Tutorial 3

Problem 1

The data from a 4.5 kg compaction test are given in Table 1 below:

Water content (w) %	8	11	13	15	19
Density (ρ) kg/m^3	1945	2090	2120	2080	1990

Table 1: results of compaction test

Determine:

(a) The maximum dry density
(b) The optimum water content
(c) The degree of saturation at the maximum dry density if the specific gravity of the particles (G_s) is 2.65.

Powrie (2004)

Problem 2

The results given in Table 2 were obtained from a standard (2.5 kg) Proctor compaction test:

Mass of empty tin (g)	14	14	14	14	14
Mass of tin + wet sample (g)	88	68	98	94	93
Mass of tin +dry sample (g)	81	62	87	82	80
Density (kg/m^3)	1730	1950	2020	1930	1860

Table 2: Compaction test data for Problem 2

Plot a graph to determine:

(a) The maximum dry density
(b) The optimum water content
(c) The actual density at the optimum water content

If the relative density of the particles is G_s=2.65, considering the optimum point, calculate

(d) The specific volume
(e) The degree of saturation at the maximum dry density

Problem 3

The results given in Table 3 were obtained in two compaction tests.

Water content, w [%]	Bulk Unit Weight [kN/ m^3]	
	15 blows / layer	25 blows / layer
11.2	18.9	20.0
12.9	19.7	20.9
14.0	20.1	21.3
16.3	20.5	21.1
18.8	20.4	20.6
20.5	20.0	20.1

Table 3

Note: Bulk Unit Weight $\gamma_{bulk} = \frac{M_{Total} \cdot g}{V_{Total}}$, where M is the total mass ($M=M_s+M_w$), *g* is acceleration due to gravity (take as 9.81 m/s^2) and V is the total volume. Assume $G_s=2.7$.

On a single graph plot the dry unit weight against the water content for each set of results and plot lines corresponding to degrees of saturation of 90, 95 and 100 %.

The test carried out using 25 blows / layer corresponds to the British Standard compaction test approach. For this test find the British Standard maximum dry unit weight and optimum water content and express the maximum dry unit weight for the second test as a percentage of the maximum dry unit weight obtained using the British Standard approach.

Problem 4

(a) For the test results obtained in Problem 3, calculate the degree of saturation and the air content ($A=V_A/V$) per unit volume of soil at the maximum dry unit weight for the British Standard approach (25 blows/ layer). Find the water content this material would have if it was fully saturated at the same volume.

(b) Repeat the calculations in Problem 4(a) for the case where the soil is compacted with only 15 blows / layer.

Additional problems to try: Knappett & Craig (2012) Problems 1.6, 1.7 & 1.8

References:

Knappett, J.A. & Craig, R.F. (2012) *Craig's Soil Mechanics*. 8th Ed., Spon Press.

Powrie, W. (2004) *Soil Mechanics: Concepts and Applications*. Spon Press