

# MATERIAL FATIGUE SILENT, SUDDEN, DEADLY

Material fatigue is defined as a cumulating degradation of material caused by dynamic stress with amplitude below the tensile strength limit.



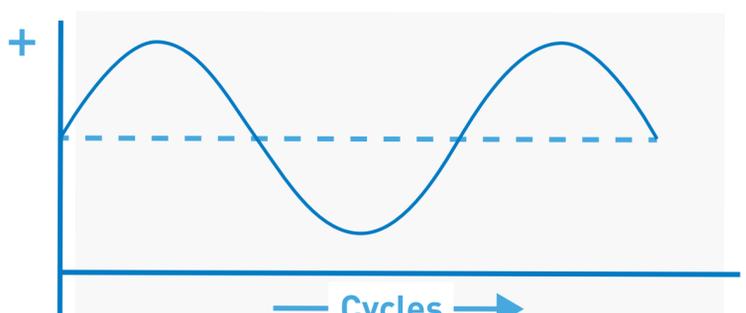
## Low-cycle fatigue

Number of cycles up to  $10^4$  and amplitude of stress above the yield point. **Low-cycle fatigue is not important for a design of the joint.**



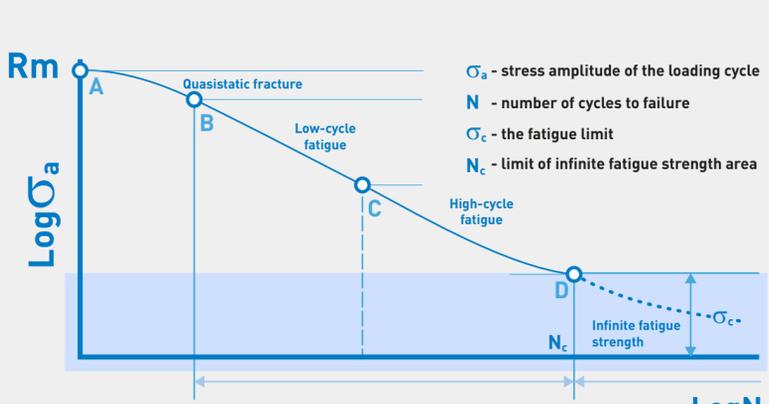
## High-cycle fatigue

Number of cycles more than  $10^4$  and amplitude of stress, usually way below the yield point. **Designers of a fastened joint should always consider the influence of high-cycle fatigue when dynamic forces are expected!**



When the lower amplitude of the loading cycle crosses the zero line, all preload in the fastened joint is lost and the screw will rotate loose or even break after some time.

**Wöhler's curve** is showing the dependency between the load amplitude of one cycle and the number of cycles without fracture.

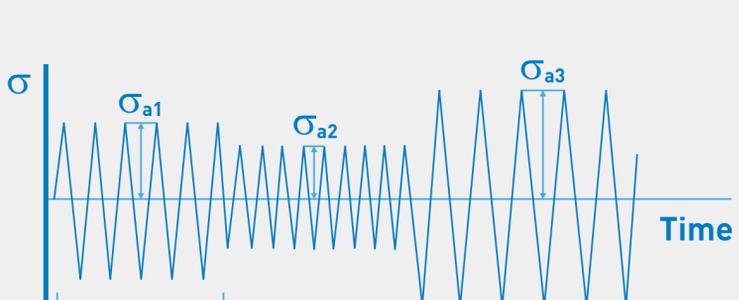


When an engineer is designing a fastened joint, he should do his best to operate in the area of infinite fatigue strength.

## Prediction



**Important! Any damage caused by dynamic loading has cumulative character.**



$$\frac{n_1}{N_{f1}} + \frac{n_2}{N_{f2}} + \frac{n_3}{N_{f3}} + \dots$$

**Fracture occurs when:**

$$\frac{n_1}{N_{f1}} + \frac{n_2}{N_{f2}} + \dots = \sum_{j=1}^k \frac{n_j}{N_{fj}} = 1$$

To avoid the material fatigue, the sum of all ratios  $N_i/N_{fi}$  must be below 1.

## Prevention

- Use waisted shank**
- Avoid sharp edges**
- Use polished surface**
- Use coldformed surface**
- Avoid plated finish**
- Prevent corrosion**
- Prevent chemical reactions**

## Calculation



**Warning! When using these relations, design engineer should be familiar with the risk and work with higher factor of safety.**

**General rule: the higher the strength of the material, the lower the resistance to fatigue.**

	Ferrite	Perlite	Martensite
$R_m/\delta_0$ ratio	0.6	0.4	0.25

Average values of ratio  $R_m/\delta_0$  for different phases of steel microstructure.



**When an accident occurs, do not touch broken fastener! Please call Bossard expert!**

For more information refer to the white paper "Material fatigue" found at [www.bossard.com](http://www.bossard.com).