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Soil Origin and Its Properties Formulas

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List of 31 Soil Origin and Its Properties Formulas

Soil Origin and Its Properties

1) Degree of Saturation given Dry Unit Weight of Soil

$$fx \quad S = \left(\left(\frac{\gamma_{dry}}{\gamma_{water}} \right) \cdot \left(\left(\frac{1}{G_s} \right) + w_s \right) \right)$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b_img.jpg\)](#)

$$ex \quad 0.615967 = \left(\left(\frac{6.12\text{kN/m}^3}{9.81\text{kN/m}^3} \right) \cdot \left(\left(\frac{1}{2.65} \right) + 0.61 \right) \right)$$

2) Degree of Saturation of Soil

$$fx \quad S = \left(\frac{w_s \cdot G_s}{e_s} \right)$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d_img.jpg\)](#)

$$ex \quad 0.702826 = \left(\frac{0.61 \cdot 2.65}{2.3} \right)$$

3) Dry Unit Weight of Soil given Relative Density

$$fx \quad \gamma_{dry} = \left(\frac{\gamma_{min} \cdot \gamma_{max}}{\gamma_{max} - R_D \cdot (\gamma_{max} - \gamma_{min})} \right)$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d_img.jpg\)](#)

$$ex \quad 7.518797\text{kN/m}^3 = \left(\frac{5\text{kN/m}^3 \cdot 10\text{kN/m}^3}{10\text{kN/m}^3 - 0.67 \cdot (10\text{kN/m}^3 - 5\text{kN/m}^3)} \right)$$



4) Dry Unit Weight of Soil with any Degree of Saturation

$$fx \quad \gamma_{dry} = \left(\frac{\gamma_{water} \cdot G_s \cdot S}{1 + (w_s \cdot G_s)} \right)$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$ex \quad 5.961361 \text{ kN/m}^3 = \left(\frac{9.81 \text{ kN/m}^3 \cdot 2.65 \cdot 0.6}{1 + (0.61 \cdot 2.65)} \right)$$

5) Maximum Porosity given Relative Density in Porosity

$$fx \quad n_{max} = n_{min} \cdot \frac{R - (\eta \cdot R) - \eta + 1}{R - (\eta \cdot R) + n_{min} - 1}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$ex \quad 0.896703 = 0.8 \cdot \frac{11 - (0.32 \cdot 11) - 0.32 + 1}{11 - (0.32 \cdot 11) + 0.8 - 1}$$

6) Maximum Unit Weight of Soil given Relative Density

$$fx \quad \gamma_{max} = \left(\frac{\gamma_{min} \cdot \gamma_{dry} \cdot R}{\gamma_{dry} \cdot (R - 1) + \gamma_{min}} \right)$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$ex \quad 5.084592 \text{ kN/m}^3 = \left(\frac{5 \text{ kN/m}^3 \cdot 6.12 \text{ kN/m}^3 \cdot 11}{6.12 \text{ kN/m}^3 \cdot (11 - 1) + 5 \text{ kN/m}^3} \right)$$



7) Maximum Void Ratio of Soil given Relative Density

$$\text{fx } e_{\max} = \frac{e_o - (R \cdot e_{\min})}{1 - R}$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)

$$\text{ex } 0.28 = \frac{0.50 - (11 \cdot 0.30)}{1 - 11}$$

8) Minimum Porosity given Relative Density in Porosity

$$\text{fx } n_{\min} = n_{\max} \cdot \frac{1 + (\eta \cdot R) - \eta - R}{n_{\max} - \eta - R + (\eta \cdot R)}$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

$$\text{ex } 0.909302 = 0.92 \cdot \frac{1 + (0.32 \cdot 11) - 0.32 - 11}{0.92 - 0.32 - 11 + (0.32 \cdot 11)}$$

9) Minimum Unit Weight of Soil given Relative Density

$$\text{fx } \gamma_{\min} = \left(\frac{\gamma_{\text{dry}} \cdot \gamma_{\max} \cdot (R - 1)}{(R \cdot \gamma_{\text{dry}}) - \gamma_{\max}} \right)$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

$$\text{ex } 10.6769\text{kN/m}^3 = \left(\frac{6.12\text{kN/m}^3 \cdot 10\text{kN/m}^3 \cdot (11 - 1)}{(11 \cdot 6.12\text{kN/m}^3) - 10\text{kN/m}^3} \right)$$



10) Minimum Void Ratio of Soil given Relative Density

$$fx \quad e_{\min} = \left(e_{\max} - \left(\frac{e_{\max} - e_o}{R} \right) \right)$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$ex \quad 0.772727 = \left(0.80 - \left(\frac{0.80 - 0.50}{11} \right) \right)$$

11) Natural Void Ratio of Soil given Relative Density

$$fx \quad e_o = (e_{\max} \cdot (1 - R_D) + (R_D \cdot e_{\min}))$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$ex \quad 0.465 = (0.80 \cdot (1 - 0.67) + (0.67 \cdot 0.30))$$

12) Porosity Given Relative Density in Porosity

$$fx \quad \eta = \frac{n_{\max} \cdot (1 - n_{\min} - R_D) + R_D \cdot n_{\min}}{1 - n_{\min} + R_D \cdot n_{\min} - R_D \cdot n_{\max}}$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)

$$ex \quad 0.866221 = \frac{0.92 \cdot (1 - 0.8 - 0.67) + 0.67 \cdot 0.8}{1 - 0.8 + 0.67 \cdot 0.8 - 0.67 \cdot 0.92}$$


13) Porosity of soil

$$fx \quad \eta = \left(\frac{V_v}{V} \right)$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80_img.jpg\)](#)

$$ex \quad 0.325 = \left(\frac{6.5m^3}{20m^3} \right)$$



14) Porosity of Soil given Void Ratio [Open Calculator](#) 

$$fx \quad \eta = \left(\frac{e_s}{1 + e_s} \right)$$

$$ex \quad 0.69697 = \left(\frac{2.3}{1 + 2.3} \right)$$

15) Relative density given porosity [Open Calculator](#) 

$$fx \quad R_D = \frac{(n_{\max} - \eta) \cdot (1 - n_{\min})}{(n_{\max} - n_{\min}) \cdot (1 - \eta)}$$


$$ex \quad 1.470588 = \frac{(0.92 - 0.32) \cdot (1 - 0.8)}{(0.92 - 0.8) \cdot (1 - 0.32)}$$

16) Relative Density of Cohesionless Soil given Unit Weight of Soil [Open Calculator](#) 

$$fx \quad R_D = \frac{\left(\frac{1}{\gamma_{\min}} \right) - \left(\frac{1}{\gamma_{\text{dry}}} \right)}{\left(\frac{1}{\gamma_{\min}} \right) - \left(\frac{1}{\gamma_{\max}} \right)}$$

$$ex \quad 0.366013 = \frac{\left(\frac{1}{5\text{kN/m}^3} \right) - \left(\frac{1}{6.12\text{kN/m}^3} \right)}{\left(\frac{1}{5\text{kN/m}^3} \right) - \left(\frac{1}{10\text{kN/m}^3} \right)}$$




17) Relative Density of Cohesionless Soil given Void Ratio 

$$fx \quad R_D = \left(\frac{e_{\max} - e_o}{e_{\max} - e_{\min}} \right)$$

Open Calculator 

$$ex \quad 0.6 = \left(\frac{0.80 - 0.50}{0.80 - 0.30} \right)$$

18) Specific Gravity of Soil given Degree of Saturation 

$$fx \quad G_s = \left(\frac{S \cdot e_s}{w_s} \right)$$

Open Calculator 

$$ex \quad 2.262295 = \left(\frac{0.6 \cdot 2.3}{0.61} \right)$$

19) Total Volume of Soil using Porosity 

$$fx \quad V = \left(\frac{V_v}{\eta} \right)$$

Open Calculator 

$$ex \quad 20.3125m^3 = \left(\frac{6.5m^3}{0.32} \right)$$

20) Void ratio of soil 

$$fx \quad e_s = \left(\frac{V_v}{V_s} \right)$$

Open Calculator 

$$ex \quad 2.166667 = \left(\frac{6.5m^3}{3m^3} \right)$$



21) Void Ratio of Soil given Degree of Saturation

$$fx \quad e_s = \left(\frac{w_s \cdot G_s}{S} \right)$$

[Open Calculator !\[\]\(6605b201d6f14d9b3bcb8ab5f274d107_img.jpg\)](#)

$$ex \quad 2.694167 = \left(\frac{0.61 \cdot 2.65}{0.6} \right)$$

22) Void Ratio of Soil given Porosity

$$fx \quad e_s = \left(\frac{\eta}{1 - \eta} \right)$$

[Open Calculator !\[\]\(e8fb589d58dad1692debababa5e928b6_img.jpg\)](#)

$$ex \quad 0.470588 = \left(\frac{0.32}{1 - 0.32} \right)$$

23) Volume of Voids using Porosity

$$fx \quad V_v = (\eta \cdot V)$$

[Open Calculator !\[\]\(4688aadfd656ded00cd6bdfae55089a9_img.jpg\)](#)

$$ex \quad 6.4m^3 = (0.32 \cdot 20m^3)$$

24) Water Content of Soil given Degree of Saturation

$$fx \quad w_s = \left(\frac{S \cdot e_s}{G_s} \right)$$

[Open Calculator !\[\]\(4146d17f71dced09c6ad789cacceaa6d_img.jpg\)](#)

$$ex \quad 0.520755 = \left(\frac{0.6 \cdot 2.3}{2.65} \right)$$



Degree of Saturation

25) Air Content with Respect to Degree of Saturation

$$fx \quad a_c = 1 - S$$

[Open Calculator !\[\]\(d66ff64371a51729ac8c1cdaa685ba6f_img.jpg\)](#)

$$ex \quad 0.4 = 1 - 0.6$$

26) Buoyant Unit Weight of Soil with Saturation 100 Percent

$$fx \quad \gamma_b = \left(\frac{(G_s \cdot \gamma_{\text{water}}) - \gamma_{\text{water}}}{1 + e} \right)$$

[Open Calculator !\[\]\(faf942dc3e59ce8eb64b4ac481eca7e0_img.jpg\)](#)

$$ex \quad 7.3575 \text{ kN/m}^3 = \left(\frac{(2.65 \cdot 9.81 \text{ kN/m}^3) - 9.81 \text{ kN/m}^3}{1 + 1.2} \right)$$

27) Degree of Saturation given Air Content with Respect to Degree of Saturation

$$fx \quad S = 1 - a_c$$

[Open Calculator !\[\]\(95b425611cbd2b8716a140cf67c81822_img.jpg\)](#)

$$ex \quad 0.6 = 1 - 0.4$$

28) Degree of Saturation given Void Ratio in Specific Gravity

$$fx \quad S = w_s \cdot \frac{G_s}{e}$$

[Open Calculator !\[\]\(56549452e01ca28bdf2500ced9653143_img.jpg\)](#)

$$ex \quad 1.347083 = 0.61 \cdot \frac{2.65}{1.2}$$



29) Degree of Saturation of Soil Sample

[Open Calculator !\[\]\(99f58673407353e96a019fbca558fd72_img.jpg\)](#)

$$fx \quad S = \left(\frac{V_w}{V_v} \right)$$

$$ex \quad 0.666667 = \left(\frac{2m^3}{3m^3} \right)$$

30) Volume of Voids given Degree of Saturation of Soil Sample

[Open Calculator !\[\]\(de95854c7ee024cfadc48187bbb781b2_img.jpg\)](#)

$$fx \quad V_v = \frac{V_w}{S}$$

$$ex \quad 3.333333m^3 = \frac{2m^3}{0.6}$$

31) Volume of Water given Degree of Saturation of Soil Sample

[Open Calculator !\[\]\(6a9b39b98eb945faa14c645ec99e4eaa_img.jpg\)](#)

$$fx \quad V_w = S \cdot V_v$$

$$ex \quad 1.8m^3 = 0.6 \cdot 3m^3$$



Variables Used



- a_c Air Content
- e Void Ratio
- e_{\max} Maximum Void Ratio
- e_{\min} Minimum Void Ratio
- e_o Natural Void Ratio
- e_s Void Ratio of Soil
- G_s Specific Gravity of Soil
- n_{\max} Maximum Porosity
- n_{\min} Minimum Porosity
- R Relative Density
- R_D Relative Density in Soil Mechanics
- S Degree of Saturation
- V Volume of Soil (*Cubic Meter*)
- V_s Solid Volume (*Cubic Meter*)
- V_v Volume of Voids (*Cubic Meter*)
- V_v Void Space Volume (*Cubic Meter*)
- V_w Volume of Water (*Cubic Meter*)
- w_s Water Content of Soil from Pycnometer
- Y_b Buoyant Unit Weight (*Kilonewton per Cubic Meter*)
- Y_{dry} Dry Unit Weight (*Kilonewton per Cubic Meter*)
- Y_{\max} Maximum Unit Weight (*Kilonewton per Cubic Meter*)



- γ_{\min} Minimum Unit Weight (*Kilonewton per Cubic Meter*)
- γ_{water} Unit Weight of Water (*Kilonewton per Cubic Meter*)
- η Porosity of Soil



Constants, Functions, Measurements used

- **Measurement: Volume** in Cubic Meter (m^3)
Volume Unit Conversion 
- **Measurement: Specific Weight** in Kilonewton per Cubic Meter (kN/m^3)
Specific Weight Unit Conversion 



Check other formula lists

- [Bearing Capacity for Strip Footing for C- \$\Phi\$ Soils Formulas](#) 
- [Bearing Capacity of Cohesive Soil Formulas](#) 
- [Bearing Capacity of Non-cohesive Soil Formulas](#) 
- [Bearing Capacity of Soils Formulas](#) 
- [Bearing Capacity of Soils: Meyerhof's Analysis Formulas](#) 
- [Foundation Stability Analysis Formulas](#) 
- [Atterberg Limits Formulas](#) 
- [Bearing Capacity of Soil: Terzaghi's Analysis Formulas](#) 
- [Compaction of Soil Formulas](#) 
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- [Lateral Pressure for Cohesive and Non Cohesive Soil Formulas](#) 
- [Minimum Depth of Foundation by Rankine's Analysis Formulas](#) 
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