Hertz Contact Stress: Spheres and Parallel Cylinders

Contact radius or half-width, maximum contact pressure and the maximum subsurface shear stress and its depth for two spheres or two parallel cylinders.

Method: Hertz elastic contact of spheres and parallel cylinders

Input parameters

Unit system: SI

Parameter	Value	Unit
Contact geometry	Two parallel cylinders (cylinder on flat: d_2 = 0)	
Load	8.0000	kN
Diameter of body 1	120.00	mm
Diameter of body 2 (0 for a flat, negative for a concave seat)	300.00	mm
Contact length (cylinders)	50.000	mm
Elastic modulus of body 1	207.00	GPa
Poisson's ratio of body 1	0.30000	
Elastic modulus of body 2	207.00	GPa
Poisson's ratio of body 2	0.30000	

Calculated results

Parameter	Value	Unit
Contact radius (spheres) or half-width (cylinders)	0.27706	mm
Maximum contact pressure	367.64	MPa
Maximum subsurface shear stress	110.29	MPa
Depth of maximum shear	0.21777	mm
Mean contact pressure	288.74	MPa

Notes for this case

- Hertz theory: elastic, frictionless, smooth bodies with the contact small compared with the radii. Maximum shear 0.31 p_max at 0.48a for spheres and 0.30 p_max at 0.786b for cylinders (ν = 0.3).

Formula and method

$$\text{spheres}: \quad a = \sqrt[3]{\frac{3F}{8}\frac{(1-\nu_1^2)/E_1 + (1-\nu_2^2)/E_2}{1/d_1 + 1/d_2}}, \quad p_{max} = \frac{3F}{2\pi a^2}$$

$$\text{cylinders}: \quad b = \sqrt{\frac{2F}{\pi l}\frac{(1-\nu_1^2)/E_1 + (1-\nu_2^2)/E_2}{1/d_1 + 1/d_2}}, \quad p_{max} = \frac{2F}{\pi b l}$$

Variables

geometry	Contact geometry	-
F	Load	N
d_1	Diameter of body 1	m
d_2	Diameter of body 2 (0 for a flat, negative for a concave seat)	m
l	Contact length (cylinders)	m

E_1	Elastic modulus of body 1	Pa
ν_1	Poisson's ratio of body 1	-
E_2	Elastic modulus of body 2	Pa
ν_2	Poisson's ratio of body 2	-
a or b	Contact radius (spheres) or half-width (cylinders)	m
p_{max}	Maximum contact pressure	Pa
τ_{max}	Maximum subsurface shear stress	Pa
z_s	Depth of maximum shear	m
p_{avg}	Mean contact pressure	Pa

Method and standards

Hertz elastic contact theory.

Assumptions and limits

- Elastic, frictionless, non-conforming contact.

References

Hertz elastic contact of spheres and parallel cylinders

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/mechanical/machine-design/hertz-contact-stress

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Reopens the calculator with the inputs of this report.