Shaft Key Shear and Crushing Stress (Key Length)

Shear and crushing (bearing) stresses in a parallel or sunk shaft key from the torque, and the key length needed for allowable stresses in shear and crushing.

Method: Shigley's Mechanical Engineering Design; ch. 7 (keys); ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Torque transmitted	1,000.0	N·m
Shaft diameter	50.000	mm
Key width	14.000	mm
Key height	9.0000	mm
Key length	60.000	mm
Allowable shear stress of the key	60.000	MPa
Allowable crushing stress	100.00	MPa

Calculated results

Parameter	Value	Unit
Tangential force at the shaft surface 2T / d	40.000	kN
Shear stress in the key F / (b l)	47.619	MPa
Crushing stress F / (h l / 2)	148.15	MPa
Length needed for shear	47.619	mm
Length needed for crushing	88.889	mm
Key length needed (larger of the two)	88.889	mm

Notes for this case

- The key entered is shorter than the length needed: it is overstressed in shear or crushing.
- Half the key height bears on the hub (sunk key). Stress concentration and fatigue are not included.

Formula and method

$$F = \frac{2T}{d}, \quad \tau = \frac{F}{b\,l}, \quad \sigma_c = \frac{F}{(h/2)\,l}$$

$$l = \max\left(\frac{F}{b\,\tau_a}, \frac{2F}{h\,\sigma_{c,a}}\right)$$

Variables

T	Torque transmitted	N·m
d	Shaft diameter	m
b	Key width	m
h	Key height	m
l	Key length	m
τ_a	Allowable shear stress of the key	Pa
$\sigma_{c,a}$	Allowable crushing stress	Pa
F	Tangential force at the shaft surface 2T / d	N
τ	Shear stress in the key F / (b l)	Pa

σ_c	Crushing stress F / (h l / 2)	Pa
l_s	Length needed for shear	m
l_c	Length needed for crushing	m
l_{req}	Key length needed (larger of the two)	m

Method and standards

Force at the shaft surface sheared across the key width and pressed against half its height.

Assumptions and limits

- Uniform pressure; no fatigue or stress concentration. A key shorter than the length needed is flagged.

References

- Shigley's Mechanical Engineering Design
- ch. 7 (keys)
- V.B. Bhandari
- Design of Machine Elements
- ch. 9

Report details

Report reference	FCC-1S2W-SB9K (the same inputs always give the same reference)
Generated	17 November 2026, 19:45 UTC
Calculator	Shaft Key Shear and Crushing Stress (Key Length)
Method last reviewed	12 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	3 reference cases of this calculator, computed independently, are checked on every release

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/key-shear-crushing

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.