Soil Phase Relations: Void Ratio, Porosity, Saturation, Unit Weights

Void ratio, porosity, degree of saturation, air content and bulk, dry and saturated unit weights of a soil from water content, specific gravity and bulk density.

Method: Three-phase soil relations (Das, Principles of Geotechnical Engineering; Craig, Soil Mechanics)

Input parameters

Unit system: SI

Parameter	Value	Unit
Water content (of dry mass)	18.000	%
Specific gravity of the solids	2.6800	
Bulk density	1,950.0	kg/m³

Calculated results

Parameter	Value	Unit
Dry density ρ/(1 + w)	1,652.5	kg/m³
Void ratio G_s ρ_w/ρ_d − 1	0.62174	
Porosity e/(1 + e)	38.338	%
Degree of saturation w G_s/e	77.588	%
Air content n(1 − S_r)	8.5922	%
Bulk unit weight	19.123	kN/m³
Saturated unit weight	19.966	kN/m³
Submerged unit weight	10.159	kN/m³

Formula and method

$$\rho_d = \frac{\rho}{1+w}, \quad e = \frac{G_s \rho_w}{\rho_d} - 1, \quad n = \frac{e}{1+e}, \quad S_r = \frac{w G_s}{e}, \quad \gamma_{sat} = \frac{(G_s + e)\rho_w g}{1+e}$$

Variables

w	Water content (of dry mass)	-
G_s	Specific gravity of the solids	-
ρ	Bulk density	kg/m³
ρ_d	Dry density ρ/(1 + w)	kg/m³
e	Void ratio G_s ρ_w/ρ_d − 1	-
n	Porosity e/(1 + e)	-
S_r	Degree of saturation w G_s/e	-
a_c	Air content n(1 − S_r)	-
γ	Bulk unit weight	N/m³
γ_{sat}	Saturated unit weight	N/m³
\gamma'	Submerged unit weight	N/m³

Method and standards

Phase diagram relations.

Assumptions and limits

- Water density 1000 kg/m³.

References

• Three-phase soil relations (Das, Principles of Geotechnical Engineering; Craig, Soil Mechanics)

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/geotechnical/soil-phase-relations

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Reopens the calculator with the inputs of this report.