

Contents

1	Introduction.	1
1.1	Background.	1
1.2	Objectives.	2
1.3	Book Outline.	3
	References	3
2	Literature Review	5
2.1	Introduction.	5
2.2	Ground Deformation Due to Excavation	5
2.2.1	Field Investigation	5
2.2.2	Numerical Analysis	8
2.2.3	Analytical Solution.	10
2.2.4	Centrifuge Modelling	11
2.3	Soil-Structure Interaction of Multi-propped Excavation	12
2.3.1	Field Investigation	12
2.3.2	Numerical Analysis	13
2.3.3	Centrifuge Modelling	14
2.4	Excavation Base Instability Due to Hydraulic Uplift.	15
2.4.1	Field Investigation	15
2.4.2	Recommendations in Design Codes	17
2.5	Techniques for Simulation of Multi-propped Excavation in Centrifuge	17
2.6	Summary	18
	References	19
3	Field Investigation of a Multi-propped Excavation in Soft Clay	21
3.1	Introduction.	21
3.2	The Site	22
3.2.1	Geotechnical Profile	22
3.2.2	Construction Sequence	25
3.3	Instrumentation	28

- 3.4 Ground Deformation and Soil-Structure Interaction at Panel 4 30
 - 3.4.1 Lateral Wall Displacement of Panel 4 30
 - 3.4.2 Lateral Ground Movement Behind Panel 4 31
 - 3.4.3 Ground Surface Settlement Behind Panel 4 31
 - 3.4.4 Ground Surface Settlement and $\delta_{v-Max}/\delta_{h-Max}$ Ratios in Shanghai 32
 - 3.4.5 Change of Lateral Total Earth Pressure 34
 - 3.4.6 Distrubtion of Lateral Total Earth Pressure 35
 - 3.4.7 Prop Load and Equilibrium Analysis of Wall. 37
 - 3.4.8 Apparent Pressure Envelope for Excavations in Shanghai 38
 - 3.4.9 Pore Water Pressure 40
 - 3.4.10 Effective Stress Path 41
- 3.5 Summary and Conclusions 43
- References 44
- 4 Numerical Analyses of the Multi-propped Excavation in Soft Clay 47**
 - 4.1 Background. 47
 - 4.2 Finite Element Analysis 48
 - 4.2.1 Finite Element Mesh and Boundary Conditions 48
 - 4.2.2 Constitutive Model and Model Parameters. 49
 - 4.2.3 Numerical Modelling Procedure 50
 - 4.3 Comparison of Measured and Computed Results 50
 - 4.3.1 Lateral Wall Displacement. 50
 - 4.3.2 Ground Surface Settlement 53
 - 4.3.3 Contour of Deviatoric Strain 55
 - 4.3.4 Mobilisation of Undrained Shear Strength 56
 - 4.3.5 Lateral Total Earth Pressure. 57
 - 4.3.6 Pore Water Pressure 59
 - 4.3.7 Apparent Earth Pressure 60
 - 4.4 Summary and Conclusions 61
 - References 62
- 5 Dimensional Analysis of Excavation in Clay Subjected Hydraulic Uplift. 65**
 - 5.1 Introduction. 65
 - 5.2 Variables Affecting Basal Resistance Against Hydraulic Uplift 65
 - 5.3 Dimensional Analysis 66
 - 5.4 Key Dimensionless Groups for This Study 67
 - References 68

6 Centrifuge Modelling of Multi-propped Excavation in Clay

Destabilised by Hydraulic Uplift 71

6.1 Introduction 71

6.2 Principles and Scaling Laws 71

6.3 Limitations of Centrifuge Modelling 73

6.3.1 Variation of Centrifugal Acceleration with Model
Depth 73

6.3.2 Grain Size Effect 74

6.3.3 Boundary Effect 74

6.4 Test Program and Objectives 75

6.5 Model Package 75

6.5.1 Actuator: For Simulating Prop Installation 76

6.5.2 Rubber Bag: For Simulating Excavation 78

6.5.3 Flow Rate Control Valve: Controlling
Excavation Rate 79

6.5.4 Model Wall 79

6.5.5 Model Prop 80

6.5.6 Model Pile 80

6.6 Model Preparation and Characterisation of Undrained Shear
Strength of Clay 81

6.7 Instrumentation 86

6.7.1 Measurement of Pore Water Pressure 87

6.7.2 Measurement of Ground Settlement 88

6.7.3 Measurement of Undrained Shear Strength of Clay . . . 89

6.7.4 Measurement of Prop Load 90

6.7.5 Measurement of Bending Movement and Axial Load
of Pile 90

6.7.6 Measurement of Subsurface Soil Movement 91

6.8 Test Procedure 93

References 94

**7 Finite Element Analyses: For Back-Analysis and Parametric
Study. 97**

7.1 Introduction 97

7.2 Back-Analyses of Centrifuge Tests 98

7.2.1 Finite Element Mesh and Boundary Conditions 98

7.2.2 Constitutive Model and Model Parameters 99

7.2.3 Numerical Modelling Procedure 100

7.3 Numerical Parametric Study 100

References 101