Relative Density (Density Index) of Sand

Relative density of a sand from its in-place void ratio or dry density and its maximum and minimum, with the usual description from very loose to very dense.

Method: Relative density D_r = (e_max − e)/(e_max − e_min); written in dry densities (ASTM D4254 definition); bands after Lambe and Whitman

Input parameters

Unit system: SI

Parameter	Value	Unit
In-place dry density	1,650.0	kg/m³
Minimum dry density (loosest)	1,500.0	kg/m³
Maximum dry density (densest)	1,800.0	kg/m³

Calculated results

Parameter	Value	Unit
Relative density	54.545	%
Description (1 very loose … 5 very dense)	3.0000	

Notes for this case

- Description: medium dense (bands 15, 35, 65 and 85 %).

Formula and method

$$D_r = \frac{e_{max} - e}{e_{max} - e_{min}} = \frac{\rho_{d,max}}{\rho_d} \cdot \frac{\rho_d - \rho_{d,min}}{\rho_{d,max} - \rho_{d,min}}$$

Variables

ρ_d	In-place dry density	kg/m³
$\rho_{d,min}$	Minimum dry density (loosest)	kg/m³
$\rho_{d,max}$	Maximum dry density (densest)	kg/m³
D_r	Relative density	-
state	Description (1 very loose … 5 very dense)	-

Method and standards

Definition.

Assumptions and limits

- Clean sands.
- The in-place density should lie between the minimum and maximum; outside that range D_r falls below 0 or above 100 % and the page warns.

References

- Relative density D_r = (e_max − e)/(e_max − e_min)
- written in dry densities (ASTM D4254 definition); bands after Lambe and Whitman

Report details

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Release checks	4 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/relative-density-soil

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.