1288	372
NL30	M30	3,5	2091	430	1761	454
NL33	M33	3,5	2815	532	2362	562
NL36	M36	4,0	3633	626	3053	662
NL39	M39	4,0	4683	748	3925	790
NL42	M42	4,5	5799	860	4866	908



As of 22-11-2007

Torque Guidelines For Stainless Steel Washers (Metric)

Nord-Lock stainless steel (A4) washers with stainless steel bolt, lubricated with GTP600

Washer Size	Bolt Size	Pitch (mm)	A4-70, $G_F=0,65$		A4-80, $G_F=0,65$	
			Torque (Nm)	Clamp Load (kN)	Torque (Nm)	Clamp Load (kN)
NL3 ss	M3	0,5	0,9	1,5	1,2	2,0
NL4 ss	M4	0,7	2,0	2,6	2,7	3,4
NL5 ss	M5	0,8	3,9	4,1	5,3	5,5
NL6 ss	M6	1,0	6,9	5,9	9,2	7,8
NL8 ss	M8	1,25	17	11	22	14
NL10 ss	M10	1,5	33	17	43	23
NL12 ss	M12	1,75	56	25	75	33
NL14 ss	M14	2,0	89	34	119	45
NL16 ss	M16	2,0	136	46	181	61
NL18 ss	M18	2,5	191	56	254	75
NL20 ss	M20	2,5	267	72	356	95
NL22 ss	M22	2,5	364	89	485	118
NL24 ss	M24	3,0	460	103	613	137
NL27 ss	M27	3,0	671	134	895	179
NL30 ss	M30	3,5	915	164	1220	219
NL33 ss	M33	3,5	1233	203	1644	270
NL36 ss	M36	4,0	1591	239	2121	319
NL39 ss	M39	4,0	2053	285	2737	381
NL42 ss	M42	4,5	2540	328	3386	437

GTP600 = graphite lubricant
 G_F = ratio of yield point
 μ_g = thread friction
 μ_w = washer friction
 1ft = 0,3048 m
 1lb = 0,4536kg = 4,450 N
 1ftlb = 0,3048 x 0,4536 x 9,81 = 1,356 Nm

Lubrication

NORD-LOCK recommends the use of a good lubricant (e.g. GTP600 or Molykote® 1000) in order to reduce friction, minimize preload deviation and protect against corrosion.

Reuse

NORD-LOCK washers can normally be reused. However, for high temperature applications, reuse is not recommended. Always lubricate fasteners before reusing!

Temperatures

NORD-LOCK washers have similar temperature characteristics as bolts/nuts of corresponding material. The hardness of NORD-LOCK steel washers decreases at temperatures above 200°C. Stainless steel (A4) washers start to degrade at temperatures above 500°C. For applications up to 700°C we recommend our Inconel® 718 washers.

Calculation of load area

The load area [mm²] under the washer must be larger than the clamp load [N] divided by the yield point [N/mm²] of the material.

$$\text{Load area (mm}^2\text{)} > \frac{\text{Clamp Load (N)}}{\text{Yield point (N/mm}^2\text{)}}$$

Design

2D & 3D models of all NORD-LOCK products.



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