The unvirgin theoretical equation of compressibility applied to Boston Blue Clay

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ABSTRACT
The Principle of Natural Proportionality is applied to the recompression zone of Boston Blue clay.

RESUMEN
El principio de proporcionalidad natural se aplica para describir el comportamiento de la arcilla azul de Boston en la zona de recomprensión.

1 INTRODUCTION

"Undrained shear strength of a glacial clay overconsolidated by desiccation". G. Mesri and S. Ali (1999). Geotechnique 49, No. 2, 181 182 is a paper where the author presented a discussion, Mesri, G. and Ali, S. (2002). Geotechnique 52, No. 1, 65 69. In that discussion the author applied the general theoretical equations provided by the principle of natural proportionality (Juarez Badillo. 1985) to mathematically describe the mechanical behaviour of geomaterials to the experimental data of the paper. This time the unvirgin experimental data is considered.

2 THEORETICAL EQUATIONS

Figure 1 is a reproduction of Figure16 of that discussion (Mesri and Ali. 2002) where the general virgin compressibility equation given by

$$\frac{V}{V_1}=\frac{1+e}{1+e_1}=\left(\frac{\sigma_v'}{\sigma_{v1}'}\right)^{-\gamma} \qquad [1]$$

where V = volume, e = void ratio, σ'_v = effective vertical stress, γ = compressibility coefficient, and (σ'_{v1}, e_1) is a know point, was applied to the virgin zones as well as the swelling zones of that figure.

This time the author is presenting Figure 2 where the general unvirgin compressibility equation given by (Juárez-Badillo. 1981)

$$V=\frac{V_0}{1+\left(\frac{\sigma}{\sigma^*}\right)^{\gamma_u}} \qquad [2]$$

where V_0 = volume at $\sigma = 0$, $\sigma^*=\sigma$ at $V = 1/2V_0$ and γ_u = unvirgin compressibility coefficient. In terms of void ratios Equation [2] reads

$$1+e=\frac{1+e_0}{1+\left(\frac{\sigma}{\sigma^*}\right)^{\gamma_u}} \qquad [3]$$

is applied to the recompression zones of the figure.

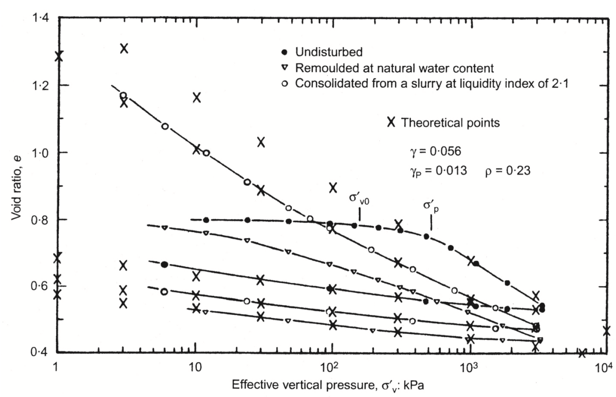

Figure 1. A typical EOP e versus logσ'_v relationships of the undisturbed Boston Blue clay sample; those of the reconstituted specimens are show for reference (Mesri and Ali. 2002)

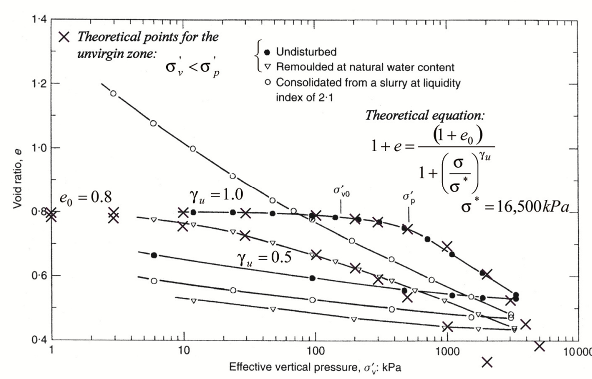

Figure 2. A typical EOP e versus logσ_v relationships of the undisturbed Boston Blue clay sample; those of the reconstituted specimens are show for reference

3 PRACTICAL APPLICATION

It may be observed that for the undisturbed specimen $e_0 = 0.8$, $\gamma_u = 1.0$ and $\sigma^* = 16{,}500$ kPa and for the remoulded at natural water content specimen $e_0 = 0.8$, $\gamma_u = 0.5$ and $\sigma^* = 16{,}500$ kPa. The author was surprised to observe the same values of σ^*.

Observing carefully Figures 1 and 2 we may see that for the undisturbed specimen the transition form unvirgin to virgin takes place at about 500 kPa while it appears that both equations, virgin and unvirgin, give similar values between 500 and 2000 kPa. For the remoulded at natural water content specimen the transition from unvirgin to virgin takes place at about 250 kPa where $\gamma = 0.056$ while the void ratios are somewhat smaller that for the undisturbed sample as well as for the consolidated from a slurry at liquidity index of 2.1 sample.

The author has applied Equation [3] to the recompression unvirgin zone of two identical samples of México City clay, one in undisturbed state and the other in a remoulded at natural water content state with the following results (Juárez-Badillo et al. 2008). For the undisturbed sample $e_0 = 9.65$, $\gamma_u = 1.0$ and $\sigma^* = 20$ kg/cm^2 while for the remoulded at natural water content sample e_0=10.35, $\gamma_u = 0.5$ and $\sigma^* = 20$kg/cm^2. The author was surprised to see the same value of σ^*.The author believes that it is a coincidence that the values of σ^* were the same. Something important to confirm with other clays is that $\gamma_u = 1.0$ for the undisturbed samples and $\gamma_u = 0.5$ for the remoulded at natural water content samples. The author has found that $\gamma_u = 1.0$ is very common for rocks and compacted sands while for concrete $\gamma_u = 2.0$ (Juárez-Badillo. 1981; 1985). For a rockfill the author found $\gamma_u = 1.0$ while $\sigma^* = 17.5+(1/8)\psi$ MPa where ψ is the total suction (Oldecop and Alonso. 2008).

It is important to observe that the interception of Equations [1] and [3] gives the theoretical quasi preconsolidation pressure in clays since the virgin curve corresponds to the end of primary EOP of the clay. The true theoretical preconsolidation pressure is obtained from Equation [1] and the Equation [3] applied to the end of secondary EOS curve of the clay (Juarez-Badillo. 1988), (Juarez-Badillo et al. 2008)

4 CONCLUSIONS

The theoretical unvirgin equation of compressibility successfully describe the recompression zone of Boston Blue clay for both states: undisturbed and reconstituted specimens.

5 ACKNOWLEDGMENT

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