Gravity Dam Stability: Overturning, Sliding and Base Pressure

Factors of safety against overturning and sliding and base pressures of a gravity dam with a vertical upstream face, from geometry, water and uplift.

Method: Elementary profile analysis of gravity dams (Garg, Irrigation Engineering and Hydraulic Structures (Khanna), ch. on gravity dams)

Input parameters

Unit system: SI

Parameter	Value	Unit
Top width	4.0000	m
Base width	20.000	m
Dam height	25.000	m
Upstream water depth	24.000	m
Unit weight of masonry or concrete	23.500	kN/m³
Uplift intensity factor at the heel	50.000	%
Friction coefficient at the base	0.70000	

Calculated results

Parameter	Value	Unit
Factor of safety against overturning	2.4135	
Factor of safety against sliding	1.4551	
Eccentricity of the resultant (toward the toe)	0.78206	m
Base pressure at the toe	362.53	kPa
Base pressure at the heel	224.75	kPa

Notes for this case

• Per metre length; water 9.81 kN/m³; triangular uplift from c·γ_wh_w at the heel to zero at the toe. No tension at the heel requires e ≤ B/6. Earthquake, silt and wave loads are not included.

Formula and method

$$FS_o = \frac{\sum M_R}{\sum M_O}, \quad FS_s = \frac{\mu(\sum W - U)}{P}, \quad p = \frac{V}{B}\left(1 \pm \frac{6e}{B}\right)$$

$$p_{toe} = \frac{2V}{3x}, \quad p_{heel} = 0$$

Variables

b	Top width	m
B	Base width	m
H	Dam height	m
h_w	Upstream water depth	m
γ_c	Unit weight of masonry or concrete	N/m³
c	Uplift intensity factor at the heel	-
μ	Friction coefficient at the base	-
FS_o	Factor of safety against overturning	-
FS_s	Factor of safety against sliding	-
e	Eccentricity of the resultant (toward the toe)	m

p_{toe}	Base pressure at the toe	Pa
p_{heel}	Base pressure at the heel	Pa

Method and standards

Statics of the dam section.

Assumptions and limits

- Static loads; rigid section; per metre length.

References

- Elementary profile analysis of gravity dams (Garg, Irrigation Engineering and Hydraulic Structures (Khanna), ch. on gravity dams)

Report details

Report reference	FCC-6SZX-DQGT (the same inputs always give the same reference)
Generated	17 November 2026, 19:45 UTC
Calculator	Gravity Dam Stability: Overturning, Sliding and Base Pressure
Method last reviewed	13 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/civil/hydraulics/gravity-dam-stability

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.