

VOLUME CHANGE AND SWELLING PRESSURE OF EXPANSIVE CLAY IN THE
CRYSTALLINE SWELLING REGIME

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ABSTRACT

A significant amount of research has been carried out to characterize expansive clay behavior from either microstructural or macrostructural perspectives; however, there exists a current gap in our knowledge about the basic mechanisms that relate one structural level to another. This research investigates: how volume changes occurring on the interlayer scale upscale to volume change and swelling pressure for bulk particle systems, how variables such as void ratio, compaction conditions, particle and pore fabric, confining conditions, initial conditions, pore fluid chemistry, and clay chemistry govern this upscaling process, and what models are available to quantify these effects.

Three types of clay were used: Na-smectite, Ca-smectite, and a Ca-exchanged form of the Na-smectite. Results obtained include: SEM imaging of Na and Ca smectite, void ratio vs. compaction pressure, water vapor sorption isotherms, axial deformation vs. relative humidity (RH) for free swell boundary conditions, and swelling pressure vs. RH for constant strain boundary conditions. Effects of initial density, interlayer cation, clay fabric, and stress paths were qualitatively analyzed in light of three conceptual models, and quantified by defining constitutive surfaces for smectite for crystalline swelling.

With better knowledge of how microstructural swelling translates to macroscopic behavior, the geotechnical engineering community and industry will be more equipped to approach and resolve the several problems involving expansive clays.