Exit Gradient by Khosla's Theory

Exit gradient at the downstream end of a weir floor with an end cut-off, by Khosla's formula, compared with the safe exit gradient of the soil.

Method: Classical irrigation engineering relations (duty and delta, Bligh and Lane creep, Khosla exit gradient)

Input parameters

Unit system: SI

Parameter	Value	Unit
Seepage head	4.0000	m
Depth of the downstream cut-off	3.0000	m
Total floor length	40.000	m
Safe exit gradient for the soil	0.16667	

Calculated results

Parameter	Value	Unit
b/d	13.333	
λ	7.1854	
Exit gradient	0.15833	
Safety ratio (≥ 1 safe)	1.0527	
Cut-off depth for the safe gradient	2.7260	m

Notes for this case

• Khosla's analysis of seepage under a floor with a downstream cut-off of depth d gives the exit gradient G_E = H/(dπ√λ), with λ = [1 + √(1 + α²)]/2 and α = b/d. If the gradient at exit exceeds the soil's safe value (about 1/4–1/5 for coarse sand, 1/5–1/6 for fine sand, 1/6–1/7 for silt), the soil can be lifted (piping). Deeper cut-offs or longer floors reduce it; the cut-off depth for the safe gradient is found by iteration.

Formula and method

$$G_E = \frac{H}{d\pi\sqrt{\lambda}}, \quad \lambda = \frac{1+\sqrt{1+\alpha^2}}{2}, \quad \alpha = \frac{b}{d}$$

Variables

H	Seepage head	m
d	Depth of the downstream cut-off	m
b	Total floor length	m
G_s	Safe exit gradient for the soil	-
α	b/d	-
λ	λ	-
G_E	Exit gradient	-
G_s/G_E	Safety ratio (≥ 1 safe)	-
d_{req}	Cut-off depth for the safe gradient	m

Method and standards

Exit gradient.

Assumptions and limits

- Floor of negligible thickness; homogeneous soil.

References

Classical irrigation engineering relations (duty and delta, Bligh and Lane creep, Khosla exit gradient)

Report details

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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/irrigation-farm/khosla-exit-gradient

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.