MECHANICAL BEHAVIOR OF
SOIL-BENTONITE CUTOFF WALLS

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(ABSTRACT)

A soil-bentonite cutoff wall is a type of subsurface vertical barrier constructed by backfilling a trench with a mixture of soil, bentonite, and water. Although soil-bentonite cutoff walls are common, their mechanical behavior is not well understood. Current design procedures do not consider the final stress state of the consolidated soil-bentonite backfill or deformations in adjacent ground. The final stress state in the completed wall is important because it influences the hydraulic conductivity of the cutoff (Barrier 1995), the cutoff’s susceptibility to hydraulic fracture, and the magnitude of deformations adjacent to the cutoff wall. Deformations adjacent to the cutoff wall can be significant and can cause damage to adjacent structures. The objectives of this research are to 1) add to the current body of knowledge of the properties of soil-bentonite mixtures, 2) evaluate constitutive models and select a model to represent soil-bentonite, 3) model a soil-bentonite cutoff wall using finite elements, and 4) investigate the influence of several factors on the deformations in adjacent ground.

These objectives were met by first summarizing information from the literature on soil-bentonite properties and then performing a laboratory testing program on different soil-bentonite mixtures. Five constitutive models were evaluated to determine how well they match the data from the laboratory testing program. A model referred to as the RS model was chosen to best represent soil-bentonite, and provided a good match of the soil-bentonite behavior. The RS model, which is a special case of a more complicated existing model, is a non-associative Modified Cam Clay type model that has parameters to change the yield surface and plastic potential surface into ellipses of varying shapes. The RS model was implemented into the finite element program SAGE.
A finite element model was developed using SAGE to simulate all stages of construction of a soil-bentonite cutoff wall including excavation of a trench under bentonite-water slurry, replacement of the bentonite-water slurry with soil-bentonite backfill, and consolidation of the soil-bentonite backfill. The model was calibrated with a well-documented case history, and predicted deformations in adjacent ground were close to measured deformations. Evaluation of the model indicates that there is good confidence in the prediction of deformations in adjacent ground, but there is lower confidence in the predicted stresses in the consolidated soil-bentonite and settlement of the backfill in the trench. A parametric study was then performed using the finite element model assuming sand sites of varying density and OCR. Deformations in adjacent ground were calculated for various soil conditions, soil-bentonite properties, and trench configurations. A correlation was found between maximum calculated settlement in adjacent ground and factor of safety against trench stability during excavation.
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# TABLE OF CONTENTS

Abstract .........................................................................................................................ii
Acknowledgements ........................................................................................................iv
Table of Contents .............................................................................................................vi
List of Tables ...................................................................................................................ix
List of Figures ................................................................................................................xi

## CHAPTER 1 INTRODUCTION

1.1 Description of Soil-Bentonite Cutoff Walls .............................................................1
1.2 Need for Information on Mechanical Behavior of Soil-Bentonite Cutoff Walls .......2
1.3 Objectives and Scope of Research .........................................................................2
1.4 Overview of Report ...............................................................................................4

## CHAPTER 2 LITERATURE REVIEW

2.1 Introduction ..........................................................................................................6
2.2 Construction Process ............................................................................................6
2.3 Current Design Procedures ..................................................................................7
2.4 Engineering Properties of Soil-Bentonite .............................................................9
2.5 In Situ State of Stress in Soil-Bentonite Backfill ...............................................15
2.6 Deformations of Soil-Bentonite Cutoff Walls and Adjacent Ground .................19

## CHAPTER 3 LABORATORY TESTING PROGRAM

3.1 Description of Laboratory Testing Program ..........................................................32
3.2 Grain Size Distribution and Index Tests ................................................................33
3.3 Hydraulic Conductivity Tests ..............................................................................35
3.4 Consolidation Tests ..............................................................................................38
3.5 Triaxial Tests ........................................................................................................43

## CHAPTER 4 CONSTITUTIVE MODELING FOR SOIL-BENTONITE

4.1 Introduction .........................................................................................................89
4.2 Important Aspects of Selecting a Constitutive Model .........................................90
4.3 Evaluation of Hyperbolic Model for Soil-Bentonite ...........................................91
4.4 Evaluation of Cam Clay Model and Modified Cam Clay Model for
   Soil-Bentonite .........................................................................................................95
4.5 Evaluation of R Model for Soil-Bentonite .........................................................109
4.6 Evaluation of RS Model for Soil-Bentonite ......................................................114
APPENDIX B  PRELIMINARY FINITE ELEMENT ANALYSES WITH SAGE ................................................................. 318

B.1  Verification of the RS Model in SAGE ................................................................. 318
B.2  Analysis of Arching in a Soil-Bentonite Cutoff Wall ........................................... 326
B.3  Shearing of a Thin 2-D Element of Soil-Bentonite .............................................. 327

APPENDIX C  INPUT DATA FILE FOR CASE HISTORY ANALYSIS WITH SAGE ......................................................... 339

VITA .................................................................................................................................................. 369
## LIST OF TABLES

Table 2.1  Consolidation Data on Various Soil-Bentonite Mixtures (after Khoury et al. 1992) ................................ ................................ ................................ ............................................................. 11

Table 2.2  Consolidation Data from Undisturbed Samples (Evans and Cooley 1993) .... 11

Table 3.1  Index Properties of Soil-Bentonite Mixtures SB1 and SB3 ......................... 34

Table 3.2  Consolidation Test Results on SB1 and SB3 ................................ ................. 41

Table 3.3  Isotropically Consolidated Undrained Triaxial Test Results for SB1 ......... 48

Table 3.4  Isotropically Consolidated Undrained Triaxial Test Results for SB3 ........... 48

Table 3.5  K \(_0\) Consolidated Undrained Triaxial Test on SB1 ................................ .......... 51

Table 3.6  Undrained Strength Parameter Values for SB1 and SB3 ............................ 52

Table 3.7  Isotropically Consolidated Drained Triaxial Test Results for SB1 ................. 54

Table 3.8  Isotropically Consolidated Drained Triaxial Test Results for SB3 ................. 55

Table 3.9  Drained Strength Parameter Values for SB1 and SB3 ............................ 55

Table 4.1  Hyperbolic Parameter Values for SB1 ................................ ........................... 94

Table 4.2  Cam Clay and Modified Cam Clay Parameter Values for SB1 ................... 102

Table 4.3  Values of K \(_0\) for R Model with M=1.3 ................................ ............................ 113

Table 4.4  Values of K \(_0\) for RS Model with M=1.3 ................................ ...................... 120

Table 4.5  Parameter Values for RS Model for SB1 and SB3 ................................ ....... 121

Table 6.1  Soil Parameter Values used in Finite Element Model ............................... 188

Table 6.2  Stress History of Clay Layers ................................ ................................ ...... 190

Table 6.3  Steps for Modeling Construction Sequence ................................ ................. 198

Table 6.4  Modeling of Soil-Bentonite During Fill Placement ................................ ..... 206
Table 6.5 Modified Finite Element Analysis ................................................................. 214

Table 7.1 Soil Parameters used in Parametric Study Base Case ...................................... 237

Table 7.2 Steps for Modeling Base Case ......................................................................... 239

Table 7.3 Summary of Parametric Study ......................................................................... 247

Table 7.4 Soil Parameter Values for Sand used in Parametric Study ............................... 248

Table 7.5 Summary of Maximum Deformations in Adjacent Ground for Parametric Study ................................................................. 250

Table 7.6 Factor of Safety During Excavation and Maximum Settlement Values After Excavation and Consolidation ................................................................. 252
LIST OF FIGURES

Figure 2.1 Soil-Bentonite Cutoff Wall Construction Process (Barrier 1995) ......... 24

Figure 2.2 Compression Ratio Versus Fines Content for Various Soil-Bentonite Mixtures (D’Appolonia 1980) ................................................................. 25

Figure 2.3 Triaxial Test Data on Various Soil-Bentonite Mixtures (D’Appolonia 1980) ................................................................. 26

Figure 2.4 Effect of Consolidation Pressure on Hydraulic Conductivity of Soil-Bentonite Mixtures (Barrier 1995) ................................................................. 27

Figure 2.5 Theoretical Predictions of Major Principal Effective Stress in a Soil-Bentonite Cutoff Wall ................................................................. 28

Figure 2.6 Ground Deformations Due to Construction of a Soil-Bentonite Cutoff Wall (Filz 1996) ................................................................. 29

Figure 2.7 Ground Settlement Due to Slurry Trench Excavation (Cowland and Thorley 1985) ................................................................. 30

Figure 2.8 Building Settlements Due to Slurry Trench Excavation (Cowland and Thorley 1985) ................................................................. 31

Figure 3.1 Grain Size Distributions of SB1, SB2, and SB3 ......................... 56

Figure 3.2 Slump Versus Water Content for Various Soil-Bentonite Mixtures .... 57

Figure 3.3 Hydraulic Conductivity Results for Various Soil-Bentonite Mixtures .... 58

Figure 3.4 One-Dimensional Consolidation Test C5 on SB1 ......................... 59

Figure 3.5 One-Dimensional Consolidation Test C6 on SB1 ......................... 59

Figure 3.6 Isotropic Consolidation Test IC_1 on SB1 ................................. 60

Figure 3.7 Isotropic Consolidation Test IC_2 on SB1 ................................. 60

Figure 3.8 One-Dimensional Consolidation Test CP5 on SB3 ......................... 61

Figure 3.9 One-Dimensional Consolidation Test CP6 on SB3 ......................... 61
Figure 3.10  Major Principal Effective Stress Versus Void Ratio for Consolidation Tests on SB1 and SB3 ................................................................. 62

Figure 3.11  Mean Effective Stress Versus Void Ratio for Consolidation Tests on SB1 and SB3 ................................................................. 62

Figure 3.12  Consolidated Undrained Triaxial Test CU_3 on SB1 .................. 63

Figure 3.13  Consolidated Undrained Triaxial Test CU_4 on SB1 .................. 64

Figure 3.14  Consolidated Undrained Triaxial Test CU_5 on SB1 ............... 65

Figure 3.15  Consolidated Undrained Triaxial Test CU_6 on SB1 ............... 66

Figure 3.16  Consolidated Undrained Triaxial Test CU_7 on SB1 ............... 67

Figure 3.17  Consolidated Undrained Triaxial Test CU_8 on SB1 ............... 68

Figure 3.18  Consolidated Undrained Triaxial Test CU_9 on SB1 ............... 69

Figure 3.19  Consolidated Undrained Triaxial Test CU_11 on SB3 ............. 70

Figure 3.20  Consolidated Undrained Triaxial Test CU_13 on SB3 ............. 71

Figure 3.21  Consolidated Undrained Triaxial Test CU_14 on SB3 ............. 72

Figure 3.22  Combined Stress Path for $K_o$ Consolidation Test Ko_2 on SB1 Subsequently Sheared Undrained as Test CU_15 .......................... 73

Figure 3.23  $K_o$ Consolidation Test Ko_2 on SB1 .................................... 74

Figure 3.24  $K_o$ Consolidated Undrained Triaxial Test CU_15 on SB1 ........ 75

Figure 3.25  Undrained Strength Envelope for SB1 .................................. 76

Figure 3.26  Undrained Strength Envelope for SB3 .................................. 77

Figure 3.27  Consolidated Drained Triaxial Test CD_1 on SB1 .................. 78

Figure 3.28  Consolidated Drained Triaxial Test CD_2 on SB1 .................. 79

Figure 3.29  Consolidated Drained Triaxial Test CD_5 on SB1 .................. 80

Figure 3.30  Consolidated Drained Triaxial Test CD_6 on SB1 .................. 81
Figure 4.14  Representative Normalized CD Test of SB1 and Cam Clay Models........ 135

Figure 4.15  Comparison of One-Dimensional Consolidation Test on SB1 with Modified Cam Clay Model .................................................................................................................... 136

Figure 4.16  Comparison of Isotropic Consolidation Test on SB1 with Cam Type Models ................................................................................................................................. 137

Figure 4.17  Properties of R Model................................................................. 138

Figure 4.18  Graphical Estimate of R Parameter for SB1 .................................. 139

Figure 4.19  Shape of Yield Functions for SB1 and R Model with Various R and p’o Values ................................................................................................................................. 140

Figure 4.20  Representative Normalized CU Test of SB1 and R Model with Varying R Values ................................................................................................................................. 141

Figure 4.21  Representative Normalized CD Test of SB1 and R Model with Varying R Values ................................................................................................................................. 142

Figure 4.22  Properties of RS Model................................................................. 143

Figure 4.23  Plastic Strain Increment Vectors for SB1 Plotted at Yield Points ........ 144

Figure 4.24  Estimated Shape of Plastic Potential Function for SB1.................... 145

Figure 4.25  Points on Plastic Potential Function for SB1 and RS Model Plastic Potential Function with S=3.1 ................................................................................................................................. 146

Figure 4.26  Representative Normalized CU Test of SB1 and RS Model with Varying R Values and Constant S Value................................................................. 147

Figure 4.27  Representative Normalized CD Test of SB1 and RS Model with Varying R Values and Constant S Value................................................................. 148

Figure 4.28  Representative Normalized CU Test of SB1 and RS Model with Varying S Values and Constant R Value ................................................................. 149

Figure 4.29  Representative Normalized CD Test of SB1 and RS Model with Varying S Values and Constant R Value ................................................................. 150
Figure 4.30  Representative Normalized CU Test of SB1 and RS Model with Best Fit R and S Parameters ................................................................. 151

Figure 4.31  Representative Normalized CD Test of SB1 and RS Model with Best Fit R and S Parameters ................................................................. 152

Figure 4.32  Representative Normalized CU Test of SB3 and RS Model with Best Fit R and S Parameters ................................................................. 153

Figure 4.33  Representative Normalized CD Test of SB3 and RS Model with Best Fit R and S Parameters ................................................................. 154

Figure 5.1  Raytheon Site Plan (after HLA 1989) ................................................. 166

Figure 5.2  Typical Subsurface Profile (after Golder 1987) ................................. 167

Figure 5.3  Simplified Hydrogeologic Subsurface Profile ..................................... 168

Figure 5.4  Soil-Bentonite Cutoff Wall Construction at Raytheon (after Burke and Achhorner 1988) ................................................................. 169

Figure 5.5  Hydraulic Conductivity Tests on Soil-Bentonite (after Burgess et al. 1988) ..................................................................................... 170

Figure 5.6  Lateral Deformation with Depth at Inclinometer RGI-2 ....................... 171

Figure 5.7  Lateral Deformation with Depth at Inclinometer RGI-3 ....................... 172

Figure 5.8  Increments of Lateral Deformation at Various Times After Backfill Placement at RGI-2 and RGI-3 ..................................................... 173

Figure 5.9  Timelines for Excavation Sequence, Groundwater Levels, and Deformations in the Vicinity of RGI-2 ......................................................... 174

Figure 5.10  Groundwater Levels at the North Leg of the Cutoff Wall ............... 175

Figure 5.11  Timelines for Excavation Sequence, Groundwater Levels, and Deformation in the Vicinity of RGI-3 ......................................................... 176

Figure 5.12  Movements of Adjacent Ground During Soil-Bentonite Cutoff Wall Construction and Consolidation ..................................................... 177

Figure 6.1  Soil Profile used in Finite Element Analyses ......................................... 215
Figure 6.2  Penetration Tests Performed in Sand .......................................................... 216
Figure 6.3  Penetration Tests Performed in Clays .......................................................... 217
Figure 6.4  Preconsolidation Pressures from 1-D Consolidation Tests .......................... 218
Figure 6.5  Undrained Shear Strengths for Clays ........................................................... 219
Figure 6.6  RS Model Predictions of CU Tests of Soil-Bentonite .................................. 220
Figure 6.7  Hydraulic Conductivity Tests on Sands and Clays with Values used in Analyses ............................................................... 221
Figure 6.8  Hydraulic Conductivity Tests on Soil-Bentonite (after Burgess et al. 1988) .... 222
Figure 6.9  Plan of Raytheon Site and Section Analyzed with Finite Element Model ....... 223
Figure 6.10  Finite Element Mesh and Boundary Conditions ...................................... 224
Figure 6.11  Enlargement of Finite Element Mesh Near Soil-Bentonite Cutoff Wall ....... 225
Figure 6.12  Assumed Initial Pore Pressures ................................................................. 226
Figure 6.13  Stress Distributions Applied to Represent Bentonite-Water Slurry .............. 227
Figure 6.14  Void Ratio versus Mean Effective Stress for Soil-Bentonite ....................... 228
Figure 6.15  Schematic of Recently Placed Row of Soil-Bentonite Elements ................ 229
Figure 6.16  Pore Pressures in Soil-Bentonite Backfill .................................................. 230
Figure 6.17  Comparison of Predicted and Measured Incremental Lateral Deformation ........................................................................ 231
Figure 6.18  Comparison of Predicted and Measured Total Settlement of Ground Surface Adjacent to Soil-Bentonite Cutoff Wall ................................................................. 232
Figure 6.19  Revised Model: Predicted and Measured Incremental Lateral Deformation ........................................................................ 233
Figure 6.20  Revised Model: Predicted and Measured Total Settlement of Ground Surface Adjacent to Soil-Bentonite Cutoff Wall ................................................................. 234
Figure 7.1  Section Analyzed in Parametric Study ......................................................... 254
Figure 7.2  Preliminary Analysis: Predicted Lateral Deformations after Excavation .... 255
Figure 7.3  Pressures at Trench Wall with Depth for Base Case Analysis ................. 256
Figure 7.4  Base Case: Predicted Lateral Deformations after Excavation ............... 257
Figure 7.5  Base Case: Incremental Lateral Deformation at a Distance of 27 ft from Trench Centerline ........................................................................................................ 258
Figure 7.6  Base Case: Total Lateral Deformation at a Distance of 27 ft from Trench Centerline ........................................................................................................ 259
Figure 7.7  Base Case: Deformation at Ground Surface ........................................... 260
Figure 7.8  Base Case: Settlement in Soil-Bentonite Trench ..................................... 261
Figure 7.9  Vertical Effective Stress in Consolidated Soil-Bentonite ....................... 262
Figure 7.10  Horizontal Effective Stress in Consolidated Soil-Bentonite .................... 263
Figure 7.11  Stress State for Selected Gauss Points in Consolidated Soil-Bentonite ..... 264
Figure 7.12  Effect of Trench Depth on Deformations in Adjacent Ground ............ 265
Figure 7.13  Effect of Sand Density for OCR=1 on Deformations in Adjacent Ground .......................................................................................................................... 266
Figure 7.14  Effect of OCR of Loose Sand on Deformations in Adjacent Ground .... 267
Figure 7.15  Effect of OCR of Medium Sand on Deformations in Adjacent Ground ...... 268
Figure 7.16  Effect of OCR of Dense Sand on Deformations in Adjacent Ground ...... 269
Figure 7.17  Effect of Soil-Bentonite R Parameter on Deformations in Adjacent Ground .......................................................................................................................... 270
Figure 7.18  Effect of Soil-Bentonite λ Parameter on Deformations in Adjacent Ground .......................................................................................................................... 271
Figure 7.19  Effect of Water Table on Deformations in Adjacent Ground ............. 273
Figure 7.20  Maximum Settlement versus Factor of Safety Against Trench Stability During Excavation................................................................. 274

Figure A.1  Schematic of Stress-Strain Curves for Membrane ................................................................. 314

Figure A.2  Stress Paths from CU Tests on SB1 With and Without Baxter and Filz Triaxial Corrections........................................................................... 315

Figure A.3  Effect of Various Components of Baxter and Filz Correction......................... 316

Figure A.4  Comparison of Various Triaxial Corrections ................................................................. 317

Figure B.1  Numerical Modeling of a CD Triaxial Test Using the RS Model.................. 328

Figure B.2  Numerical Modeling of a CU Triaxial Test Using the RS Model.................. 329

Figure B.3  Stress-Strain Predictions of a One-Dimensional Consolidation Test Using the RS Model.................................................................................. 330

Figure B.4  Settlement Versus Time Predictions of a One-Dimensional Consolidation Test Using the RS Model.................................................................................. 331

Figure B.5  Numerical Modeling of an Isotropic Consolidation Test Using the RS Model.................................................................................. 332

Figure B.6  Predictions of Plane Strain Compression of Normally Consolidated Soil-Bentonite Using SAGE........................................................................... 333

Figure B.7  Predictions of Plane Strain Compression of Over Consolidated Soil-Bentonite Using SAGE........................................................................... 334

Figure B.8  Stress in Soil-Bentonite at Center of Trench for Arching Analysis............. 335

Figure B.9  Displaced Mesh for Arching Analysis ............................................................................. 336

Figure B.10  Stress-Strain Behavior of a Long Thin 2-D Element of Soil-Bentonite Using RS Model.................................................................................. 337

Figure B.11  Comparison of Behavior of Direct Shear Test on Filter Cake and SAGE Analysis of Shearing of Long Thin 2-D Soil-Bentonite Element......................... 338