Breakwater Armour Stone Size (Hudson Formula)

Median armour unit mass, nominal diameter and armour layer thickness for a rubble-mound breakwater or revetment from the design wave, slope and stability factor.

Method: Hudson armour stability formula

Input parameters

Unit system: SI

Parameter	Value	Unit
Design wave height at the structure	3.0000	m
Armour unit density	2,650.0	kg/m³
Water density	1,025.0	kg/m³
Stability coefficient (rough angular quarrystone ≈ 2–4)	4.0000	
Slope (horizontal per vertical)	2.0000	
Number of armour layers	2.0000	
Layer coefficient (quarrystone ≈ 1.0)	1.0000	

Calculated results

Parameter	Value	Unit
Median armour unit mass	2.2446	t
Median armour unit weight	22.012	kN
Nominal diameter (M₅₀/ρ_s)^{1/3}	0.94615	m
Armour layer thickness n k_Δ D_n50	1.8923	m
Stability number H/(Δ D_n50)	2.0000	
Relative buoyant density ρ_s/ρ_w − 1	1.5854	

Notes for this case

• Hudson: M₅₀ = ρ_s H³/(K_D Δ³ cot α), equivalent to H/(ΔD_n50) = (K_D cot α)^{1/3}. K_D depends on the unit type, breaking or non-breaking waves and trunk or head; it is a no-damage criterion for regular waves (later methods such as Van der Meer add storm duration and permeability).

Formula and method

$$M_{50} = \frac{\rho_s H^3}{K_D \Delta^3 \cot\alpha}, \quad \Delta = \frac{\rho_s}{\rho_w} - 1, \quad D_{n50} = \left(\frac{M_{50}}{\rho_s}\right)^{1/3}, \quad r = n k_\Delta D_{n50}$$

Variables

H	Design wave height at the structure	m
ρ_s	Armour unit density	kg/m³
ρ_w	Water density	kg/m³
K_D	Stability coefficient (rough angular quarrystone ≈ 2–4)	-
$\cot\alpha$	Slope (horizontal per vertical)	-
n	Number of armour layers	-
k_Δ	Layer coefficient (quarrystone ≈ 1.0)	-
M_{50}	Median armour unit mass	kg
W_{50}	Median armour unit weight	N
D_{n50}	Nominal diameter (M₅₀/ρ_s)^{1/3}	m

r	Armour layer thickness n k_Δ D_n50	m
N_s	Stability number H/(Δ D_n50)	-
Δ	Relative buoyant density ρ_s/ρ_w − 1	-

Method and standards

Empirical armour stability.

Assumptions and limits

- Regular waves, no-damage criterion, typical quarrystone.

References

Hudson armour stability formula

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/hydraulics/hudson-armour-stone-weight

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Reopens the calculator with the inputs of this report.