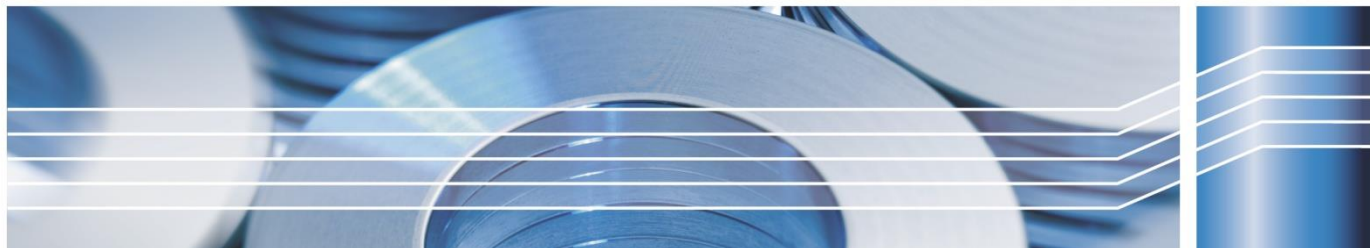


Comparative vibration Test (Junker Test)



Comparative Junker Test

1. Description of the test

Vibration tests (Junker test) for evaluating locking performance of **Original SCHNORR® safety washers** M8 made of carbon steel/spring steel (**DIN EN 10132-4**) with zinc-flake coating as well as tests of a competitors products for performance comparison

2. Reference standards of the test

The tests were based on the following reference standards:

- **DIN 25201-4:2010-03** design guide for railway vehicles and their components – Bolted joints – Part 4: Securing of bolting joints – Appendix B
- **DIN 65151:2002-08** Aerospace series – Dynamic testing of the locking characteristics of fasteners under transverse loading conditions (vibration test)

3. Test parameters and test implementation

Setting trials:

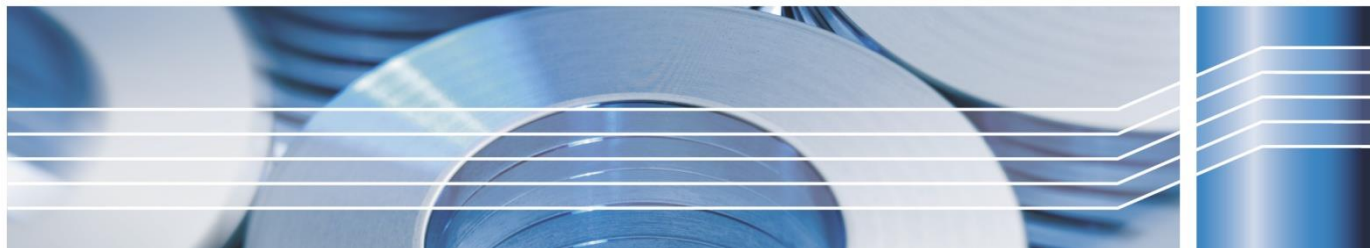
Before testing, the setting trials were implemented according to the requirements of point B.3 of the DIN 25201-4. Flat washers according to DIN EN ISO 7093-1 were used as counter surface.

Vibration frequency used in tests:

The frequency of the traverse displacements used was 12,5 Hz.

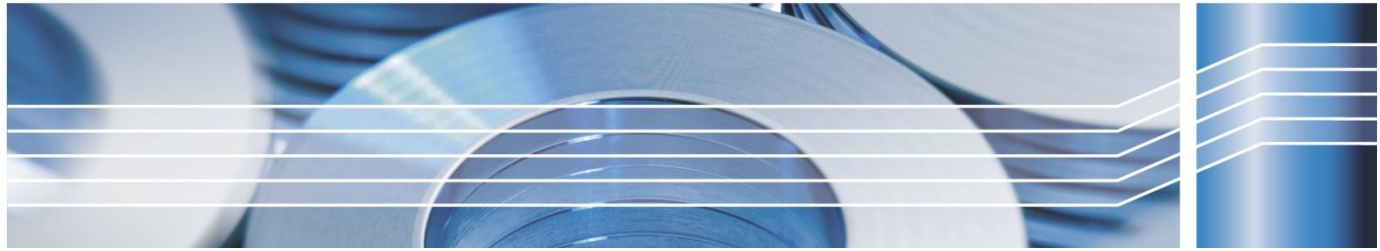
Preload and lubrication:

The tested sets were tightened by wrench until the required preload corresponding to table B.1 of the DIN 25201-4 was reached. For the objects made of carbon/spring steel (DIN EN 10132-4) screws M8 in quality 8.8 were used, with a preload of F_{V_y} of 9,1 kN. The tested sets were lubricated according to part B.5.2 of the DIN 25201-4 with lubrication-oil HD 30.



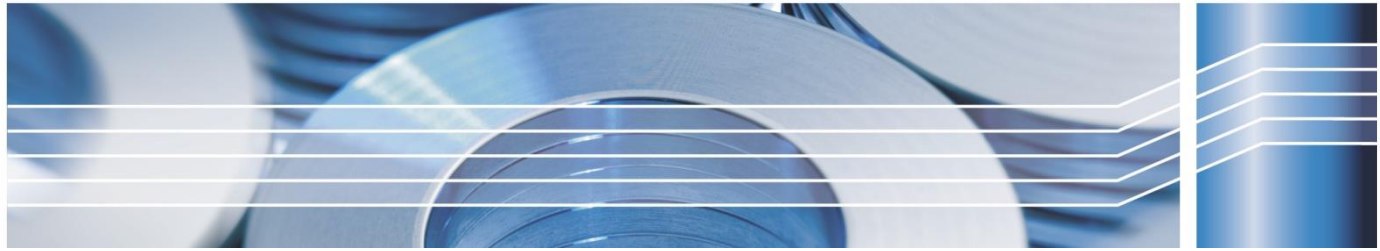
Overview of the tested bolt locking systems

Product	Surface
Original SCHNORR® Safety Washers	Zinc-Flake
Wedge-Locking Washers	Zinc-Flake
Split Lock Washer	Mechanically galvanized
Detent-Edged Washer	Zinc-Flake
Ripped Washer	Zinc-Flake
Spring Washer (DIN 137 B)	Mechanically galvanized



Original SCHNORR® Safety Washer





Overview competing products

Wedge-Locking Washers



Split Lock Washers



Detent-Edge Washers

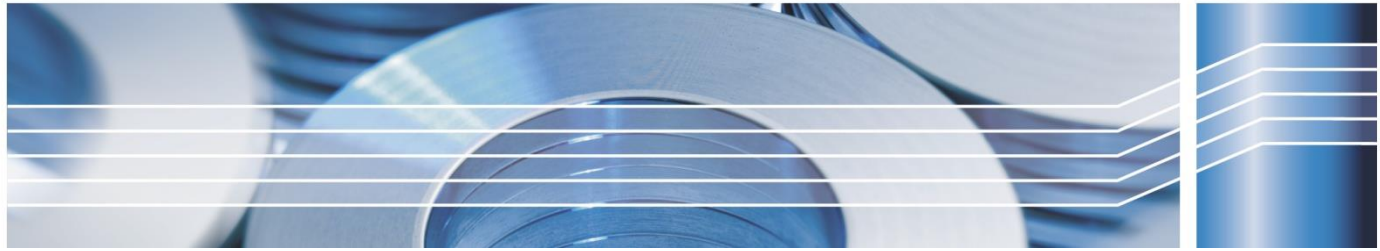


Ripped Washers

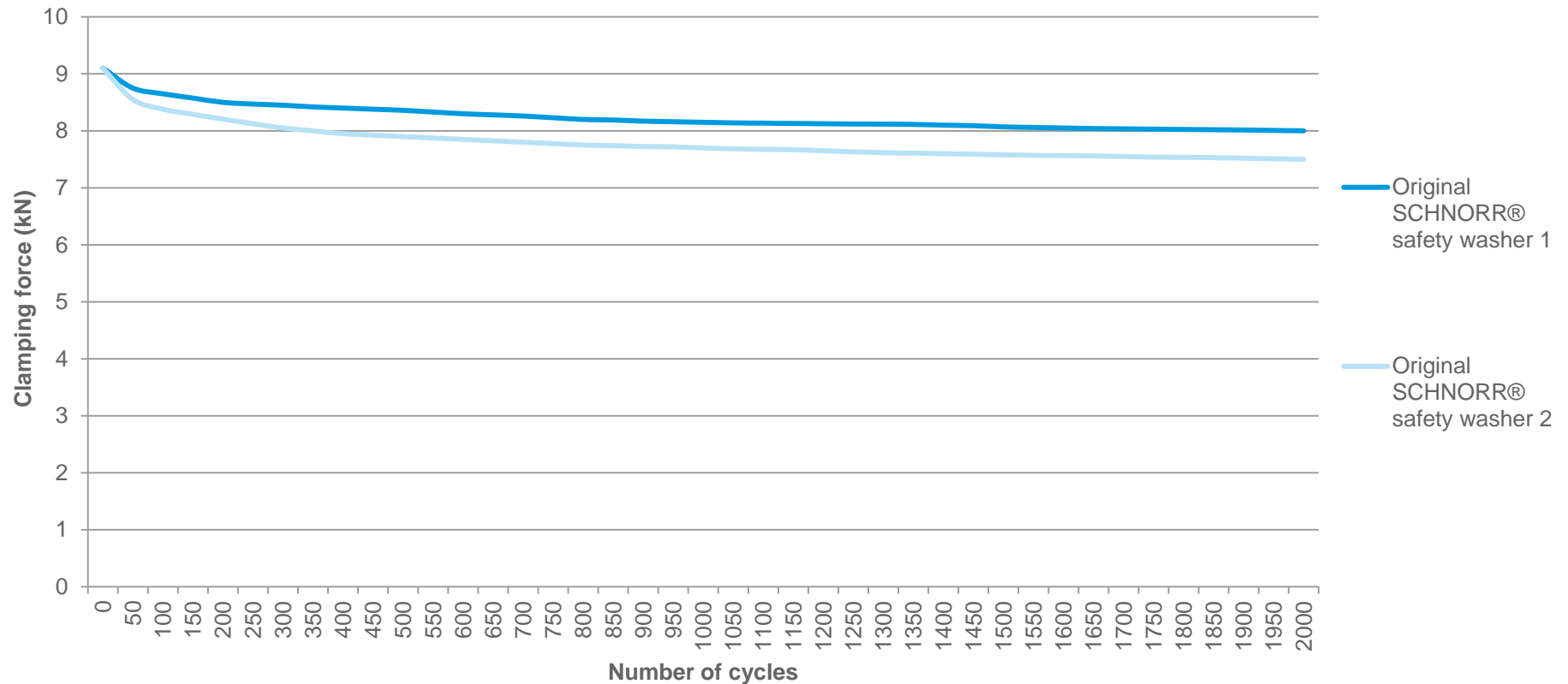


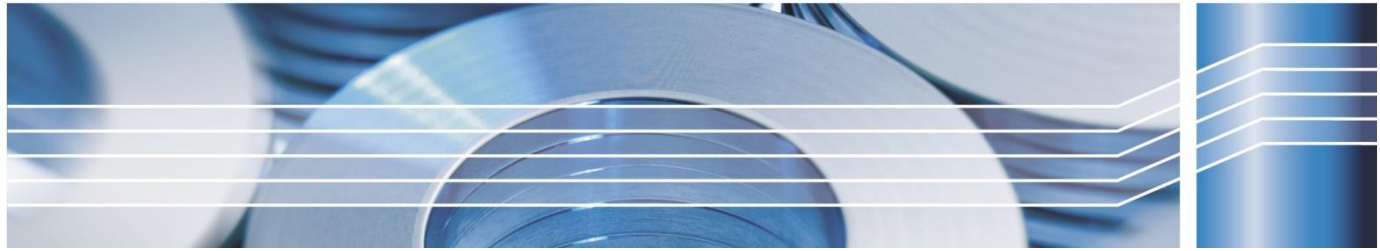
**Spring Washer
(DIN 137 B)**



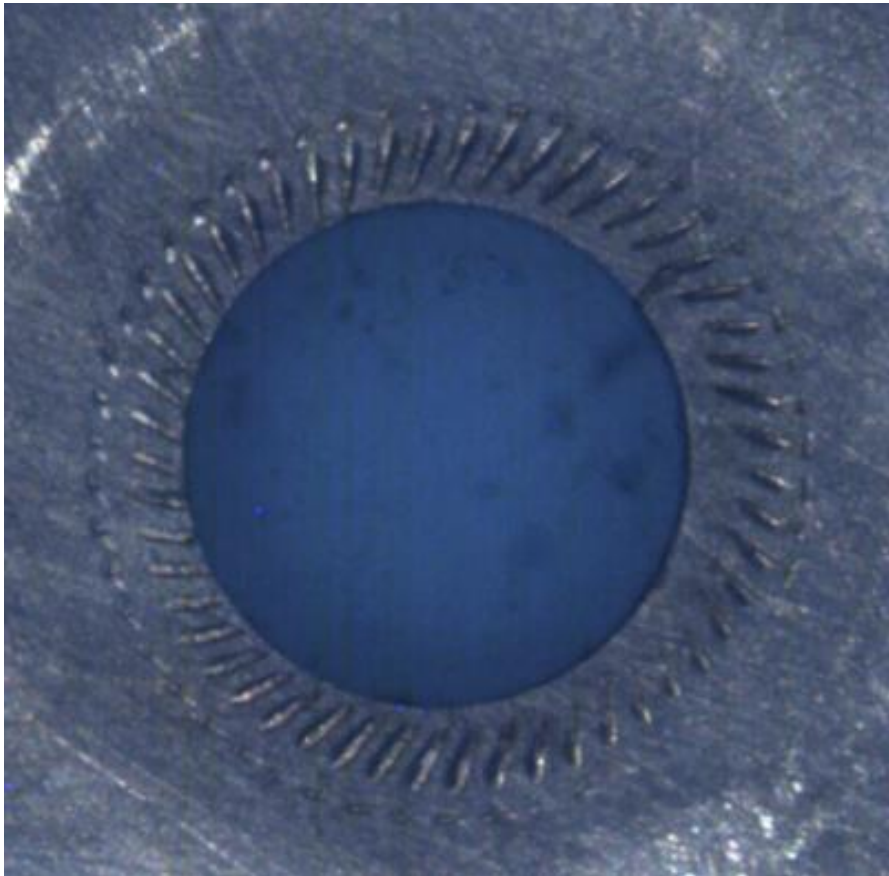


Vibration Test result Original SCHNORR® safety washers (Art.-No. 401070)

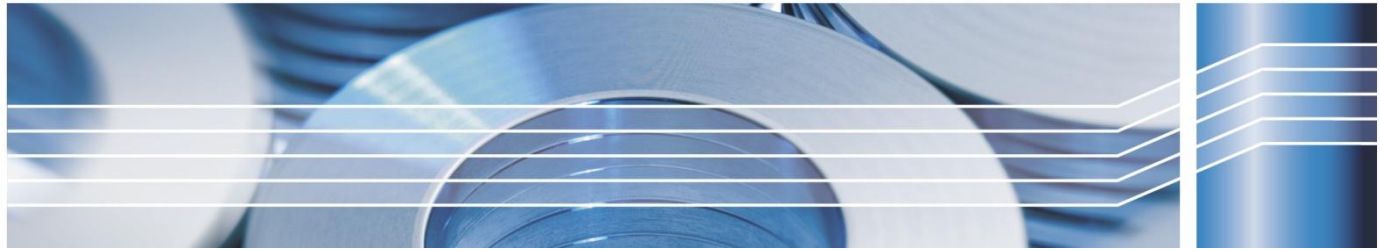




Prints of the Original SCHNORR® Safety Washers 401070

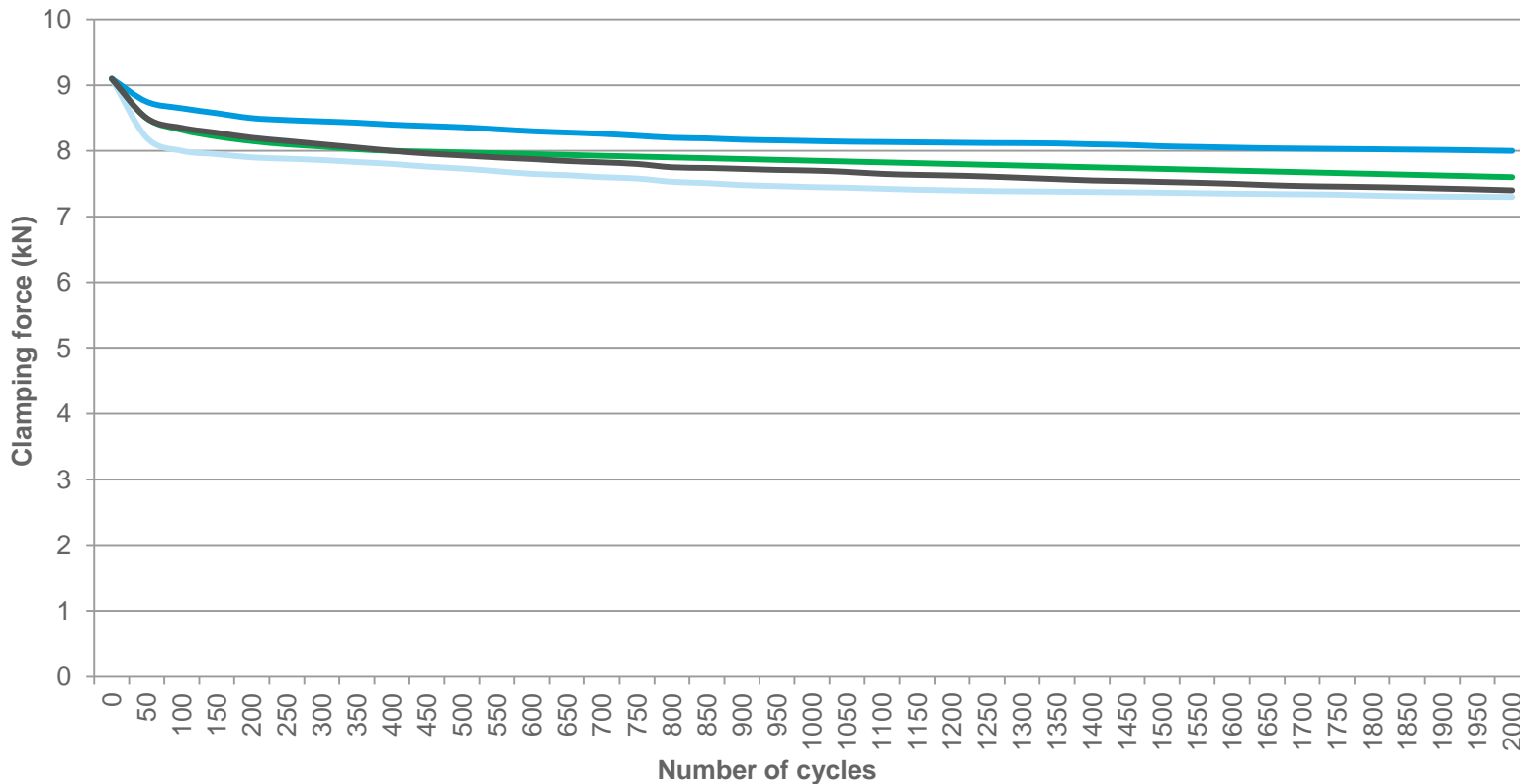


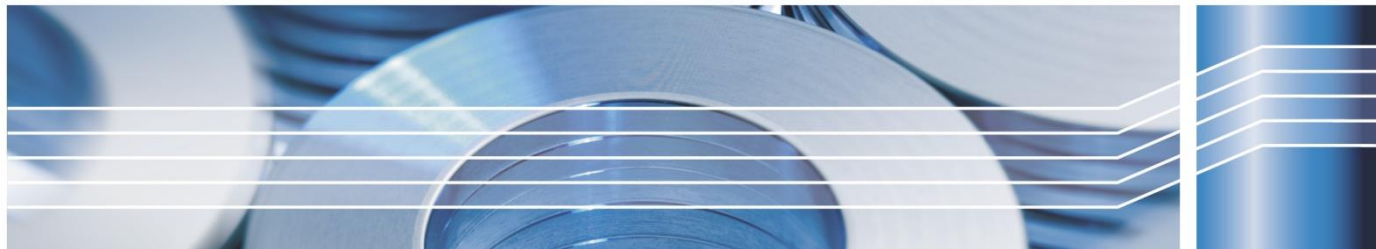
Prints are very well marked on the counter piece, which guarantees a high locking performance of the bolt



Vibration Test results

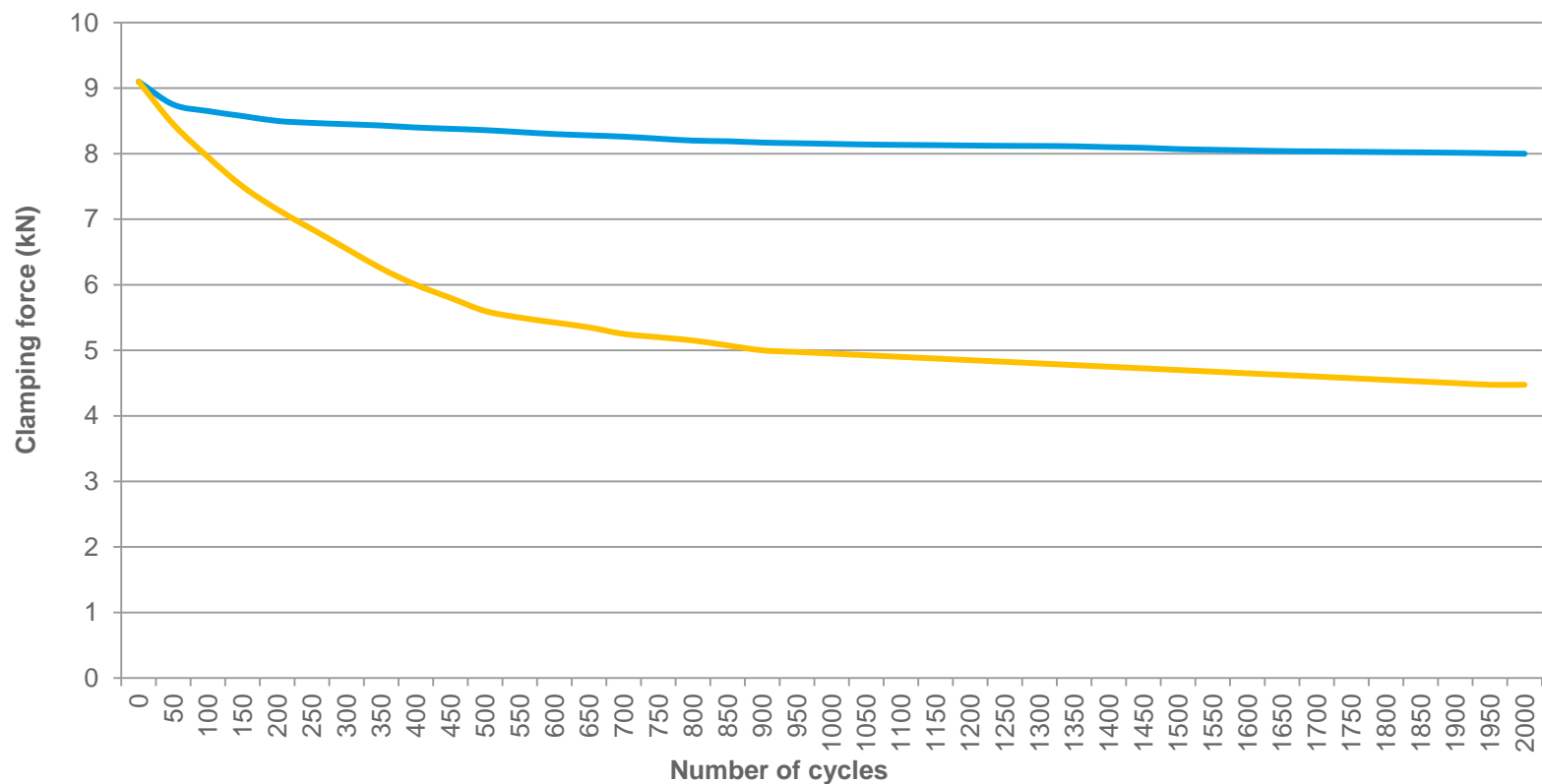
Comparison of Original SCHNORR® Safety Washers vs. Wedge-Locking Washer

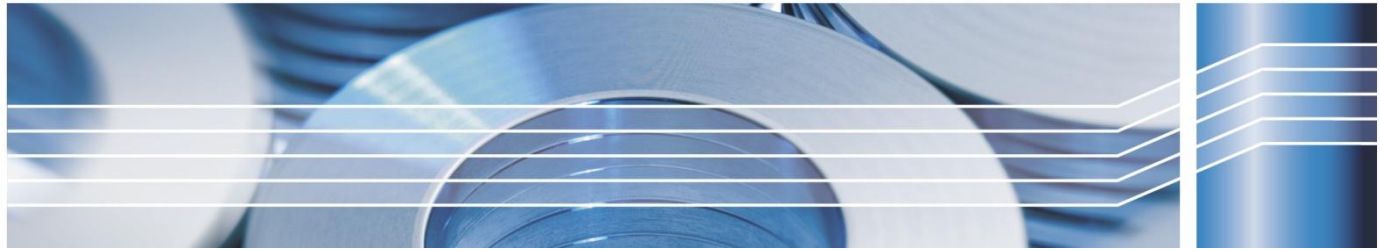




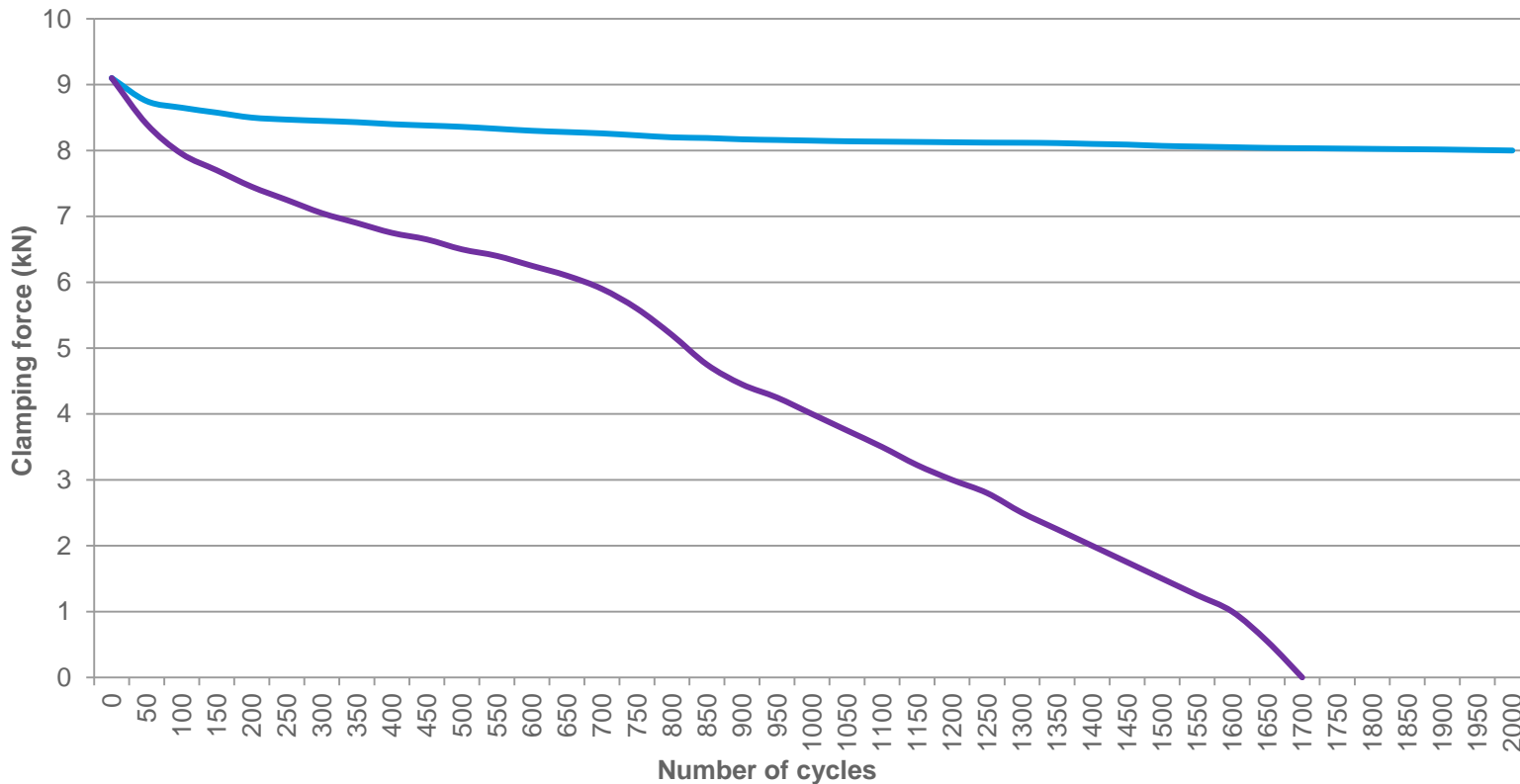
Vibration Test results

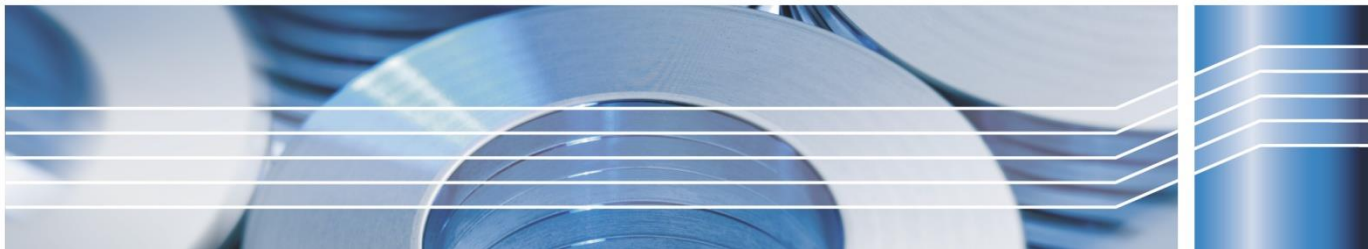
Comparison of Original SCHNORR® Safety Washers vs. Split Lock Washer



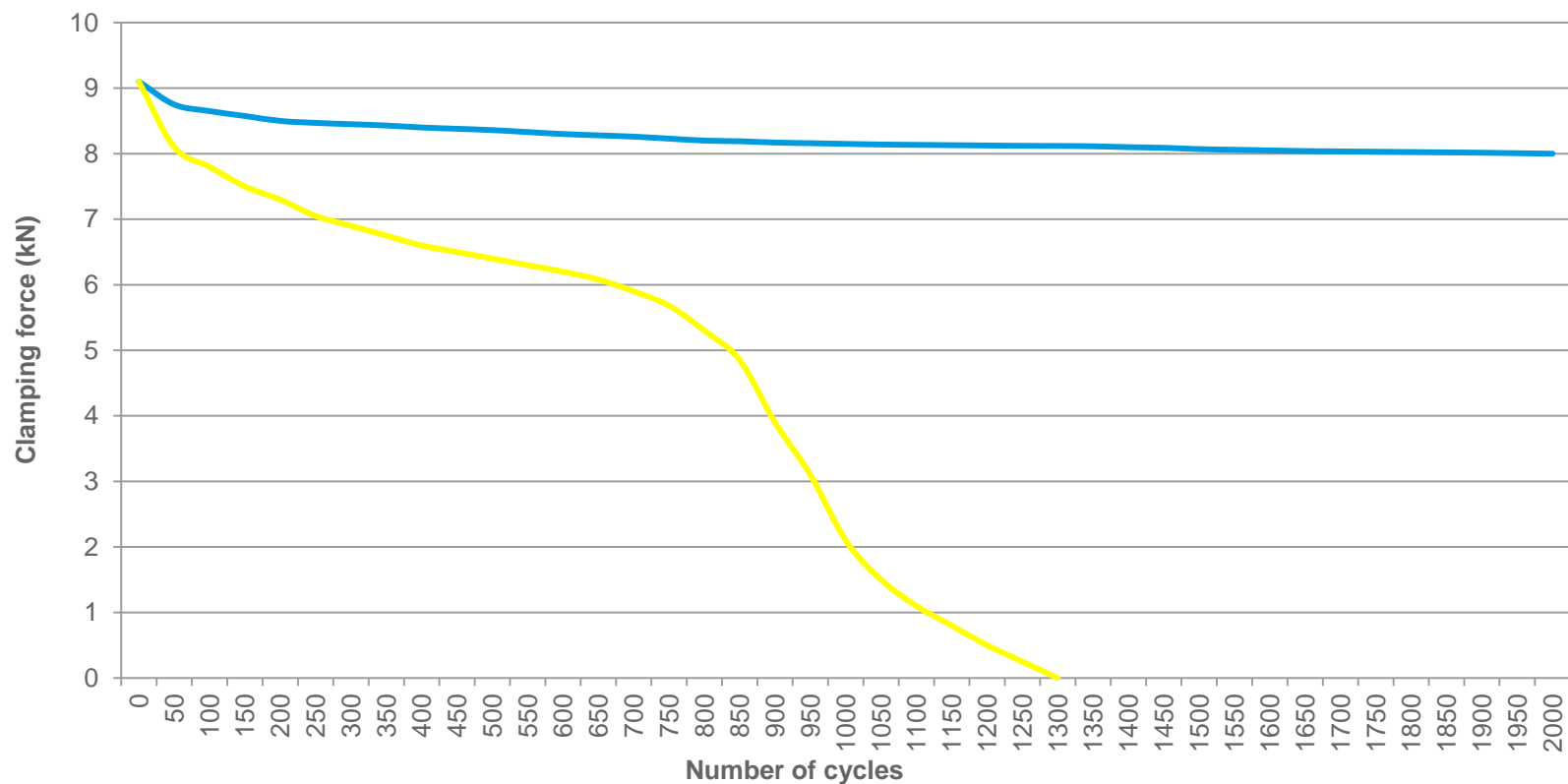


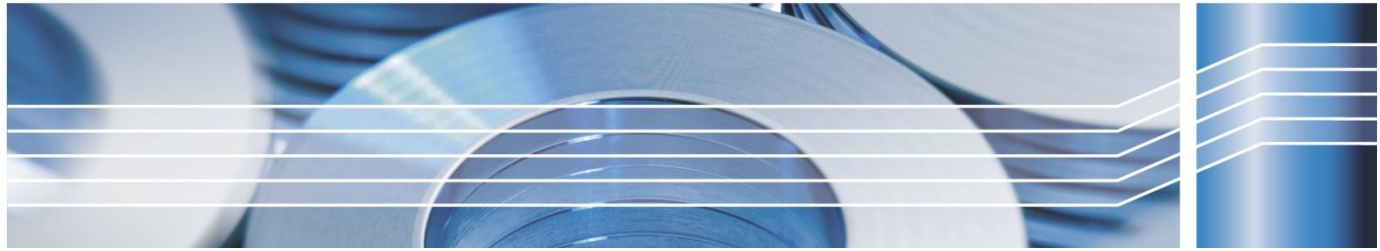
Vibration Test results Comparison of Original SCHNORR® Safety Washers vs. Detent-Edged Washer





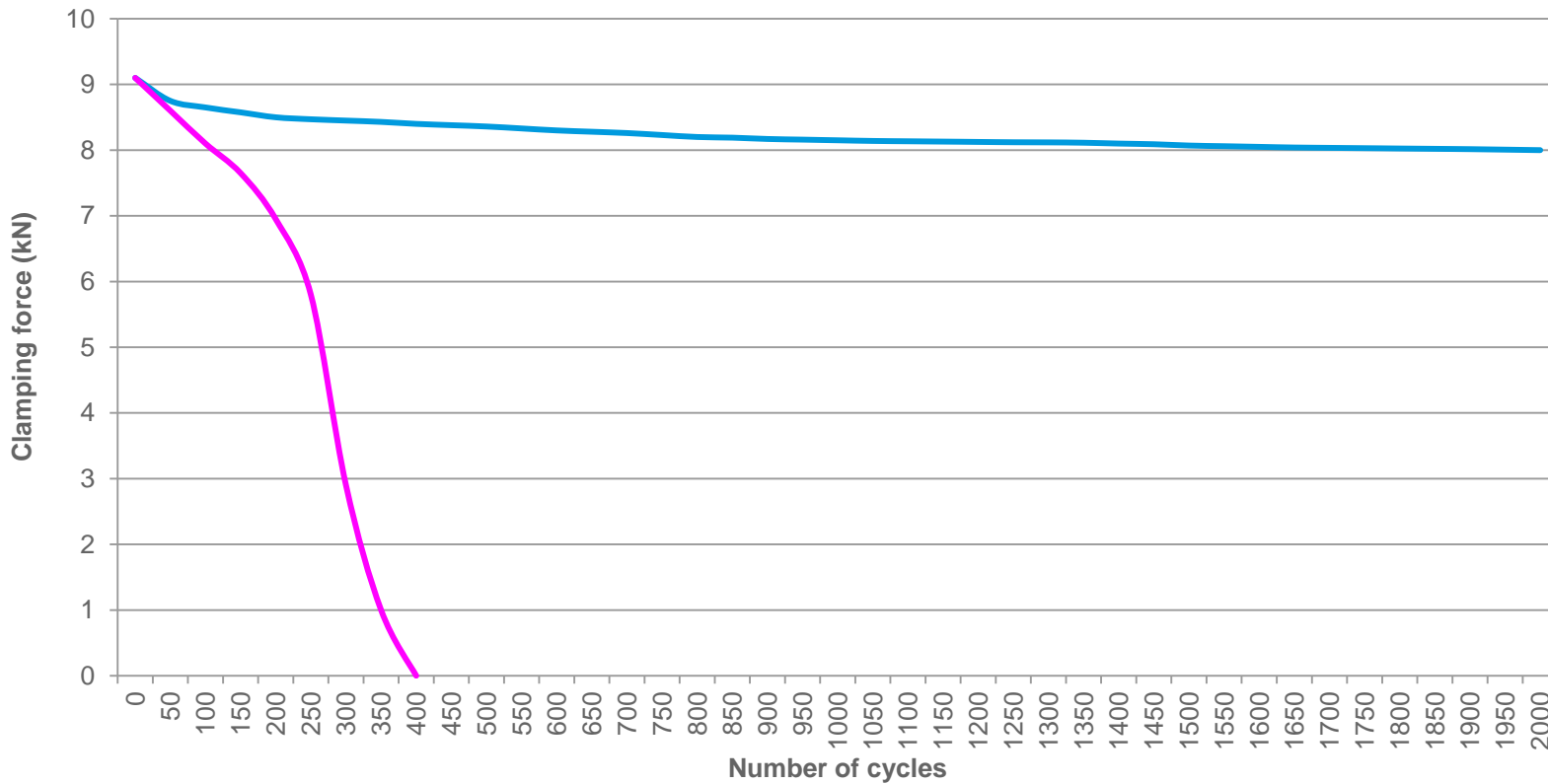
Vibration Test results Comparison of Original SCHNORR® Safety Washers vs. Ripped Washer

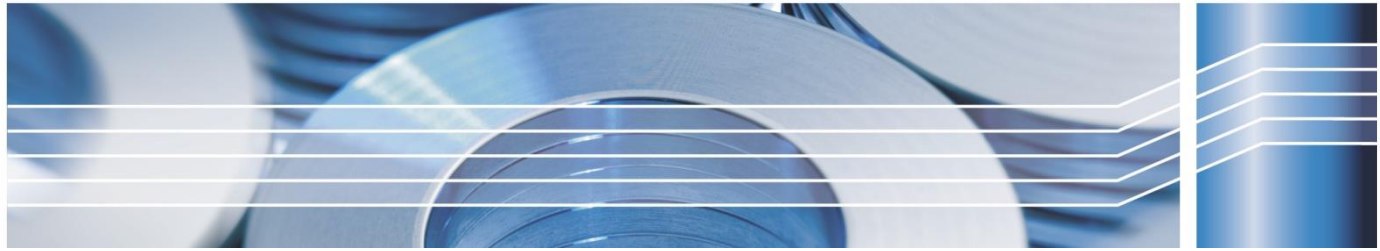




Vibration Test results

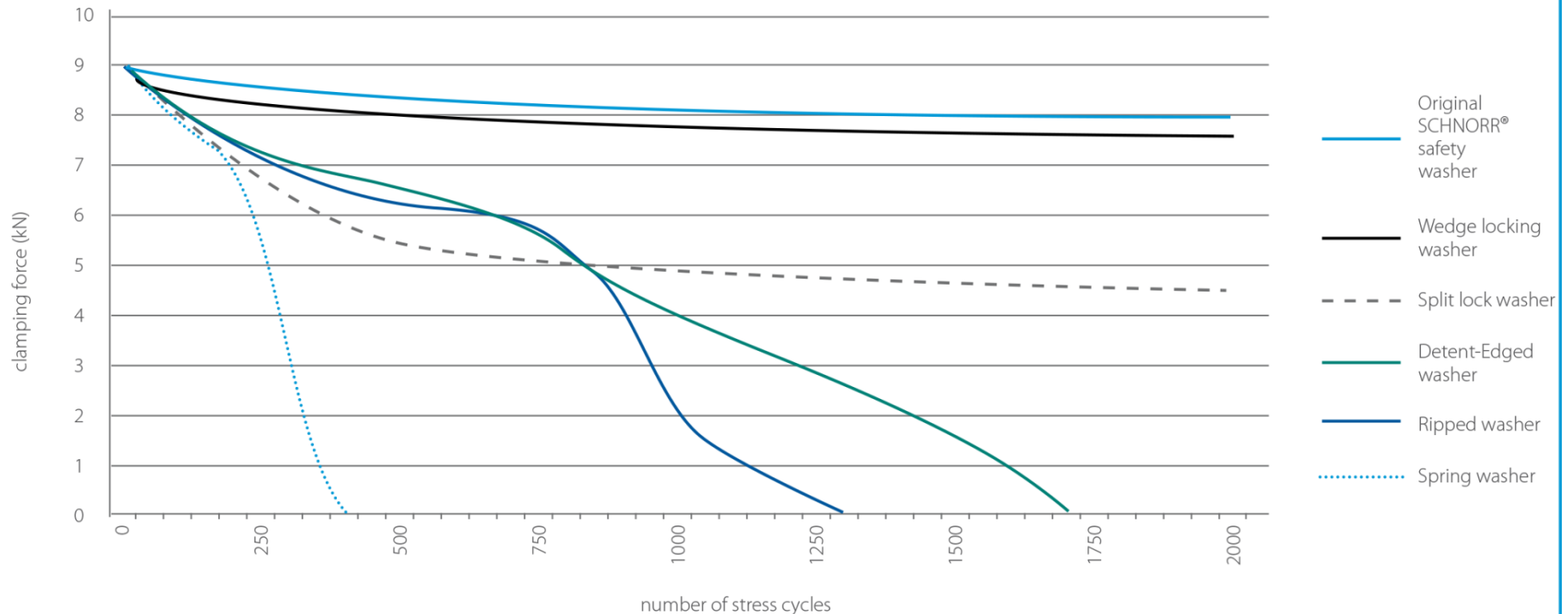
Comparison of Original SCHNORR® Safety Washers vs. Spring Washer

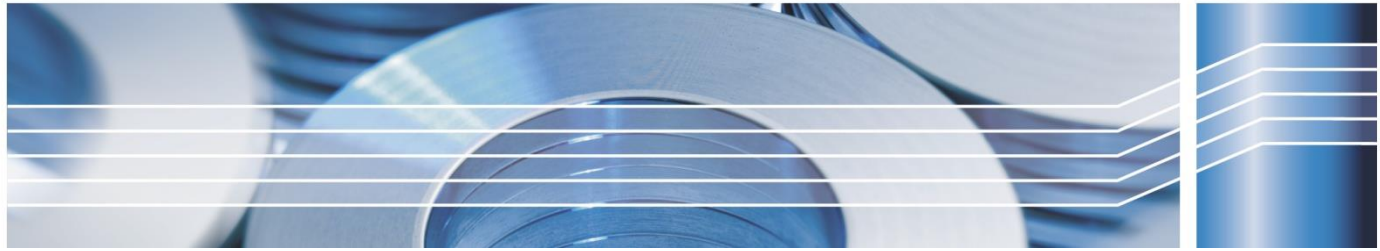




Comparison Original SCHNORR® safety washers and misc. bolt locking systems

Product comparison Original SCHNORR® Safety Washers with other bolt locking systems





Résumé

The Junker test clearly shows a superior locking performance of the Original Schnorr® safety washers in term of number of cycles lasted and in term of residual spring load after 2000 cycles in comparison to split lock washers, detent-edged washer, ripped washers and spring washers (DIN 137 B)

The test also shows that Original Schnorr® safety washers have the same locking performance as all kinds of multifunctional wedge-locking washers just like Nord-Lock, Twin-Lock and Heico-Lock.