GEOtExcel : Soil Mechanics

Soil Phase Relationships : Problem 01

The weigth of a wet soil is W. When this soil dries, its weight reduces to 30 g. If it is saturated, its weight increases to 40 g. If the specific gravity of the soil equals Gs, then calculate: A) Water content, B)Void ratio, C)The degree of Saturation, D)Prosity, E)Volume of the Soil phases, F) Air content and Percentage air voids.

Student ID	W	G_s
Public	**32.0**	**2.65**
0001	32.5	2.66
0002	33.0	2.67
0003	33.5	2.68
0004	34.0	2.69
0005	34.5	2.70
0006	35.0	2.71
0007	35.5	2.72
0008	36.0	2.73
0009	36.5	2.74
0010	37.0	2.75
0011	37.5	2.76
0012	38.0	2.77
0013	32.0	2.78
0014	32.5	2.79
0015	33.0	2.80
0016	33.5	2.81
0017	34.0	2.82
0018	34.5	2.83
0019	35.0	2.84
0020	35.5	2.85
0021	36.0	2.86
0022	36.5	2.87
0023	37.0	2.88
0024	37.5	2.89
0025	38.0	2.90
0026	32.0	2.91
0027	32.5	2.92
0028	33.0	2.93
0029	33.5	2.94
0030	34.0	2.95

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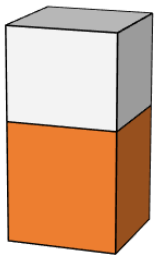
Solution:

Part A:

V_a=	
V_w=	
V_s=	
$V=V_a+V_w+V_s$ =	
$V_V=V_a+V_w$ =	

Volume



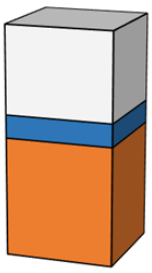
Dry Soil

W_a=	0	g
W_w=	0	g
W_s=	30	g
$W=W_a+W_w+Ws$=	32	g

Weight

V_a=	
V_w=	
V_s=	
$V=V_a+V_w+V_s$ =	
$V_V=V_a+V_w$ =	

Volume



wet Soil

W_a=	0	g
W_w=	2	g
W_s=	30	g
$W=W_a+W_w+Ws$=	32	g

Weight

☑ ***Water content*** *The water content (moisture) represents the proportion of water weight to solid weight.*

$$w = \frac{W_w}{W_s} = \frac{2}{30} = 0.0667 = 6.67 \ \%$$

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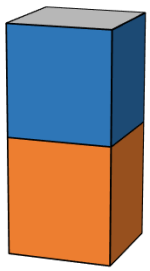
Solution:

Part B:

Volume			Weight		
V_a=			W_a=	0	g
V_w=			W_w=	10	g
V_s=			W_s=	30	g
$V=V_a+V_w+V_s$ =			$W=W_a+W_w+Ws$=	40	g
$V_V=V_a+V_w$ =					



For Saturated Soil

☑ ***Water content*** The water content (moisture) represents the proportion of water weight to solid weight.

$$w = \frac{W_w}{W_s} = \frac{10}{30} = 0.3333 = 33.33\ \%$$

Specific Gravity	G_s=	2.65
Void ratio	e=	?
Saturation rate	S_r =	1.00 = 100 %
Moisture content	w =	0.33 = 33.33 %

☑ $w \cdot G_S = S_r \cdot e$

☑ $e = \frac{w \times G_s}{S_r} = \frac{0.33 \times 2.65}{1.00} = 0.883$

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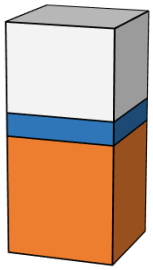
Solution:

Part C:



wet Soil

Specific Gravity	G_s= 2.65	☑ $w \cdot G_S = S_r \cdot e$
Void ratio	e= 0.883	
Saturation rate	S_r = ?	☑ $Sr = \frac{w \times G_s}{e} = \frac{0.067 \times 2.65}{0.88} = 0.20$
Moisture content	w = 0.067 = 6.67 %	☑ $S_r = 0.2000 = 20.00\ \%$

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Solution:

Part D:

- ***Void ratio***

$$e = 0.883$$

- ***Prosity***

$$n = \frac{e}{1 + e}$$

$$n = \frac{0.883}{1 + 0.883} = 0.469$$

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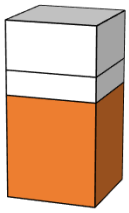
Solution:

Part E:

If we assume that this soil is dry:

V_a=	
V_w=	
V_s=	
$V_V=V_a+V_w$=	
$V=V_a+V_w+V_s$= ?	cm^3



W_a=	0	g
W_w=	2.00	g
W_s=	30.00	g
$W=W_a+W_w+Ws$=	32.00	g

γ_w =	1	g/cm^3	e =	0.883
G_s =	2.65		V=	?

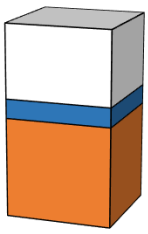
$$\gamma_d = \frac{W_s}{V} = \frac{30.0}{V}$$

$$\gamma_d = \frac{G_s.\gamma_w}{(1+e)} = \frac{2.65 \times 1}{1 + 0.883} = 1.407$$

$\rightarrow$ V= 21.32 cm^3

Wet Soil

V_a= ?		cm^3
V_w= ?		cm^3
V_s= ?		cm^3
$V_v = V_a+V_w$ = ?		cm^3
$V = V_a+V_w+V_s$=	21.32	cm^3



W_a=	0	
W_w=	2.00	g
W_s=	30.00	g
$W=W_S+W_W$=	32.00	g

$G_s = W_s / V_S$=	2.65	
$e = V_V / V_S$ =	0.883	
$\gamma_w = W_w / V_w$=	1.00	g/cm^3

☑ $V_s = W_s / G_s$ =	30.00	/	2.65	=	11.32	cm^3
☑ $V_v = e \, . \, V_s$ =	0.88	×	11.32	=	10.00	cm^3
☑ $V_w = W_w / \gamma_w$ =	2.00	/	1.0	=	2.00	cm^3
☑ $V_a = V_v - V_w$ =	10.00	-	2.00	=	8.00	cm^3

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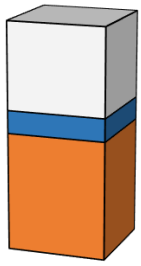
Solution:

Part F:

	V_a=	8	cm^3
	V_w=	2	cm^3
	V_s=	11.3	cm^3
$V=V_a+V_w+V_s$ =		21.3	cm^3
$V_V=V_a+V_w$ =		10	cm^3

Volume



Moist Soil

W_a=	0	g
W_w=	2	g
W_s=	30	g
$W=W_a+W_w+Ws$=	32	g

Weight

$$a_c = \frac{V_a}{V_v} = \frac{8}{10} = 0.8 = 80 \ \%$$

$$n_a = \frac{V_a}{V} = \frac{8}{21.32} = 0.375 = 37.52 \ \%$$