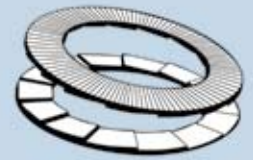


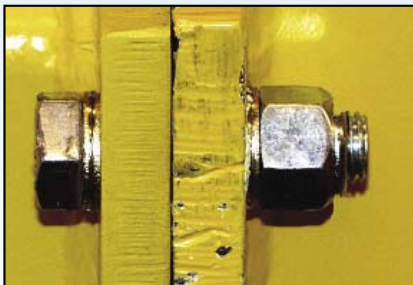
NORD-LOCK®



Bolt securing system



This unique bolt securing system uses tension to make the bolt self-locking



The small details provide the best locking effect



Nord-Lock® has cams on one side with a greater rise than the pitch of the bolt. In addition, Nord-Lock® has radial teeth on the opposite side. The washers are installed in pairs, cam face to cam face.

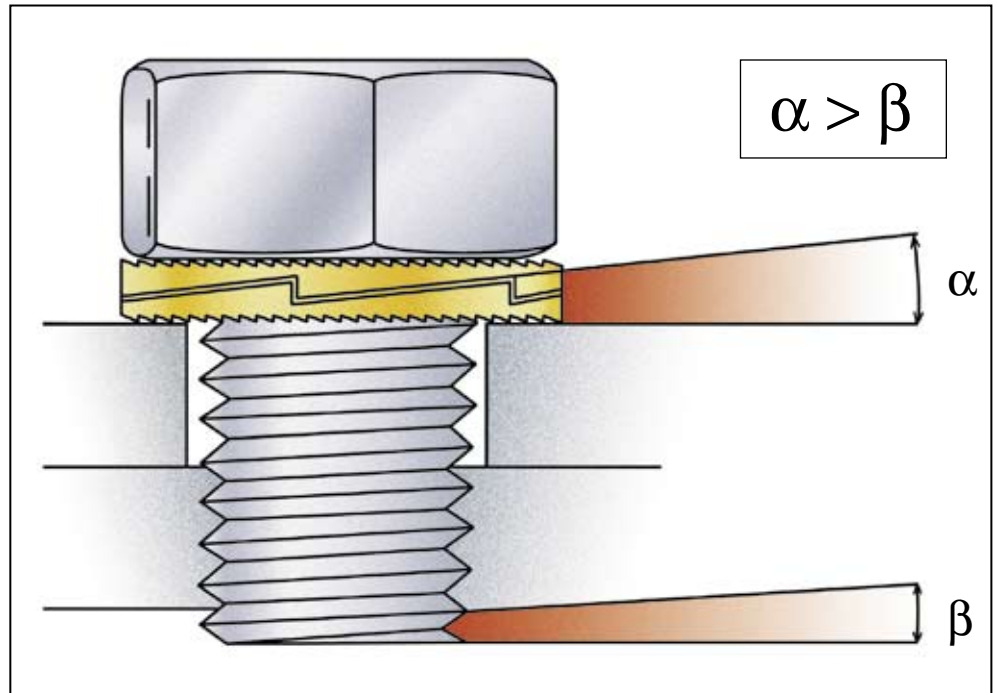


Where are they used?

- Construction equipment
- Automotive industry
- Agriculture equipment
- Off-road
- Manufacturing equipment
- Mining
- Oil industry
- Railroad equipment
- Trucking industry
- Utilities
- Power plants
- Process industries

Nord-Lock® is a pair of washers with a wedge-locking action meeting DIN 25 201 which is a unique method using tension instead of friction. The rise of the cams between the two Nord-Lock® washers is greater than the pitch of the bolt. In addition, there are radial teeth on the opposite side. When the bolt and/or nut is tightened, the teeth grip and seat the mating surfaces.

The Nord-Lock® washer is locked in place, allowing movement only across the face of the cams. The tension created makes the bolt/nut self-locking so it cannot move.



Security test

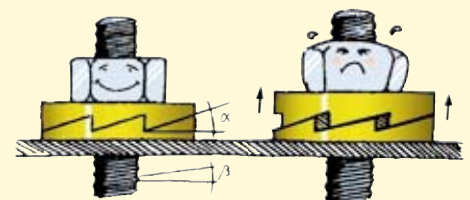
A quick test of the locking function is to tighten and loosen the fastener. When un-tightening, the cam overriding "click" effect must occur. **The locking effect can never be judged by measuring the break-away-torque** since the friction is lower between the cam faces. The break-away torque is less than the tightening torque.

Temperatures

The Nord-Lock® washers have the same temperature characteristics as the bolts and nuts of corresponding material quality.

Steel starts to degrade at temperatures over 200°C and stainless steel starts to degrade at temperatures over 500°C as do the nuts/bolts.

The key is the difference in angles. Here you see what happens when a nut attempts to loosen. The pair of washers expand more than the corresponding pitch of the thread. Nord-Lock® washers positively lock the fastener in a joint which is subjected to any vibration or dynamic loads.



Nord-Lock® maintains the bolt tension with the highest possible safety

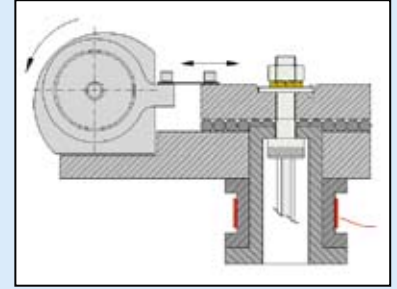
Junker vibration test (DIN 65151)

One method for testing the security of a bolted joint is the Junker-vibration test. The preload (bolt tension) is measured by a load cell and vibrating motions are generated radially through the bolt. Nord-Lock® together with a standard nut achieves a locking that is superior to other locking hardware e.g. nylon-inserted nuts. Bolts that are locked by friction in the thread lose most of their preload through vibrations while those locked

with Nord-Lock® present a minor loss of preload which is caused mainly by settlement in the thread.

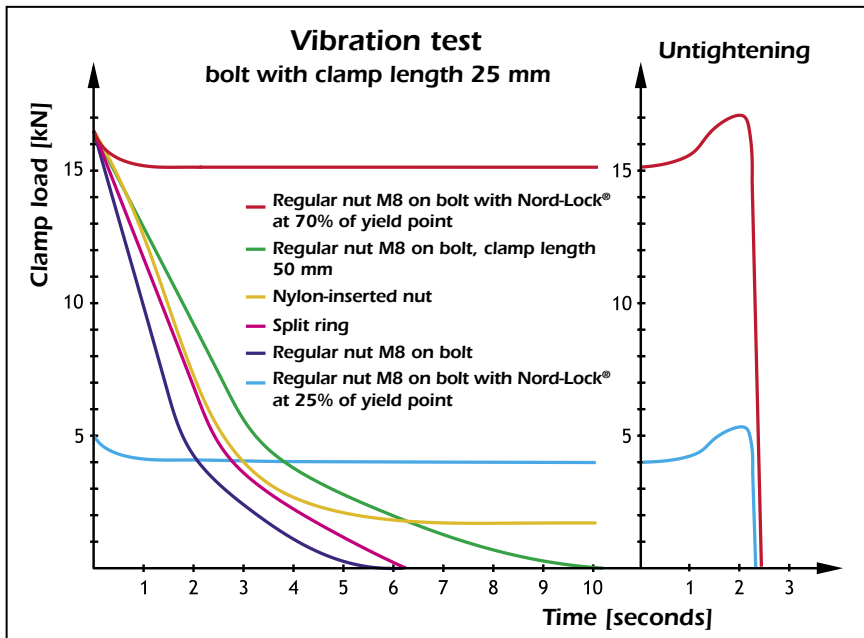
Even after moderate tightening the bolt is safely locked when using Nord-Lock®.

Recommended torque figures (see page 7) are based on tests in our own laboratory with calibrated torque transmitters and load cells.



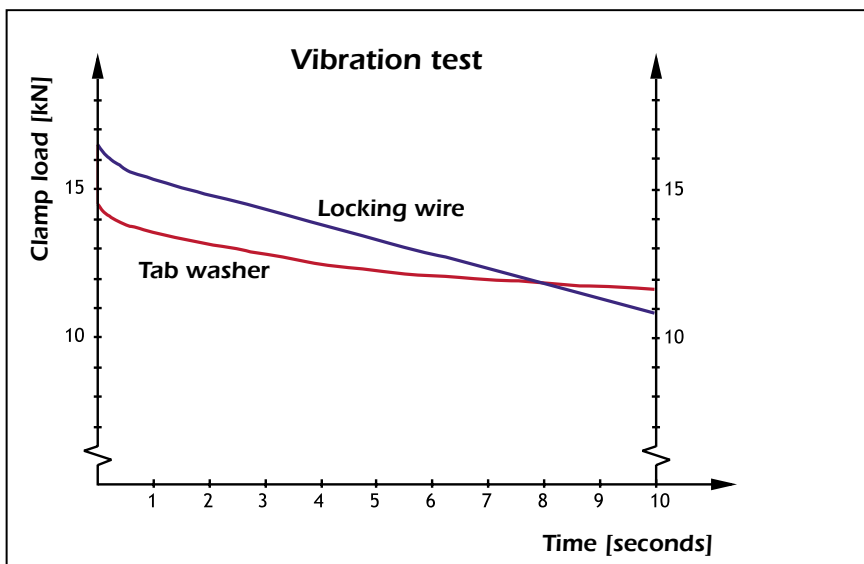
Amplitude: $\pm 0,3 \text{ mm} / \pm 0,5 \text{ mm}$
 Frequency: 40 Hz
 Clamp length: 25 mm - 50 mm
 Hardness of mating material: HRA 63-65

Junker vibration test diagrams



The Nord-Lock® washers have been used in various industries for many years with excellent results.

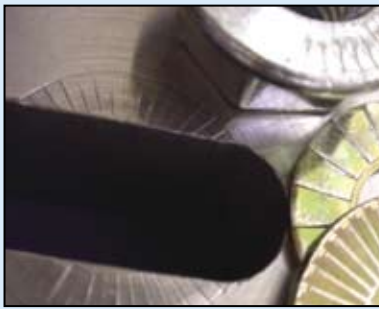
Vibration test with tab washer and locking wire



Locking wire



Tab washer



Examples of Nord-Lock® used in combination with long holes.

From top picture:

- Flange nut with NL sp (large outer diameter)
- Regular nut with NL sp (large outer diameter)
- Regular nut with NL standard (regular outer diameter)



Painted surface after use of Nord-Lock® with large outer diameter.



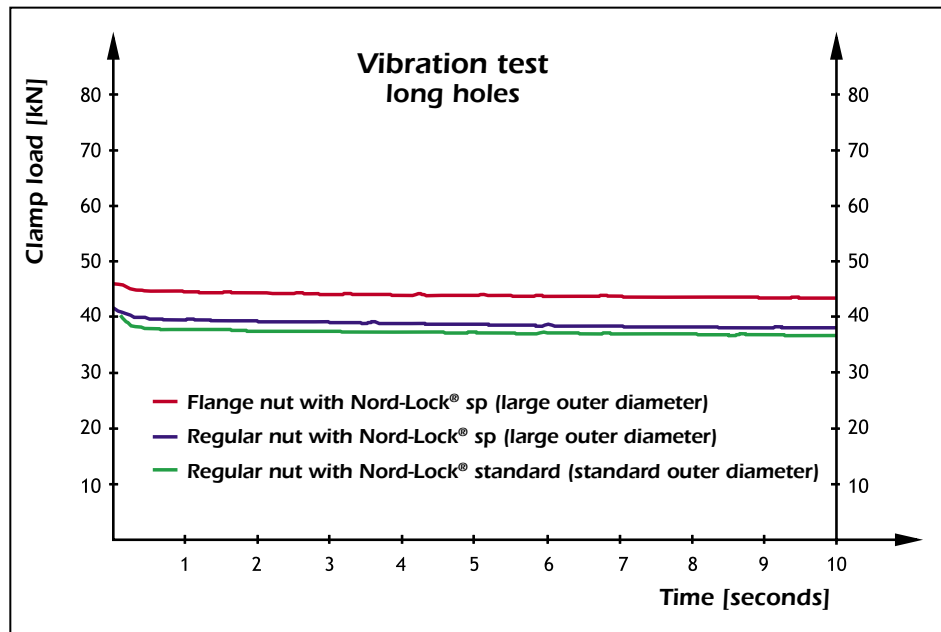
Painted surface after use of Nord-Lock® with standard diameter.

Long holes and softer materials

In order to cover as much surface as possible it is recommended to use flanged nuts and bolts in combination with Nord-Lock® washers with a large outer diameter.

Normally a standard bolt and standard Nord-Lock® washer will work, however, it is recommended to make a tightening test to determine the depths of the impressions around the hole area.

Vibration test with long holes

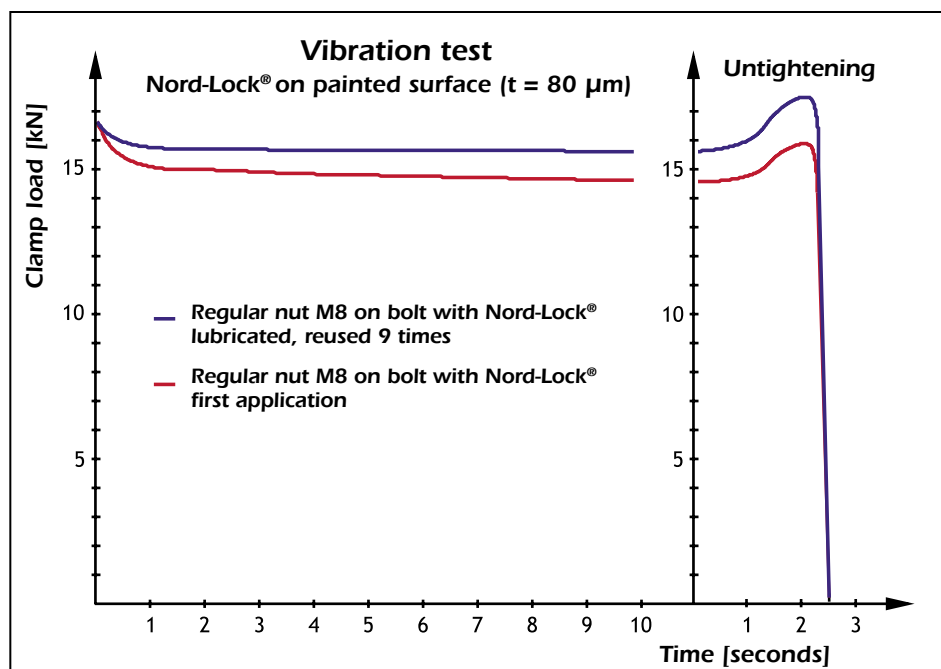


Painted surfaces

When tightening towards a painted surface sliding may occur towards the paint if there is a thick and soft layer of paint. If the paint is hard, sliding will occur between the upper washer and bolt

head/nut. In both cases there will be a positive locking effect since sliding in off-torque direction will be on the cam faces of the washers where the friction is lower than on the serrated surfaces.

Vibration test with lubricated bolt on painted surface



Corrosion resistance

Corrosion test according to SS-ISO 9227



Electro zinc yellow chromate after 144 hours



Zinc flake coated after 400 hours

Reusability

Since sliding always occurs between the Nord-Lock® washers and the head of the bolt/nut when tightening, and between the cam faces of the washers when untightening, the friction will not increase under the nut/bolt as with other serrated fasteners. In combination

with 8.8 bolt/nut Nord-Lock® can be reused up to 5 times if the washers are lubricated before re-assembly.

On high-grade and stainless steel bolt/nut it is not recommended to reuse Nord-Lock®.

Laboratory tests

Test report no. 375-130-91 carried out by the German TÜV confirms that after two million cycles the tension is maintained. An inspection of the washers showed that Nord-Lock® could be used safely.

The Nord-Lock® manufacturer will support

you in most cases as far as torque/load ratios and security tests during severe vibration in their simulators.

Please contact your local Nord-Lock® agent for consultations, you can find them at www.nord-lock.com.

Hardness

Materials	Range	Electro zinc ISO2081 (ISO/Rfe/Zn8c2C)	Zinc flake coated	Non-coated
Standard steel (through hardened)	NL3-NL42	HV1 > 425	HV1 > 385	
	NL45-NL130	HV1 > 370		
Stainless steel (A4)	NL3 ss-NL80 ss			HV0.05 > 520

Stainless steel specifications of A4

Norm	C ≤ %	Si ≤ %	Mn ≤ %	P ≤ %	S ≤ %	Cr %	Mo %	Ni %
SS 2343	0,05	1,00	2,00	0,045	0,030	16,0 – 18,5	2,50 – 3,00	10,5 – 14,0
EN 1.4436	0,05	1,00	2,00	0,045	0,025	16,5 – 18,5	2,50 – 3,00	10,5 – 13,0
AISI 316	0,08	0,75	2,00	0,045	0,030	16,0 – 18,0	2,00 – 3,00	10,0 – 14,0
SS 2348	0,03	1,00	2,00	0,045	0,030	16,5 – 18,5	2,00 – 2,50	10,0 – 13,0
EN 1.4404	0,03	1,00	2,00	0,045	0,030	16,5 – 18,5	2,00 – 2,50	10,0 – 13,0

Nord-Lock® washers are made of stainless steel SS 2343 and SS 2348.

Pre-assembled

Nord-Lock® washers are available as pre-assembled pairs. A standard hot melt glue (NATIONAL 281E) is used between the Nord-Lock® washers.

Torque – Friction – Load

Of course a bolt will give different tensions due to surface conditions, though the applied torque is the same.

Available in

- Yellow zinc chromate (standard)
- Zinc flake coated
- Stainless steel SS 2343 (AISI 316)
- Large and small outside diameter
- Pre-assembled

Available in a variety of sizes

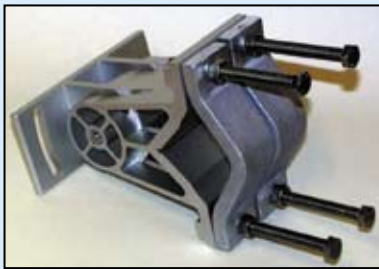
Steel: M3–M130, #5–5"

Stainless steel: M3–M80, #5–3 1/8"

Dimension list

For our current dimension list, please visit www.nord-lock.com.

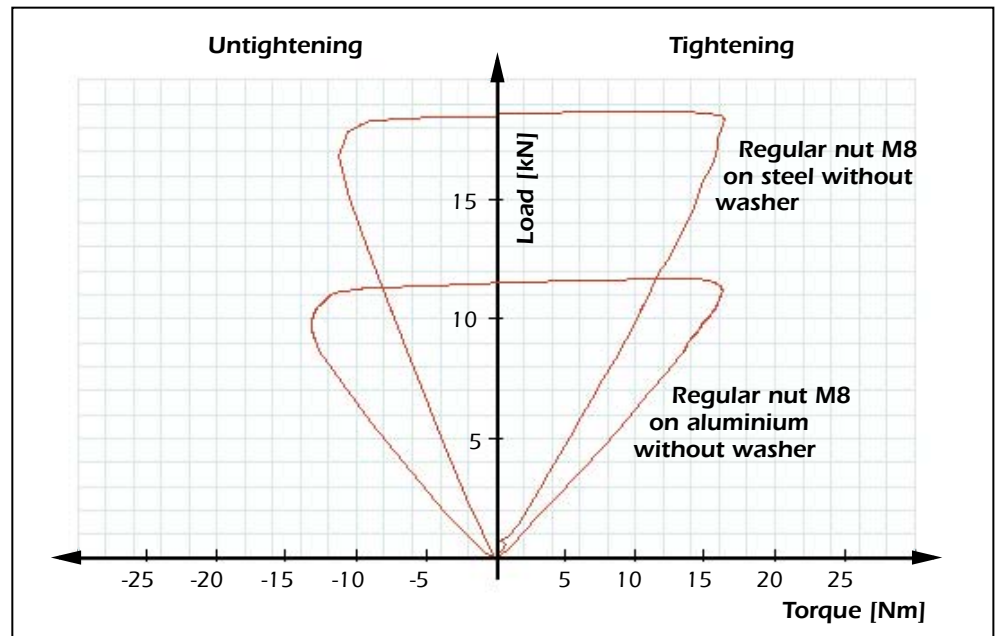




Torque - load diagrams

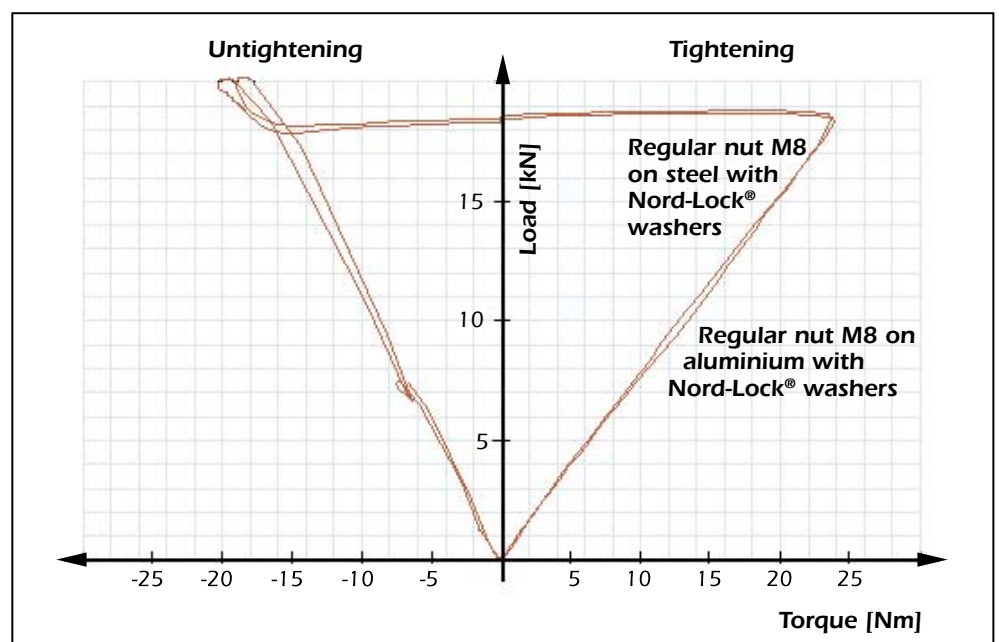
It has become more and more important to have good control of the torque-clamp load relationship when tightening a joint. To optimize the design of the joint and utilize as much of the capacity of each dimension as possible, you need to know the required tightening

torque to obtain the desired clamp load with a minimum of deviation. 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.



Above 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.

Recommended torque values

Nord-Lock® electro zinc plated/zinc flake coated with electro zinc plated bolt 8.8								
Washer size	Bolt size	Pitch [mm]	Oil, $G_f=0,75$ $\mu_g=0,12, \mu_w=0,14$		MoS2, $G_f=0,75$ $\mu_g=0,11, \mu_w=0,12$		Dry, $G_f=0,62$ $\mu_g=0,15, \mu_w=0,17$	
			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	3,0	4,2	2,7	4,2	3,0	3,5
NL5	M5	0,8	5,9	6,8	5,3	6,8	5,8	5,6
NL6	M6	1,0	10,3	9,6	9,3	9,6	10,2	8,0
NL8	M8	1,25	25	18	22	18	25	15
NL10	M10	1,5	47	28	42	28	47	23
NL12	M12	1,75	84	40	75	40	83	33
NL14	M14	2,0	133	55	119	55	132	46
NL16	M16	2,0	204	75	183	75	203	62
NL18	M18	2,5	284	92	255	92	282	76
NL20	M20	2,5	399	118	357	118	396	97
NL22	M22	2,5	554	145	497	145	550	120
NL24	M24	3,0	687	169	616	169	683	140
NL27	M27	3,0	1000	220	896	220	997	182
NL30	M30	3,5	1360	269	1220	269	1361	223
NL33	M33	3,5	1830	333	1640	333	1834	275
NL36	M36	4,0	2360	392	2110	392	2364	324
NL39	M39	4,0	3040	468	2720	468	3053	387
NL42	M42	4,5	3837	546	3428	546	3803	451

Nord-Lock® electro zinc plated with non-plated bolt 10.9						
Washer size	Bolt size	Pitch [mm]	Oil, $G_f=0,71$ $\mu_g=0,14, \mu_w=0,11$		MoS2, $G_f=0,75$ $\mu_g=0,14, \mu_w=0,10$	
			Torque [Nm]	Clamp load [kN]	Torque [Nm]	Clamp load [kN]
NL3	M3	0,5	1,7	3,2	1,7	3,4
NL4	M4	0,7	3,8	5,6	3,9	5,9
NL5	M5	0,8	7,5	9,1	7,6	9,6
NL6	M6	1,0	13,0	12,8	13,2	13,6
NL8	M8	1,25	31	23	32	25
NL10	M10	1,5	59	37	60	39
NL12	M12	1,75	106	54	108	57
NL14	M14	2,0	169	73	172	78
NL16	M16	2,0	259	100	263	106
NL18	M18	2,5	361	123	367	130
NL20	M20	2,5	506	157	515	165
NL22	M22	2,5	703	194	715	205
NL24	M24	3,0	873	226	888	238
NL27	M27	3,0	1270	293	1290	310
NL30	M30	3,5	1730	358	1750	379
NL33	M33	3,5	2330	443	2360	468
NL36	M36	4,0	3000	522	3050	551
NL39	M39	4,0	3870	624	3930	659
NL42	M42	4,5	4871	727	4946	767

Nord-Lock® electro zinc plated with non-plated bolt 12.9						
Washer size	Bolt size	Pitch [mm]	Oil, $G_f=0,71$ $\mu_g=0,14, \mu_w=0,11$		MoS2, $G_f=0,75$ $\mu_g=0,15, \mu_w=0,10$	
			Torque [Nm]	Clamp load [kN]	Torque [Nm]	Clamp load [kN]
NL3	M3	0,5	1,9	3,9	2,0	4,1
NL4	M4	0,7	4,4	6,7	4,6	7,1
NL5	M5	0,8	8,7	10,9	9,1	11,5
NL6	M6	1,0	15,1	15,4	15,8	16,3
NL8	M8	1,25	36	28	38	30
NL10	M10	1,5	68	44	71	47
NL12	M12	1,75	123	65	129	68
NL14	M14	2,0	195	88	205	93
NL16	M16	2,0	299	120	314	127
NL18	M18	2,5	417	147	438	156
NL20	M20	2,5	585	188	614	198
NL22	M22	2,5	812	232	853	245
NL24	M24	3,0	1010	271	1060	286
NL27	M27	3,0	1470	352	1540	372
NL30	M30	3,5	1990	430	2090	454
NL33	M33	3,5	2690	532	2820	562
NL36	M36	4,0	3470	626	3640	662
NL39	M39	4,0	4470	748	4690	791
NL42	M42	4,5	5620	872	5905	921

Nord-Lock® stainless steel with stainless steel bolt						
Washer size	Bolt size	Pitch [mm]	A4-70, MoS2, $G_f=0,65$ $\mu_g=0,14, \mu_w=0,15$		A4-80, MoS2, $G_f=0,65$ $\mu_g=0,14, \mu_w=0,15$	
			Torque [Nm]	Clamp load [kN]	Torque [Nm]	Clamp load [kN]
NL3	M3	0,5	0,9	1,5	1,2	2,0
NL4	M4	0,7	2,0	2,6	2,7	3,4
NL5	M5	0,8	3,9	4,2	5,3	5,5
NL6	M6	1,0	6,9	5,9	9,2	7,8
NL8	M8	1,25	17	11	22	14
NL10	M10	1,5	33	17	43	23
NL12	M12	1,75	56	25	75	33
NL14	M14	2,0	89	34	119	45
NL16	M16	2,0	136	46	181	61
NL18	M18	2,5	191	56	254	75
NL20	M20	2,5	267	72	356	96
NL22	M22	2,5	351	89	468	118
NL24	M24	3,0	460	103	613	138
NL27	M27	3,0	671	134	895	179
NL30	M30	3,5	915	164	1220	219
NL33	M33	3,5	1233	203	1644	271
NL36	M36	4,0	1591	239	2121	319
NL39	M39	4,0	2053	285	2737	381
NL42	M42	4,5	2585	333	3447	443

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=0,3048x0,4536x9,81=1,356 Nm

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.

$$\text{Load area [mm}^2\text{]} > \frac{\text{Clamp load [N]}}{\text{Yield point [N/mm}^2\text{]}}$$

Reuse

Always lubricate all fasteners before reusing! When reusing fasteners friction is always higher.

Design

You can be aided in your design application by checking out the CAD library at www.solidcomponents.com

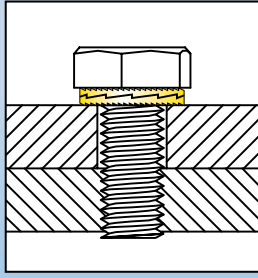
Dimensions

For our current dimension list, please go to www.nord-lock.com

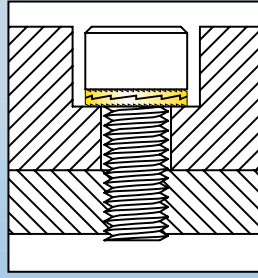
Nord-Lock® washers

Nord-Lock® washers can be used on standard grade as well as high grade bolts.

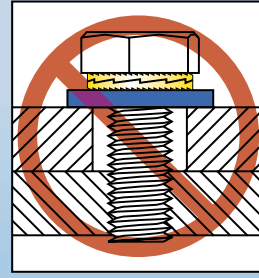
Assembly examples



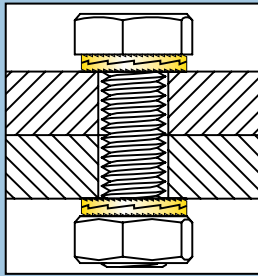
Nord-Lock® washers can be used with bolts in tapped holes.



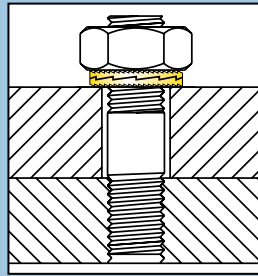
Nord-Lock® washers can also be used in counter-bored holes.



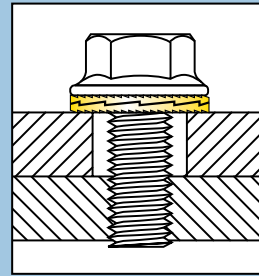
Please note that Nord-Lock® cannot be used on washers that are not locked in place.



Two pairs of Nord-Lock® washers are needed to secure bolts and nuts through holes. **Note: Keep the bolt secured when tightening the nut.**



Use Nord-Lock® to secure the nut, and there is no need for adhesives to lock the stud bolt.



For larger holes or on soft materials, use a flange nut/bolt in combination with Nord-Lock® sp (washers with increased outer diameter).

Advantages

- Resists loosening caused by vibration and dynamic loads
- Ease of assembly and disassembly
- Locking function is not lost by lubrication
- Positive locking at low or high preload levels
- Same temperature characteristics as standard bolt/nut
- Minimum surface marring or scratching
- Reusable
- Achieves maximum safety when locking fasteners

