Degree of saturation - Sr

The degree of water saturation is the ratio of the volume of the pore water and the total pore volume.

$$S_r = \frac{V_w}{V_p}$$

Vw – volume of water in soil
Vp – volume of pores
Unit: %

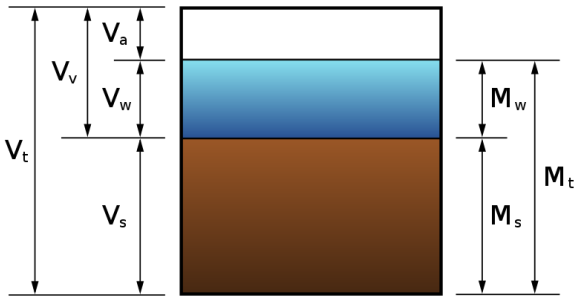
$$S_r = \frac{w \cdot \rho \cdot \rho_s / \rho_w}{\rho_s \cdot (w + 1) - \rho}$$

w – Water content

Water content is the ratio of weight of water to weight of solid particles.

$$w = \frac{m_w}{m_d} \cdot 100$$

m_w – weight of water in sample (0.01g)
m_d – weight of the dry sample (0.01g)
Unit: %



Soil composition by phase: s-soil (dry), v-void (pores filled with water or air), w-water, a-air. V is a volume, M is a mass.

Procedure:

- Weighing of the sample
- Drying sample at 105-110°C to stable weight (next day)
- Weighing dried sample

ρ - Bulk (total) density

$$\rho = \frac{m}{V}$$

m – Weight of the sample
V – Volume of the sample

Procedure:

Regular shape

- Measuring of volume of the sample (3 times each side by calliper – use the average)
- Determination of the weight of the sample
- Density calculation

Irregular shape

- Weighing the sample
- Encasement of the sample in paraffin
- To let to cool the sample with paraffin
- To weigh the sample with paraffin
- To weigh the sample with paraffin under water

$$V = \frac{m_1 - m_2}{\rho_w} - \frac{m_1 - m}{\rho_p}$$

m_1 – weight of the sample with paraffin
m_2 – weight of the sample with paraffin (underwater)
ρ_w – density of water (T=?)
ρ_p – density of paraffin (0.9 Mg/m^3)
Unit: kg/m^3 (Mg/m^3)

ρ_s - Specific density

Specific density of soil is defined as ratio of weight of solid particles (dried at 105-110°C) and their volume.

$$\rho_s = \frac{m_s}{V_s}$$

m_s – weight of solid particles of the sample
V_s – total volume of solid particles
Unit: kg/m^3

The key equipment for specific density determination is a pycnometer.

Procedure:

- Dried pycnometer
- Sample preparation – drying (105-110°C); milling
- Weighing of pycnometer (**m_1**)
- Filling of pycnometer by sample (min. 10 g) and weighing (**m_2**)
- Filling up with liquid – 10-20mm above the sample
- Boiling (10min)
- Filling up with liquid – whole volume
- Cooling (approx.20°C)
- weight of pycnometer with sample and liquid (**m_3**)
- Cleaning of pycnometer, filling up with water, drying of the surface
- Weighing of pycnometer with liquid (**m_4**)

Specific density is calculated as:

$$\rho_s = \frac{(m_2 - m_1)}{V \cdot \rho_l + m_2 - m_3} \cdot \rho_l$$

$$\rho_s = \frac{m_2 - m_1}{m_4 - m_1 + m_2 - m_3} \cdot \rho_l$$

V - pycnometer volume(100ml)
m_1 - pycnometer weight
m_2 - weight of pycnometer and sample
m_3 - weight of pycnometer with sample and liquid
m_4 - weight of pycnometer with liquid
ρ_l - density of liquid (at certain temprature…)

ρ_d - Dry density

Dry density of soil is defined as ratio of weight of solid particles (dried at 105-110°C) and volume of the sample+

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$$\rho_d = \frac{m_d}{V}$$

m – Weight of the dried sample
V – Volume of the sample
Unit: kg/m^3

Teplota °C	Hustota ρ_w Mg/m^3
10	0,99973
11	0,99963
12	0,99953
13	0,99941
14	0,99927
15	0,99913
16	0,99897
17	0,99880
18	0,99862
19	0,99843
20	0,99823
21	0,99802
22	0,99780
23	0,99757
24	0,99733
25	0,99708
26	0,99681
27	0,99654
28	0,99626
29	0,99598
30	0,99568

(CSN CEN ISO TS 17892-3)