RECENT DEVELOPMENT OF DIGITAL IMAGE PROCESSING BASED NUMERICAL METHODS FOR MICROMECHANICS OF INHOMOGENEOUS GEOMATERIALS

Z.Q. Yue

Department of Civil Engineering, The University of Hong Kong, Hong Kong, P. R. China

Geomaterials such as soils, rocks, asphalt concrete and cement concrete are either natural materials or made of natural materials. They usually consist of several different materials and components such as voids and cracks. These different individual materials and components are usually distributed in the geomaterials in either a random manner or following certain natural laws. They usually have different physical and mechanical properties and responses under external loading. It has been well recognized that the inhomogeneities and internal microstructure of geomaterials play a significant role in the mechanical response of geomaterials subject to loading and in the resistance to damage or failure. Over the last ten years, digital image processing techniques have been utilized to realize the quantitative investigation of the microstructure characterization of geomaterials and asphalt concretes [1-7].

In this paper, we present our recent work on the incorporation of digital image process techniques into conventional numerical methods such as finite element method to examine the mechanical responses of geomaterials by taking into account the actual material inhomogeneity [8-10]. Results obtained in our recent studies have shown that this new approach can be used to predict the mechanical responses of inhomogeneous geomaterials with high-efficiency. The new approach can be used to establisha workable approach for micro-mechanics of geomaterials by taking into account the actual spatial distribution of different minerals, particulars and components in geomaterials at the micro- or meso-scale range.

References

[1] Z.Q. Yue, W. Bekking and I. Morin, "Application of digital image processing to quantitative study of asphalt concrete microstructure," *Transportation Research Record*, **No. 1492**: 53-60, USA, 1995.
[2] Z.Q. Yue, I. Morin, "Digital image processing for aggregate orientation in asphalt concrete mixtures," *Canadian J. of Civ. Eng.*, **23**, 479–89, 1996.
[3] Z.Q. Yue and I. Morin, "Digital image processing for aggregate orientations in asphalt concrete: reply to discussion by Ashraf M. Ghaly," *Canadian J. of Civil Eng.,* **24**: 334–334, 1997.
[4] C.Y. Kuo and R.B. Freeman, "Image analysis evaluation of aggregates for asphalt concrete mixtures," *Transportation Research Record*, **No. 1615**: 65–71, USA. 1998.
[5] M.T. Obaidat, H.R. Al-Masaeid, F. Gharaybeh and T.S. Khedaywi, "An innovative digital image analysis approach to quantify the percentage of voids in mineral aggregates of bituminous mixtures," *Canadian J. of Civ. Eng.*, 25, 1 041–1 049, 1998.
[6] E. Masad, B. Muhunthan, N. Shashidhar and T. Harman, "Internal structure characterization of asphalt concrete using image analysis", *J. Computing in Civ. Eng.,* ASCE, 13(2), 88–95, 1999.
[7] R.L. Hu , Z.Q. Yue, L.G. Tham, et al. "Digital image analysis of dynamic compaction effects on clayey fills". *J. of Geotech. Geoenviron. Eng,* ASCE, **131(11)**, 1411-1422, 2005.
[8] Z.Q. Yue, S. Chen and L.G. Tham, "Finite element modeling of geomaterials using digital image processing," *Computers and Geotechnics*, **30**, 375–97, 2003.
[9] Z.Q. Yue, S. Chen and L.G. Tham, "Seepage analysis in inhomogeneous geomaterials using digital image processing based finite element method," *Proc, 12th Panamerican Conf. Soil Mech. and Geotech. Eng. and 39th US Rock Mech. Symp.*, Boston, USA, **1**, 297–1 302, 2003.
[10] S. Chen, Z.Q. Yue and L.G. Tham, "Digital image-based numerical modeling method for prediction of inhomogeneous rock failure," *Int. J. Rock Mech. Min. Sci*., **41**, 939–957, 2004.

Keywords: Digital image processing, geomaterials, micro-mechanics, asphalt concrete