SPIS TREŚCI

List of symbols

1. Introduction

2. Literature overview
   2.1. Experiments
   2.2. Theory

3. Hypoplasticity
   3.1. Hypoplastic constitutive law for monotonous deformation paths
   3.2. Hypoplastic law with elastic range (Niemunis and Herle 1997)
   3.3. Hypoplastic law for anisotropic materials (Bauer et al. 2004)
   3.4. Hypoplastic law for soils with low friction angles (Herle and Kolymbas 2004)

4. Calibration of material constants
   4.1. Critical friction angle \( \varphi_c \)
   4.2. Granulate hardness \( h_s \) and exponent \( n \)
   4.3. Minimum void ratio \( e_M \) at zero pressure
   4.4. Maximum void ratio \( e_0 \) at zero pressure
   4.5. Critical void ratio \( e^* \) at zero pressure
   4.6. Parameters \( \leq \) and \( f_t \)

5. Enhanced continua
   5.1. Micro-polar continuum
   5.2. Non-local continuum
   5.3. Gradient continuum

6. Micro-polar hypoplastic constitutive model

7. Finite element implementation
   7.1. Finite element equation of motion (micro-polar continuum)
   7.2. Element displacement interpolation matrix
   7.3. Strain-displacement matrix
   7.4. Stress-strain matrix

8. Finite element results with a micro-polar hypoplastic model
   8.1. Plane strain compression test
   8.2. Monotonous shearing of an infinite layer
   8.3. Cyclic shearing of an infinite layer
   8.4. Cyclic compression-extension
   8.5. Biaxial compression
   8.6. Strip foundation
   8.7. Earth pressure
   8.8. Direct and simple shear test
   8.9. Wall direct shear test
   8.10. Silo problems
   8.11. Granular anchors
9. Non-local hypoplastic constitutive model
9.1. Finite element data
9.2. Finite element results

10. Gradient hypoplastic constitutive model
10.1. Finite element data
10.2. Finite element results

11. Comparison between micro-polar, non-local and gradient model
11.1. Finite element data
11.2. Finite element results

12. Conclusions

References