Adhesive Single-Lap Joint Shear Stress (Volkersen)

Peak and average adhesive shear stress of a bonded lap joint by Volkersen's shear-lag analysis, the stress concentration and the load at an allowable stress.

Method: Volkersen shear-lag analysis

Input parameters

Unit system: SI

Parameter	Value	Unit
Joint load	8.0000	kN
Joint width	25.000	mm
Overlap length	12.500	mm
Adherend 1 thickness	1.6000	mm
Adherend 1 modulus	70.000	GPa
Adherend 2 thickness	1.6000	mm
Adherend 2 modulus	70.000	GPa
Adhesive shear modulus	1.0000	GPa
Adhesive thickness	0.20000	mm
Allowable adhesive shear stress	25.000	MPa

Calculated results

Parameter	Value	Unit
Shear-lag parameter (1/m)	298.81	
Average shear stress	25.600	MPa
Peak shear stress (at the overlap end)	50.147	MPa
Stress concentration	1.9589	
Load at the allowable peak stress	3.9882	kN

Notes for this case

• Volkersen's shear-lag model lets the adherends stretch while the adhesive shears: the load transfers mostly near the overlap ends, so the peak shear exceeds the average P/bL. With ω² = (G_a/t_a)[1/(E₁t₁) + 1/(E₂t₂)], the peak at the end of the less stiff adherend is τ_avg·(ωL/2)[coth(ωL/2) + ((1 − ψ)/(1 + ψ))tanh(ωL/2)], ψ being the stiffness ratio ≤ 1. Lengthening the overlap beyond a few 1/ω barely adds strength. Peel stresses from the load-path eccentricity (Goland–Reissner) are not included and often govern failure.

Formula and method

$$\omega^2 = \frac{G_a}{t_a}\left(\frac{1}{E_1 t_1} + \frac{1}{E_2 t_2}\right), \quad \frac{\tau_{max}}{\tau_{avg}} = \frac{\omega L}{2}\left[\coth\frac{\omega L}{2} + \frac{1-\psi}{1+\psi}\tanh\frac{\omega L}{2}\right]$$

Variables

P	Joint load	N
b	Joint width	m
L	Overlap length	m
t_1	Adherend 1 thickness	m
E_1	Adherend 1 modulus	Pa
t_2	Adherend 2 thickness	m
E_2	Adherend 2 modulus	Pa

G_a	Adhesive shear modulus	Pa
t_a	Adhesive thickness	m
τ_{allow}	Allowable adhesive shear stress	Pa
ω	Shear-lag parameter (1/m)	-
τ_{avg}	Average shear stress	Pa
τ_{max}	Peak shear stress (at the overlap end)	Pa
τ_{max}/τ_{avg}	Stress concentration	-
P_{allow}	Load at the allowable peak stress	N

Method and standards

Lap joint.

Assumptions and limits

- Linear elastic adhesive and adherends; no bending or peel.

References

Volkersen shear-lag analysis

Report details

Report reference	FCC-RH05-XB9S (the same inputs always give the same reference)
Generated	23 November 2026, 18:24 UTC
Calculator	Adhesive Single-Lap Joint Shear Stress (Volkersen)
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 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/adhesive-lap-joint-volkersen

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.