# Hertzian Contact Pressure

> **Sample document with complete example values. It shows the report the purchased export produces for YOUR input - it is not itself a report for any part.**

Project: Sample project Part/Position: no real part Prepared by: Sample, not released

Cylinder-plane (line contact) - p_max = 494.8 N/mm² - Overall verdict OK

Overall assessment: OK - the maximum pressure stays within the allowable pressure.

## Inputs

| | |
|---|---|
| Contact case | Cylinder-plane (line contact) |
| Radius R1 | 10 mm |
| Contact force F | 1,000 N |
| Effective length L | 15 mm |
| Body 1 (E1 / ν1) | 210,000 / 0.3 |
| Body 2 (E2 / ν2) | 210,000 / 0.3 |
| Yield strength body 1 (product size 20 mm) | 430 N/mm² |
| Yield strength body 2 (product size 80 mm) | 370 N/mm² |
| Allowable pressure p_allow | 617 N/mm² |

## Contact parameters

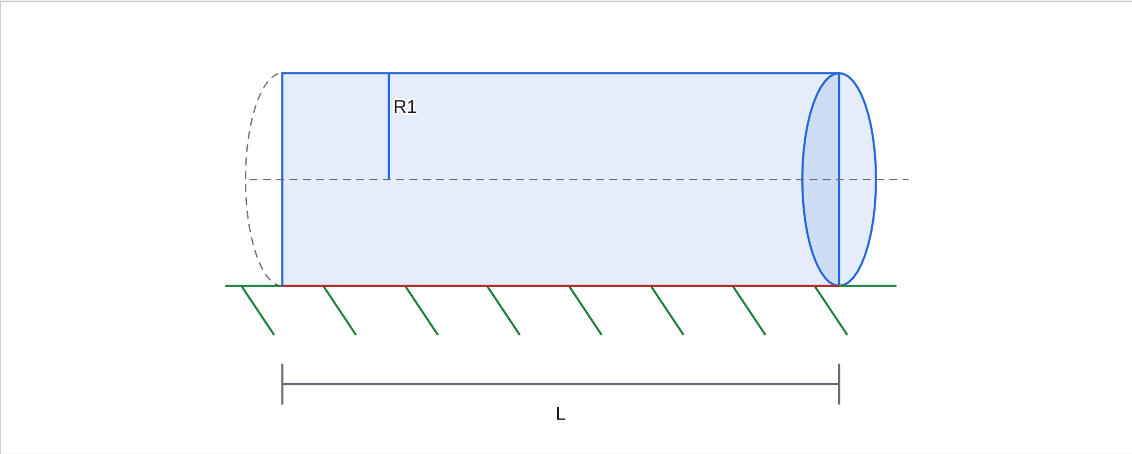
| | |
|---|---|
| Reduced modulus of elasticity E* | 115,385 N/mm² |
| Equivalent radius R | 10 mm |
| Maximum pressure p_max | 494.8 N/mm² |
| Mean pressure p_m | 388.6 N/mm² |
| Half contact width b | 0.0858 mm |
| Line load F' | 66.7 N/mm |
| Approach δ (approximation) | 2.37 µm |
| Max. shear stress τ_max (0.3·p_max) | 148.6 N/mm² |
| Depth of max. shear stress z(τ_max) | 0.0674 mm |
| Alternating shear stress τ_yz (0.25·p_max) | 123.7 N/mm² |
| Depth of the alternating shear stress z(τ_yz) | 0.0429 mm |

## Verification against the allowable pressure

| Criterion | Value | Limit | Status |
|---|---|---|---|
| Utilization p_max/p_allow | 80.2 % | 100 % | ● OK |
| Safety S = p_allow/p_max | 1.25 | 1.00 | ● OK |

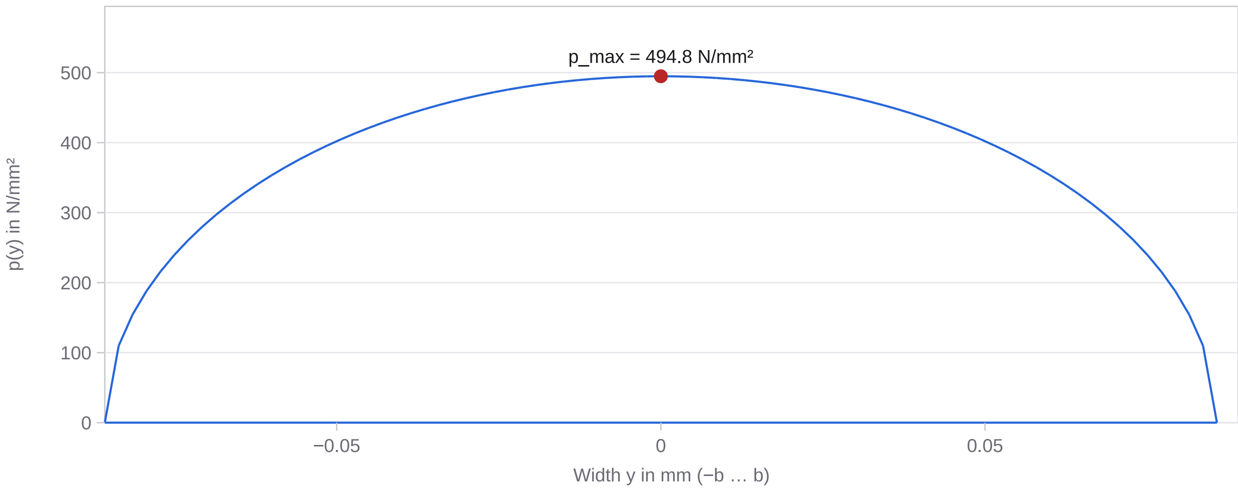
Body 2 governs with p_allow = 617 N/mm²; the other body is at 717 N/mm². Both see the same pressure, and the check runs against the lower allowable level.

## System sketch: contact case and radii




The sketch is schematic: the radii drawn do not correspond to the values entered; only the contact case is relevant.

## Pressure distribution across the contact width




## Calculation basis

Elasticity: both bodies deflect elastically, and their compliances add up to the reduced modulus $1/E^* = (1-\nu_1^2)/E_1 + (1-\nu_2^2)/E_2$. The curvatures add up to the equivalent radius $1/R = 1/R_1 \pm 1/R_2$ (a concave counter-body carries a negative sign, which increases the conformity and thus the contact area). The shape of the pressure distribution stays semi-elliptical throughout: the curvature enters solely through the equivalent radius, and a negative summand changes the value of that sum, not the form of the equation (Hütte, Das Ingenieurwissen, fig. 5-47, which depicts the distribution on the concave case).

Line contact: calculated with the line load $F' = F/L$. The half contact width is $b = \sqrt{4 \cdot F' \cdot R/(\pi \cdot E^*)}$, the maximum pressure $p_{max} = 2 \cdot F'/(\pi \cdot b)$, and the mean pressure $\pi/4$ of that. The approach can only be stated as a Palmgren approximation for steel/steel.

The failure-relevant shear stress develops below the surface. Its maximum and the corresponding depth are determined numerically from the depth profile of the principal stresses (for $\nu = 0.3$, roughly $0.31 \cdot p_{max}$ at $0.48 \cdot a$ for point contact and 0.300 to $0.304 \cdot p_{max}$ at 0.78 to $0.79 \cdot b$ for line contact, depending on the source). This depth is the reference for the required case-hardening depth. In addition, the alternating shear stress $\tau_{yz}$ is reported ($0.25 \cdot p_{max}$ at $0.5 \cdot b$ for line contact, $0.215 \cdot p_{max}$ at $0.35 \cdot a$ for point contact, after Niemann): it reverses sign on rolling over, lies closer to the surface, and is considered the actual cause of pitting fatigue.

Verification: the utilization is $p_{max}/p_{allow}$, the safety factor $p_{allow}/p_{max}$. The static onset of yielding below the surface follows from the ratio $\tau_{max}/p_{max}$: for line contact $p_{allow} \approx 1.67 \cdot R_{p0.2}$, independent of Poisson's ratio, because $\sigma_y$ and $\sigma_z$ on the axis contain no $\nu$. For point contact the factor does depend on $\nu$ and is evaluated per material: $1.61 \cdot R_{p0.2}$ for steel ($\nu$ = 0.3), but $1.77 \cdot R_{p0.2}$ at $\nu = 0.42$ (POM). Context-dependent guideline values apply for rolling contact fatigue. Both bodies see the same pressure but each has its own allowable level: what is compared are the allowable pressures, not the yield strengths -

through the ν-dependent factor the body with the higher yield strength can govern in exceptional cases. Young's modulus does not enter the check; through E* it only lowers the pressure itself.

## About this sample

All values on these pages come from a freely chosen example calculation and belong to no real part. The purchased export contains the same sections with your input, your header data (project, part, prepared by) and as searchable text. Pricing and scope: maschinenbaurechner.de/en/pricing