

Home > Journal > Earth & Environmental Sciences > IJG

[Indexing](#) [View Papers](#) [Aims & Scope](#) [Editorial Board](#) [Guideline](#) [Article Processing Charges](#)

IJG> Vol.2 No.3, August 2011

OPEN ACCESS

A Flexible Model for Moisture-Suction Relationship for Unsaturated Soils and Its Application

PDF (Size:544KB) PP. 204-213 DOI : 10.4236/ijg.2011.23022

Author(s)

Nadarajah Ravichandran, Shada H. Krishnapillai

ABSTRACT

The mathematical equation for the moisture-suction relationship also known as soil water characteristic curve (SWCC) is one of the constitutive relations necessary for the computational modeling of deformation and flow problems of unsaturated soil using the finite element method. In this paper, a new empirical equation for the SWCC is developed that incorporates the actual airentry suction and the maximum possible suction of the soil as input parameters. The capability of the new model is investigated by fitting the experimental data for twelve different soils that includes sands, silts, and clays. The model fits the experimental data well including in high suction range which is one of the difficulties observed in other commonly used models such as the Brooks and Corey, van Genuchten, and Fredlund and Xing models. The numerical stability and the performance of the new model at low and high degrees of saturations in finite element simulation are investigated by simulating the dynamic response of a compacted embankment and the results are compared with similar predictions made using widely used SWCC models.

KEYWORDS

Soil-Water Characteristic Curve, Unsaturated Soils, SWCC for Low Degree of Saturation, Moisture-Suction Relationship, Comparison of Soil-Water Characteristic Curves

Cite this paper

N. Ravichandran and S. Krishnapillai, "A Flexible Model for Moisture-Suction Relationship for Unsaturated Soils and Its Application," *International Journal of Geosciences*, Vol. 2 No. 3, 2011, pp. 204-213. doi: 10.4236/ijg.2011.23022.

References

- [1] D. G. Fredlund and H. Rahardjo, " Soil Mechanics for Unsaturated Soils. A Wiley-Interscience Publication," John Wiley and Sons, Hoboken, 1993.
- [2] C.W.W. Ng and Y.W. Pang, " Influence of Stress State on Soil-Water Characteristics and Slope Stability," *Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 126, No. 2, 2000, pp. 157-166. doi:10.1061/(ASCE)1090-0241(2000)126:2(157)
- [3] C. E. Zapata, " Uncertainty in Soil-Water Characteristic Curve and Impact on Unsaturated Shear Strength Predictions," Ph.D. Dissertation, Arizona State University, Tempe, 1999.
- [4] Y. Mualem, " Extension of the Similarity Hypothesis Used for Modeling the Soil Water Characteristics," *Water Resources Research*, Vol. 13, No. 4, 1977, pp. 773-780. doi:10.1029/WR013i004p00773
- [5] D. B. Jaynes, " Comparison of Soil-Water Hysteresis Models," *Journal of Hydrology*, Vol. 75, No. 1-4, 1985, pp. 287-299. doi:10.1016/0022-1694(84)90054-4
- [6] W. L. Hogarth, J. Hopmans, J. Y. Parlange and R. Haverkamp, " Application of a Simple Soil-Water Hysteresis Model," *Journal of Hydrology*, Vol. 98, No. 1-2, 1988, pp. 21-29. doi:10.1016/0022-1694(88)90203-X
- [7] J. R. Nimmo, " Semi-Empirical Model of Soil Water Hysteresis," *Soil Science Society of America*

- [Open Special Issues](#)
- [Published Special Issues](#)
- [Special Issues Guideline](#)

[IJG Subscription](#)

[Most popular papers in IJG](#)

[About IJG News](#)

[Frequently Asked Questions](#)

[Recommend to Peers](#)

[Recommend to Library](#)

[Contact Us](#)

Downloads: 165,285

Visits: 394,329

[Sponsors, Associates, and Links >>](#)

- [8] Q. H. Pham, D. G. Fredlund and S. L. Barbour, " A Practical Hysteresis Model for the Soil-Water Characteristic Curve for Soils with Negligible Volume Change," *Géotechnique*, Vol. 53, No. 2, 2003, pp. 293-298.
- [9] H. Yang, H. Rahardjo, E. Leong, C. and D. G. Fredlund, " Factors Affecting Drying and Wetting Soil-Water Characteristic Curves of Sandy Soils," NRC Research Press, Montreal, 2004.
- [10] R. H. Brooks and A. T. Corey, " Hydraulic properties of porous media. Hydrology Paper, Colorado State University," Fort Collins, Vol. 27, No. 3, 1964.
- [11] M. Th. van Genuchten, " A Closed-Form Equation for Predicting the Hydraulic Conductivity of Unsaturated Soils," *Soil Science Society of America Journal*, Vol. 44, No. 5, 1980, pp. 892-898. doi:10.2136/sssaj1980.03615995004400050002x
- [12] D. G. Fredlund and A. Xing, " Equations for the Soil-Water Characteristic Curve," *Canadian Geotechnical Journal*, Vol. 31, No. 4, 1994, pp. 521-532. doi:10.1139/t94-061
- [13] W. Gardner, " Mathematics of Isothermal Water Conduction in Unsaturated Soils," Highway Research Board Special Report 40, International Symposium on Physico- Chemical Phenomenon in Soils, Washington, 1956, pp. 78-87.
- [14] W. Brutsaert, " Probability Laws for Pore Size Distributions," *Soil Science*, Vol. 101, No. 2, 1966, pp. 85-92. doi:10.1097/00010694-196602000-00002
- [15] C. McKee and A. Bumb, " Flow-Testing Coalbed Methane Production Wells in the Presence of Water and Gas," *SPE Formation Evaluation*, Vol. 2, No. 4, 1987, pp. 599-608.
- [16] K. Kosugi, " The Parameter Lognormal Distribution Model for Soil Water Retention," *Water Resource Research*, Vol. 30, No. 4, 1994, pp. 891-901. doi:10.1029/93WR02931
- [17] K. Kawai, D. Karube and S. Kato, " The Model of Water Retention Curve Considering Effects of Void Ratio" In: H. Rahardjo, D. G. Toll and E. C. Leong, Eds., *Unsaturated Soils for Asia*, Balkema, Rotterdam, 2000, pp. 329-334.
- [18] S. K. Vanapalli, D. E. Pufahl and D. G. Fredlund, " The Influence of Soil Structure and Stress History on the Soil-Water Characteristic of a Compacted Till," *Geotechnique*, Vol. 49, No. 2, 1999, pp. 143-159. doi:10.1680/geot.1999.49.2.143
- [19] H. B. Dye, S. L. Houston and B. D. Welfert, " Influence of Unsaturated Soil Properties Uncertainty on Moisture Flow Modeling," *Geotechnical and Geological Engineering*, Vol. 29, No. 2, 2011, pp. 161-169.
- [20] E. C. Leong and H. Rahardjo, " Review of Soil-Water Characteristic Curve Equations," *Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 123, 1997, pp. 1106-1117. doi:10.1061/(ASCE)1090-0241(1997)123:12(1106)
- [21] W. S. Sillers, D. G. Fredlund and N. Zakerzadeh, " Mathematical Attributes of Some Soil-Water Characteristic Curve Models," *Geotechnical and Geological Engineering*, Vol. 19, No. 3-4, 2001, pp.