Retaining Wall Stability: Overturning, Sliding and Base Pressure

Factors of safety against overturning and sliding of a gravity or cantilever retaining wall, and the base pressures, from its weights, lever arms and earth thrust.

Method: Rigid-body stability of retaining walls; trapezoidal base pressure (Das, Principles of Foundation Engineering)

Input parameters

Unit system: SI

Parameter	Value	Unit
Total vertical load (wall and soil on the heel)	260.00	kN/m
Lever arm of W from the toe	2.1000	m
Horizontal earth thrust	75.000	kN/m
Height of the thrust above the base	1.8000	m
Base width	3.5000	m
Base friction coefficient	0.50000	
Passive resistance counted	0	kN/m

Calculated results

Parameter	Value	Unit
Against overturning M_R/M_O	4.0444	
Against sliding (μW + P_p)/P_h	1.7333	
Eccentricity of the resultant	0.16923	m
Maximum base pressure	95.837	kPa
Minimum base pressure	52.735	kPa

Formula and method

$$FS_o = \frac{W x_W}{P_h y_h}, \quad FS_s = \frac{\mu W + P_p}{P_h}, \quad q = \frac{W}{B}\left(1 \pm \frac{6e}{B}\right) \quad (|e| \le B/6)$$

$$x = \frac{W x_W - P_h y_h}{W}, \quad e = \frac{B}{2} - x, \quad q_{max} = \frac{2W}{3x'}, \; q_{min} = 0 \quad (|e| > B/6, \; x' = \min(x, B - x))$$

Variables

W	Total vertical load (wall and soil on the heel)	N/m
x_W	Lever arm of W from the toe	m
P_h	Horizontal earth thrust	N/m
y_h	Height of the thrust above the base	m
B	Base width	m
μ	Base friction coefficient	-
P_p	Passive resistance counted	N/m
FS_o	Against overturning M_R/M_O	-
FS_s	Against sliding (μW + P_p)/P_h	-
e	Eccentricity of the resultant	m
x	Distance of the resultant from the toe	m
x'	Distance of the resultant from the nearer edge of the base	m

q_{max}	Maximum base pressure	Pa
q_{min}	Minimum base pressure	Pa

Method and standards

Statics of a rigid wall.

Assumptions and limits

- Rigid wall per metre run.
- With no overturning moment or no horizontal thrust the matching factor of safety is not applicable and is not shown.
- Outside the middle third the base pressure is a triangle over 3x', and the minimum pressure is zero (part of the base lifts).

References

- Rigid-body stability of retaining walls; trapezoidal base pressure (Das, Principles of Foundation Engineering)

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/civil/foundations/retaining-wall-stability

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Reopens the calculator with the inputs of this report.