ELSEVIER

Computers and Geotechnics, Vol. 20, No. 3/4, pp. 245–266, 1997

Printed in Great Britain
PII: S0266-352X(97)00005-0 0266-352X/97 $17.00+0.00

Modified Darcy's Law, Terzaghi's Effective Stress Principle and Fick's Law for Swelling Clay Soils

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ABSTRACT

Governing equations often used in soil mechanics and hydrology include the classical Darcy's law, Terzaghi's effective stress principle, and the classical Fick's first law. It is known that the classical forms of these relations apply only to non-swelling, granular materials. In this paper, we summarize recent generalizations of these results for swelling porous media obtained using hybrid mixture theory (HMT) by the authors. HMT is a methodical procedure for obtaining macroscopic constitutive restrictions which are thermodynamically admissible by exploiting the entropy inequality for spatially-averaged properties. HMT applied to the modeling of swelling clay particles, viewed as clusters of adsorbed water and clay minerals, produces additional terms necessary to account for the physico-chemical forces between the adsorbed water and clay minerals or, more generally, for swelling colloids. New directions for modeling consolidation of swelling clays are proposed based on our view of clay particles as a two-phase system. © *1997 Elsevier Science Ltd.*

INTRODUCTION

Because swelling colloids are so pervasive, the modeling of swelling soils affects all disciplines dealing with naturally occurring soil, as well as the design of structures containing swelling colloids as a component. In particular, smectite affects the transport of nutrients and contaminants, the design

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