Active Earth Pressure with Surcharge and Water Table

Rankine active pressure on a wall with surcharge and a water table in the backfill: base pressure, soil and water thrust and line of action.

Method: Rankine active pressure with effective stresses (Das, Principles of Geotechnical Engineering, 7th ed. (Cengage, 2010), ch. 13)

Input parameters

Unit system: SI

Parameter	Value	Unit
Wall height	6.0000	m
Depth of water table below the top	3.0000	m
Effective friction angle	30.000	°
Unit weight above the water table	18.000	kN/m³
Saturated unit weight	20.000	kN/m³
Uniform surcharge	10.000	kPa

Calculated results

Parameter	Value	Unit
Active coefficient	0.33333	
Total lateral pressure at the base	60.953	kPa
Soil thrust (incl. surcharge)	116.28	kN/m
Water thrust	44.145	kN/m
Total thrust per metre	160.43	kN/m
Height of the resultant above the base	1.9225	m

Notes for this case

- Rankine: smooth vertical wall, horizontal backfill, cohesionless soil. Below the water table soil pressure uses the submerged weight and water pressure is added in full: drains that keep the backfill dry halve the thrust in many cases.

Formula and method

The formula is shown on the calculator page: https://calc.firecad.com/civil/geotechnical/earth-pressure-surcharge-water

Variables

H	Wall height	m
h_w	Depth of water table below the top	m
\phi'	Effective friction angle	rad
γ	Unit weight above the water table	N/m³
γ_{sat}	Saturated unit weight	N/m³
q	Uniform surcharge	Pa
K_a	Active coefficient	-
p_{base}	Total lateral pressure at the base	Pa
P_s	Soil thrust (incl. surcharge)	N/m
P_w	Water thrust	N/m
P	Total thrust per metre	N/m
$\bar{z}$	Height of the resultant above the base	m

Method and standards

Rankine with effective stress.

Assumptions and limits

- Cohesionless backfill (no c′ term, no tension crack); static water; unit weight of water γ_w = 9.81 kN/m³.
- A saturated unit weight not above the moist one is flagged.

References

- Rankine active pressure with effective stresses (Das, Principles of Geotechnical Engineering, 7th ed. (Cengage, 2010), ch. 13)

Report details

Report reference	FCC-EP2G-JYWX (the same inputs always give the same reference)
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Release checks	2 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/geotechnical/earth-pressure-surcharge-water

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.