

# Estimating Parameters for Modelling Soil Hydrostructural Properties

Erik Braudeau

IRD - Montpellier, France erik.braudeau@mpl.ird.fr

Marcello Donatelli

ISCI - Bologna, Italy m.donatelli@isci.it

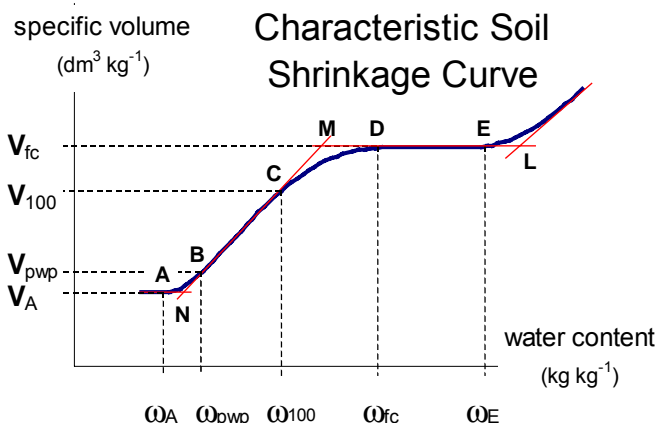
**Introduction** One of the major problems encountered when simulating soil water redistribution is given by the variability of soil apparent volume as a function of soil water content (SWC). In fact, most models neglect the variation of apparent hydraulic conductivity of soils, of preferential water flow, as well as the soil-atmosphere vapour exchange from below surface soil layers. These processes are greatly dependent on the modelling of hydro-structural properties of the soil, of which the *Shrinkage Curve* (SC) is the major representative. The object of our work was to discern all the pertinent soil parameters needed to model the hydro-structural functioning of soil (the SC) that can be obtained from commonly available soil data.

**Methods** There are two laboratory methods for soil shrinkage characterisation:

The **COLE index** (coeff. of linear extensibility) on either natural clods (COLE std), or on saturated soil paste material (COLE rod)

$$\text{COLE} = (L_{\text{moist}} / L_{\text{dry}}) - 1 \quad \text{where } L \text{ is length}$$

The **Shrinkage Curve** method (Braudeau *et al.*, 1999) gives a continuous measured shrinkage curve of a re-cast soil sample, and its characteristic points of transition between two shrinkage phases



The physical parameters of a structured horizon of soil provided by the standard measured SC are :

Accurate values of

Minimum specific micropore volume =  $\omega_N / \rho_w$

Maximum specific micropore volume =  $\omega_M / \rho_w$

$\omega_B$  = SWC at Air Entry Point in microporosity (plasma)

COLE rod =  $(\omega_M - \omega_N) / 3(\omega_N + V_s \cdot \rho_w)$  [1]

With  $V_s$  = Specific volume of solids and  $\rho_w$  = water density

Approximated values of

V at Field Capacity = VD

$\omega_{fc}$  = SWC at field capacity =  $\omega_D$

$\omega_{100}$  = SWC at -100 kPa =  $\omega_C$

$\omega_{pwp}$  = SWC at permanent wilting point =  $\omega_B$

$(\Delta V / \Delta \omega)_{bs}$  = slope of basic shrink phase = Kbs

COLE std =  $(V_M - V_N) / 3V_N$  [2]

Because of the constant specific volume before and between the two shrinkage phases,  $V_A = V_N$ , and  $V_{fc} = V_M = V_D = V_E$ .

**Estimating SC parameters**

$\theta_{fc}$  and  $\theta_{pwp}$  were estimated using pedotransfers [ methods British Soil Survey Topsoils ( $\theta_{fc}$ ) and Rawls ( $\theta_{pwp}$ ) ]

Kbs,  $V_s$  and  $\theta_{100}$  were estimated by :

$Kbs = 0.013(\text{Clay} + \text{Silt})$  dm<sup>3</sup> kg<sup>-1</sup>

$V_s = 0.4$  dm<sup>3</sup> kg<sup>-1</sup>

$\theta_{100} = 2/3 (\theta_{fc} + \theta_{pwp})$  m m<sup>-1</sup>

The following relations allow calculation of the SC parameters

$\theta_M = 0.42 \theta_{fc} + 0.58 \theta_{100}$

$\omega_M = \theta_M V_M$  ;  $\omega_D = \theta_{fc} V_M$

$\omega_N = \omega_M + (V_N - V_M) / Kbs$

$V_N - V_M = Kbs \text{ COLE}_{rod} 3(\omega_N + V_s \cdot \rho_w)$

$\omega_C = \omega_M + (V_C - V_M) / Kbs$  ;  $\omega_C = \theta_{100} V_C$

$\omega_B = \omega_M + (V_B - V_M) / Kbs$  ;  $\omega_B = \theta_{pwp} V_B$

$\omega_N = 0.42 \omega_A + 0.58 \omega_B$

The estimated parameters allow fitting the SC using either the procedure described by Braudeau *et al.* (1999) or other methods.

**Results** the SC parameters were estimated for four Alluvial Soils of various textures in the Delta of Mejerda in Tunisia, and they were compared to the measured values.

