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TECHNICAL NOTE

Some aspects of the behaviour of compacted soils along wetting paths

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Wetting and oedometric loading tests have been performed on several clayey compacted soils. The results highlight the influence of compaction water content and compaction stress on wetting paths. Comparing the changes in degree of saturation induced by mechanical loading and hydraulic loading (wetting path under null stress), it may be noticed that the oedometric path has an opposite curve of that of the wetting path, due to the fact that the void ratio decreases under constant water content when the stress is increased in one case (compression) and increases with water content in the other (swelling).

KEYWORDS: clays; compaction

Des essais d'humidification et oedométriques ont été réalisés sur différents sols argileux compactés. Les résultats mettent en évidence l'influence de la teneur en eau et la contrainte de compactage sur les chemins d'humidification. En comparant les variations du degré de saturation induites par le chargement mécanique et le chargement hydrique (humidification sous contrainte nulle), on note que le chemin oedométrique présente une courbe opposée à celle du chemin d'humidification, ceci est du au fait que l'indice des vides décroit à teneur en eau constante lorsque la contrainte augmente dans un cas (compression) et augmente avec la teneur en eau dans l'autre (gonflement).

INTRODUCTION

Compacted soils are commonly used in the construction of soil structures such as roads, railroad embankments and earth dams. Several investigators have highlighted the influence of the hydromechanical history on the drying–wetting response of compacted soils. Also, a large number of factors, which are either not measured or difficult to control, influence the engineering behaviour of compacted soils (Guillot *et al.*, 2001; Alonso & Pinyol, 2008). Several studies have been carried out to investigate the influence of compaction stress and compaction water content on the behaviour of unsaturated clayey soils (Fleureau *et al.*, 2002; Tarantino & Tombolato, 2005; Sun *et al.*, 2006; Brown & Sivakumar, 2008; Tang *et al.*, 2008; Birle *et al.*, 2008; Tarantino & De Col, 2008). Compaction at different water contents results in different fabrics of the soil (Ahmed *et al.*, 1974; Gens *et al.*, 1995; Delage *et al.*, 1996; Vanapalli *et al.*, 1999). After observing with a scanning electron microscope (SEM) the arrangement of grains within compacted specimens, Delage *et al.* (1996) concluded that on the dry side of optimum, a well-developed granular aggregate structure with interaggregate porosity is visible. The clayey fraction forms grain joint infills (aggregate microstructure with bimodal particle size distribution (PSD), macro- and micropores). On the other hand, on the wet side of optimum, a structure of well-developed wetter clay forming a matrix that envelopes the silt grains and fills the intergranular voids is observed (matrix microstructure with monomodal PSD, mainly micropores). Vanapalli *et al.* (1999) showed that the desaturation curve of a specimen compacted dry of optimum is noticeably different from that of a specimen compacted at optimum or wet of optimum. At the same suction, the degree of saturation of the specimen compacted dry of optimum is somewhat lower than that of the two others, which is in agreement with the more open structure revealed by SEM observations. Fleureau *et al.* (2002) showed that for kaolin–sand and sand–clay mixtures, the slope of the line on the dry side of optimum in the (w, log s) coordinate system, was smaller than the slope on the wet side, as an effect of the decrease in density below the optimum. Tarantino & Tombolato (2005) showed that post-compaction suction of clayey specimens compacted at high water contents increased with increasing degree of saturation. This behaviour was explained in a qualitative fashion by invoking the coupling between mechanical and water retention behaviour occurring during compaction. Sivakumar *et al.* (2006) showed that the relationship between specific water volume and suction was unaffected by the compaction effort at suction values higher than 100 kPa, whereas Birle *et al.* (2008) showed that the soil–water retention curves in terms of gravimetric water content were independent of the initial dry density. Recently, post-compaction states of samples compacted on the dry side of optimum over a wide range of water contents and vertical stresses have been investigated by Tarantino & De Col (2008), and three water content regions were identified. As the degree of saturation is increased at constant water content by the compaction process, post-compaction suction increases at higher water contents (region I), decreases at medium water contents (region II) and remains constant at lower water contents. The authors formulated a coupled mechanical water retention model by combining features of the models presented by Wheeler *et al.* (2003) and Gallipoli *et al.* (2003b). The water retention model was formulated according to Gallipoli *et al.* (2003a).

This technical note presents some experimental results obtained on free wetting paths and from unsaturated oedometric loading tests performed on four compacted clayey soils coming from cores of earth dams, in relation to compaction water content and compaction stress.

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