King Saud University
College of Engineering
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15-1 Given the following information, calculate the group index and classify each of these soils into proper subdivision of AASHTO classification system.

Sample No.	Sieve Analysis: Percentage Passing 10 (2.00 mm)	40 (0.425 mm)	200 (0.075 mm)	Characteristics of Soil Binder: Liquid Limit	Plasticity Index
1	100.0	97.5	65.1	65.5	45.0
2	100.0	73.1	5.4	20.1	NP
3	100.0	46.2	20.8	16.9	NP
4	77.2	37.1	28.2	33.1	6.8
5	100.0	100.0	58.2	60.2	21.7
6	100.0	100.0	83.7	54.2	33.6
7	100.0	56.3	19.1	24.8	12.6
8	100.0	96.3	75.6	33.7	8.9
9	100.0	100.0	53.1	50.6	8.6
10	100.0	100.0	95.0	30.3	11.3
11	100.0	73.7	36.3	38.7	12.7
12	37.1	21.1	8.6	12.3	NP

Group Index values are calculated by equation 15-4, and the AASHTO classifications determined by Table 15-1 using a left-to-right elimination process.

Sample No.	Group Index	AASHTO Classification
1	45	A-7-6
2	0	A-3
3	0	A-1-b
4	0	A-2-4
5	12	A-7-5
6	29	A-7-6
7	0	A-2-6
8	6	A-4
9	4	A-5
10	11	A-6
11	1	A-6
12	0	A-1-a

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15-2 Classify each of the soils in Problem 15-1 under the Unified Soil Classification System. The following additional data are available for certain of the samples.

Sample No. 2	**D_{60} = 0.3, D_{10} = 0.03, D_{30} = 0.17**	
Sample No. 4	**Passing No.4 sieve**	**86.2%**
	Passing 3/8-in. sieve	**100.0%**
Sample No. 12	**Passing No.4 sieve**	**49.9%**
	Passing ½ -in. sieve	**80.6%**
	Passing 1-in sieve	**100.0%**
	C_u = 5	
	C_g = 2	

Using Table 15-3, the following classifications result:

Sample No.	Unified Soil Classification System
1	CH
2	SP
3	SM
4	SM or SC
5	OH or MH
6	CH
7	SM or SC
8	ML
9	OH or MH
10	CL
11	SM or SC
12	GW

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15-3 Given the following information from a compaction test performed in a laboratory by the standard Proctor compaction procedure, draw the moisture-density curve and determine the optimum moisture and maximum density for this soil:

Weight of mold = 2456 g
Volume of mold = 1/30 ft^3

Trial No.	Weight of Compacted Soil Plus Mold (g)	Moisture Content (%)
1	4136	9.4
2	4205	11.2
3	4308	13.1
4	4408	13.9
5	4398	15.8
6	4354	17.9

Sample calculation for trial No. 1:

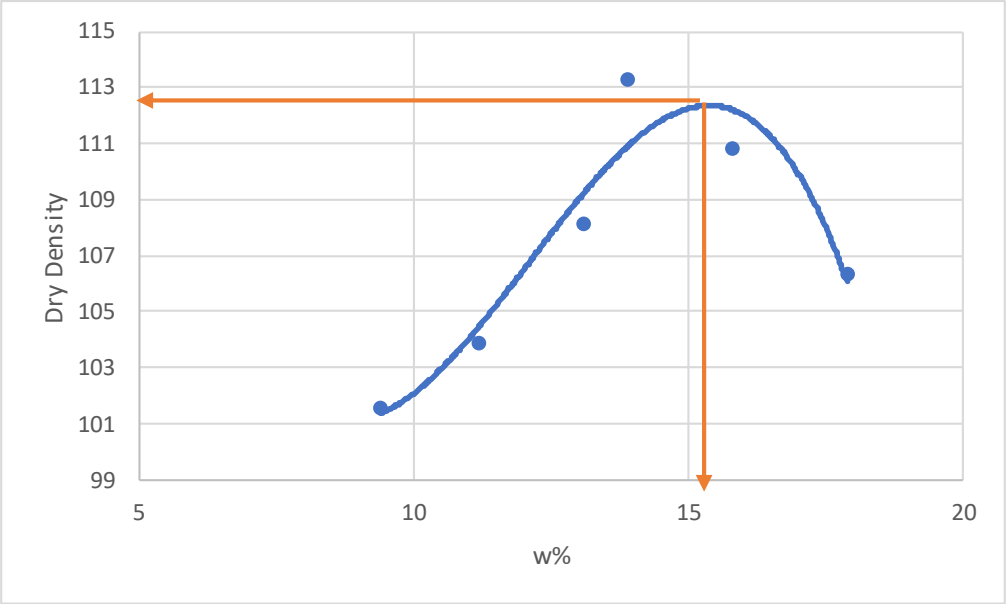
$$Wt.of\ soil = Wt.of\ soil\ and\ mold - Wt.of\ mold = 4136 - 2456 = 1680\ g$$

$$Wt.of\ soil\ in\ (lb.) = 1680\ g \times \frac{1lb.}{453.59\ g} = 3.704\ lb.$$

$$wet\ unit\ Wt. = \frac{wet\ Wt.\ lb.}{volume\ ft^3} = \frac{3.704}{1/30} = 111.1\ \frac{lb.}{ft^3}$$

$$dry\ unit\ Wt. = \frac{wet\ unit\ Wt.}{\frac{(100 + w\%)}{100}} = \frac{111.1}{\frac{(100 + 9.4)}{100}} = 101.6\ \frac{lb.}{ft^3}$$

Trial No.	Wt. of Soil + Mold (g)	Wt. of Soil (g)	Wt. of Soil (lb.)	Wet Unit Wt. (lb./ft^3)	w %	Dry Unit Wt. (lb./ft^3)
1	4136	1680	3.704	111.1	9.4	101.6
2	4205	1749	3.856	115.5	11.2	103.9
3	4308	1852	4.083	122.4	13.1	108.2
4	4408	1952	4.303	129.0	13.9	113.3
5	4398	1942	4.281	128.4	15.8	110.9
6	4354	1898	4.184	125.4	17.9	106.4



Optimum w% = 15.5%, maximum dry density = 12.5 lb./ft^3.

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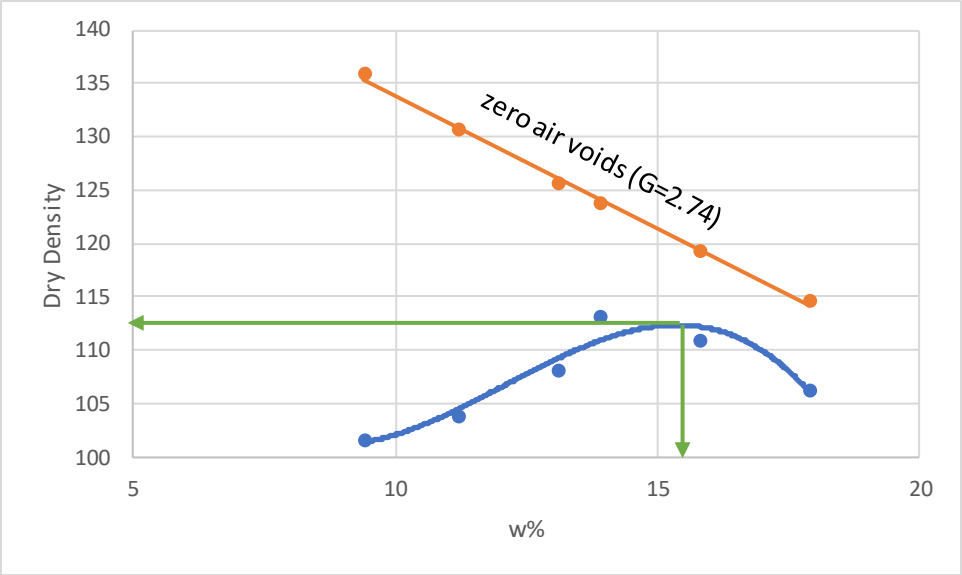
15-4 Assuming the soil of Problem 15-3 has a specific gravity of 2.74, make the necessary computations and plot the "zero air voids curve" on the drawing prepared in Problem 15-3.

Using equation 15-5, a sample calculation for trial No. 1:

$$dry\ unit\ Wt. = \frac{wG}{1+\frac{mG}{100}} = \frac{62.4 \times 2.74}{1+\frac{9.4 \times 2.74}{100}} = \frac{170.976}{1.25756} = 136.0\ \frac{lb.}{ft^3}$$

Trial No.	w %	Dry Unit Wt. (lb./ft^3)
1	9.4	136.0
2	11.2	130.8
3	13.1	125.8
4	13.9	123.8
5	15.8	119.3
6	17.9	114.7



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15-5 The dry mass of a sample of aggregate is 1206 g. The mass in a saturated surface dry condition is 1226.8 g. The volume of the aggregate, excluding the volume of absorbed water, is 440.6 cm³. Calculate the bulk specific gravity, and the percentage absorption.

By equation 15-7, the bulk specific gravity

Mass of absorbed water = 1226.8 – 1206 = 20.8 g

Volume of absorbed water = 20.8 g / 1 g/cm³= 20.8 cm³

Volume of aggregate with water = 440.6 + 20.8 = 461.4 cm³

$$G_B = \frac{M_D/V_B}{w} = \frac{1206(g)/461.4(cm^3)}{1\,(\frac{g}{cm^3})} = 2.614$$

By equation 15-7, the percentage absorption:

$$Percentage\ absorption = \frac{M_w}{M_D} \times 100 = \frac{20.8}{1206} \times 100 = 1.72\%$$

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15-6 The following weights are recorded during the determination of the specific gravity of bituminous material by pycnometer method. Calculate the specific gravity of this substance.

Weight of pycnometer, empty	**34.316 g**
Weight of pycnometer, filled with water	**60.000 g**
Weight of pycnometer, filled with bituminous material	**58.202 g**
Temperature (all determinations)	**77 °F (25 °C)**

$$G = \frac{C - A}{(B - A) - (D - C)}$$

Where:

A = Weight of pycnometer.
B = Weight of pycnometer filled with water.
C = Weight of pycnometer partially filled with asphalt, and
D = Weight of pycnometer plus asphalt plus water.

Since the pycnometer is filled with bituminous material, then D=C

$$G = \frac{58.202 - 34.316}{(60.000 - 34.316) - (58.202 - 58.202)} = 0.930$$

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