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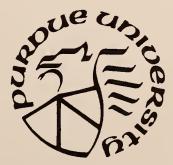
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INDIANA DEPARTMENT OF TRANSPORTATION

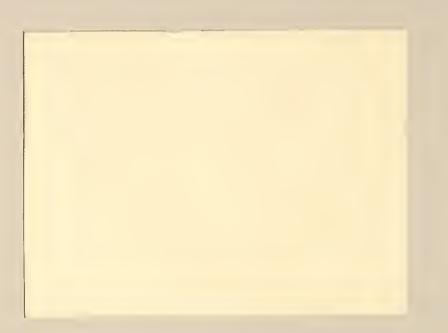
Joint Highway Research Project Interim Report FHWA/JHRP/IN 92/1

A Sensitivity Analysis of the Parameters for a Cap Plasticity Model

Philippe Bourdeau Wai-Fai Chen C. William Lovell Scott Ludlow



PURDUE UNIVERSITY



Joint Highway Research Project

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Interim Report: "A Sensitivity Analysis of the Parameters for a Cap Plasticity Model"

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by

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Joint Highway Research Project HPR 2031 Project No.: C-36-36U File No.: 6-14-21

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in Cooperation with

the Indiana Department of Highways

and the

U.S. Department of Transportation Federal Highway Administration

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein.

> Purdue University West Lafayette, Indiana 47907

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LIST	OF	TABLES	i
LIST	OF	FIGURES	i

APPENDICES

APPENDIX	Α	-	A.1	-	Case	1			
			A.2	-	Case	2			
			A.3		Case	3			
			A.4	-	Case	4			
			A.5		Case	5			
			A.6	-	Case	6			
			A.7	-	Case	7			
APPENDIX	В	-	Comp	uter	disk w	ith	input	data	files
APPENDIX	С	-	List	of	Referen	ces	-		

Page

LIST OF TABLES

Table

1.	Summary of Sensitivity Analysis of the Cap	
	Plasticity Model Parameters 1	

LIST OF FIGURES

Figure

A.1.1	Case 1	 Effect of Poisson's Ratio on the Principal Stress Difference and 	
A.1.2	Case 1	Excess Pore Pressure vs. Axial Strain - Effect of Poisson's Ratio on	2
		the Principal Stress Ratio vs. Axial Strain	3
A.1.3	Case 1	 Effect of Poisson's Ratio on the location of the Cap in the J₂^{1/2}-I₁ Space and on the q-p' Diagram 	4
A.2.1	Case 2	- Effect of the Compression Index on the Principal Stress Difference and Excess Pore Pressure vs. Axial Strain	5
A.2.2	Case 2	 Effect of the Compression Index on the Principal Stress Ratio vs. Axial 	
A.2.3	Case 2	Strain - Effect of the Compression Index on location of the Cap in the $J_2^{1/2}-I_1$	6
		Space and on the q-p' Diagram	7
A.3.1	Case 3	- Effect of the Recompression Index on the Principal Stress Difference and Excess Pore Pressure vs. Axial Strain	8
A.3.2	Case 3	- Effect of the Recompression Index on the Principal Stress Ratio vs. Axial	
A.3.3	Case 3	Strain - Effect of the Recompression Index on location of the Cap in the $J_2^{1/2}-I_1$	9
		Space and on the q-p' Diagram	10
A.4.1	Case 4	 Effect of the Pore Pressure Response Factor on the Principal Stress Difference and Excess Pore Pressure vs. 	
A.4.2	Case 4		11
	•	Factor on the Principal Stress Ratio vs. Axial Strain	12
A.4.3	Case 4	- Effect of the Pore Pressure Response Factor on location of the Cap in the $J_2^{1/2}$ -I ₁ Space and on the q-p' Diagram	

LIST OF FIGURES cont'd

Figure				Page
A.5.1	Case	5 -	Effect of the Angle of Internal Friction on the Principal Stress Difference and Excess Pore Pressure vs. Axial Strain	. 14
A.5.2	Case !	5 -	Effect of the Angle of Internal Friction on the Principal Stress Ratio vs. Axial Strain	
A.5.3	Case !	5 -	Effect of the Angle of Internal Friction on location of the Cap in the $J_2^{1/2}-I_1$ Space and on the q-p' Diagram .	
A.6.1	Case (6 –	Effect of the Undrained Shear Strength Ratio on the Principal Stress Difference and Excess Pore Pressure vs. Axial Strain	. 17
A.6.2	Case 6	5 -	Effect of the Undrained Shear Strength Ratio on the Principal Stress Ratio vs. Axial Strain	
A.6.3	Case 6	6 -	Effect of the Undrained Shear Strength Ratio on location of the Cap in the $J_2^{1/2}-I_1$ Space and on the q-p' Diagram .	
A.7.1	Case 7	7 –	Effect of the Over-consolidation Ratio on the Principal Stress Difference and Excess Pore Pressure vs.	20
A.7.2	Case 7	7 –	Axial Strain Effect of the Over-consolidation Ratio on the Principal Stress Ratio	
A.7.3	Case 7	7 –	vs. Axial Strain Effect of the Over-consolidation Ratio on location of the Cap in the $J_2^{1/2}-I_1$ Space and on the q-p' Diagram	
			J_2 , $-I_1$ space and on the q-p. Diagram .	. 22

ii

APPENDIX A

A.1 - Case 1

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TABLE 1. SUMMARY OF SENSITIVITY ANALYSIS OF THE CAP PLASTICITY MODEL PARAMETERS	USR	0.22	0.22	0.22	0.22	0.22	0.22 0.31 0.43	0.22
	÷	24	24	24	24	19 24 30	24	24
	В	10	10	10	1 5 10	10	10	10
	C ^r	0.044	0.044	0.029 0.044 0.066	0.044	0.044	0.044	0.044
	ç	0.162	0.107 0.162 0.240	0.162	0.162	0.162	0.162	0.162
	2	0.15 0.30 0.45	0.45	0.45	0.45	0.45	0.45	0.45
	PARAMETER CASE	1A 1B 1C	2A 2B 2C	ЗА 3В 3С	4A 4B 4C	5A 5B 5C	6A 6B 6C	7A 7B 7C

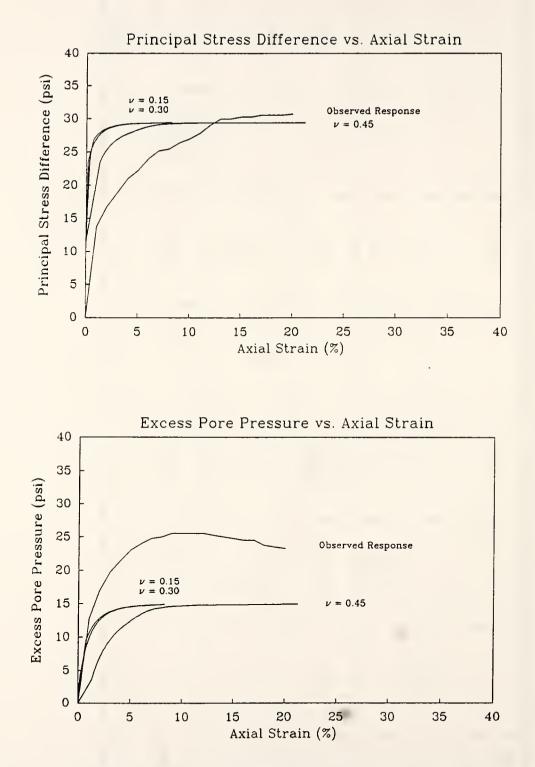


Figure A.1.1 - Effect of Poisson's Ratio on the Principal Stress Difference and Excess Pore Pressure vs. Axial Strain

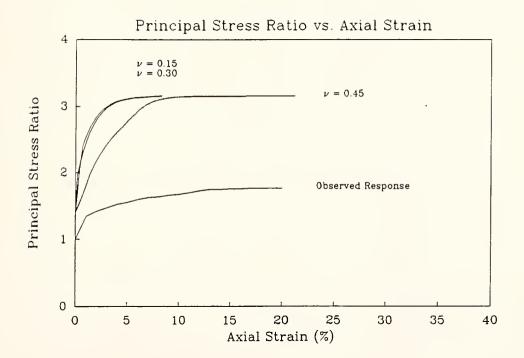


Figure A.1.2 - Effect of Poisson's Ratio on the Principal Stress Ratio vs. Axial Strain

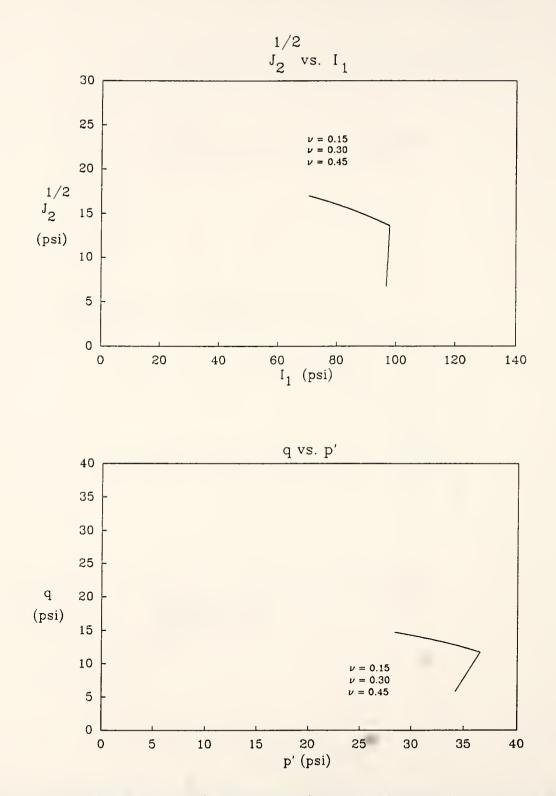


Figure A.1.3 - Effect of Poisson's Ratio on the location of the Cap in the $J_2^{1/2}-I_1$ Space and on the q-p' Diagram

A.2 - Case 2

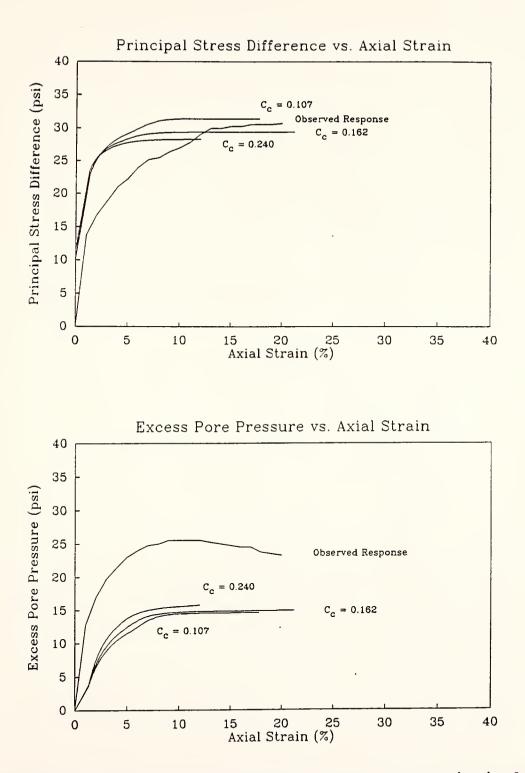


Figure A.2.1 - Effect of the Compression Index on the Principal Stress Difference and Excess Pore Pressure vs. Axial Strain

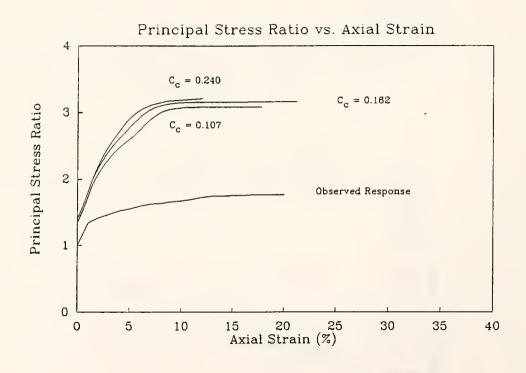


Figure A.2.2 - Effect of the Compression Index on the Principal Stress Ratio vs. Axial Strain

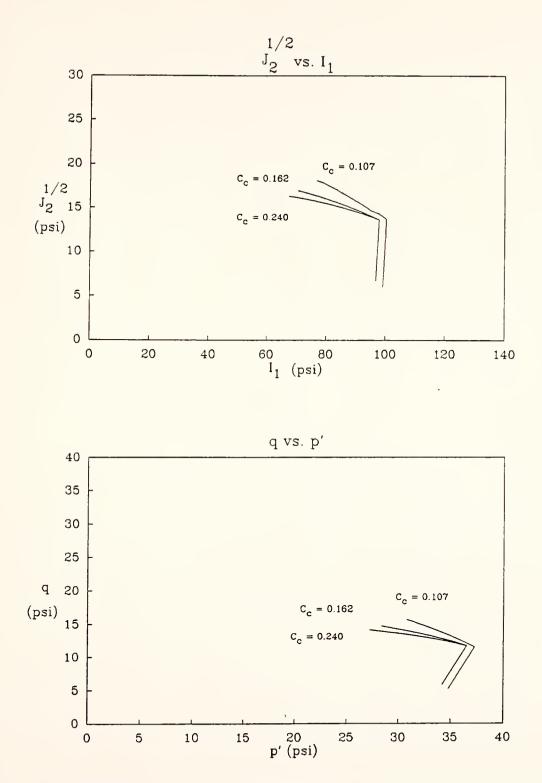


Figure A.2.3 - Effect of the Compression Index on location of the Cap in the $J_2^{1/2}-I_1$ Space and on the q-p' Diagram

A.3 - Case 3

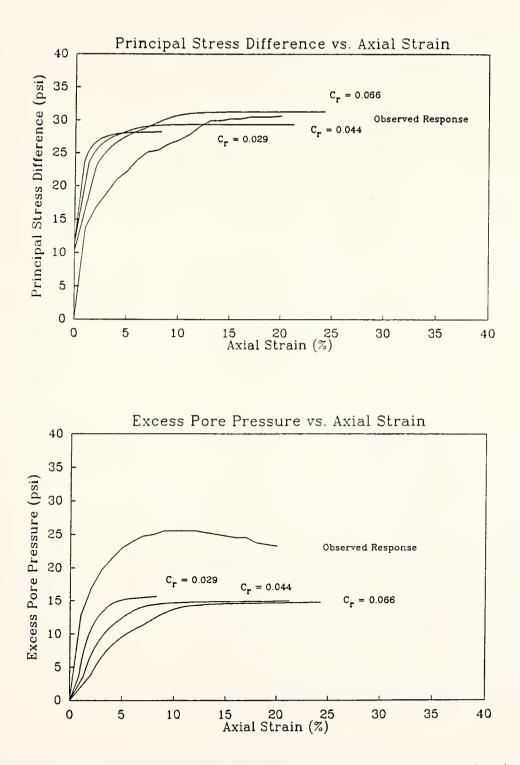


Figure A.3.1 - Effect of the Recompression Index on the Principal Stress Difference and Excess Pore Pressure vs. Axial Strain

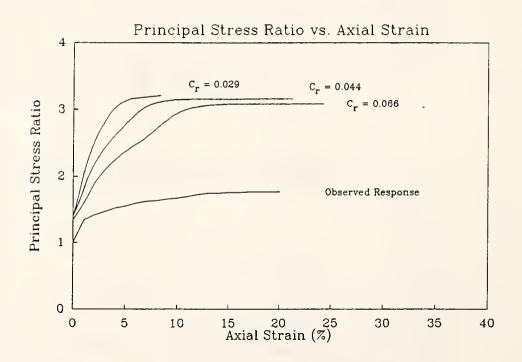


Figure A.3.2 - Effect of the Recompression Index on the Principal Stress Ratio vs. Axial Strain

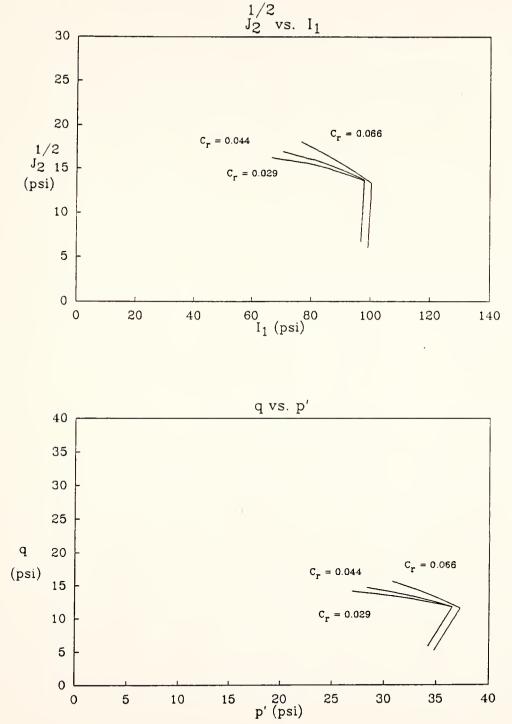


Figure A.3.3 - Effect of the Recompression Index on location of the Cap in the $J_2^{1/2}-I_1$ Space and on the q-p' Diagram

A.4 - Case 4

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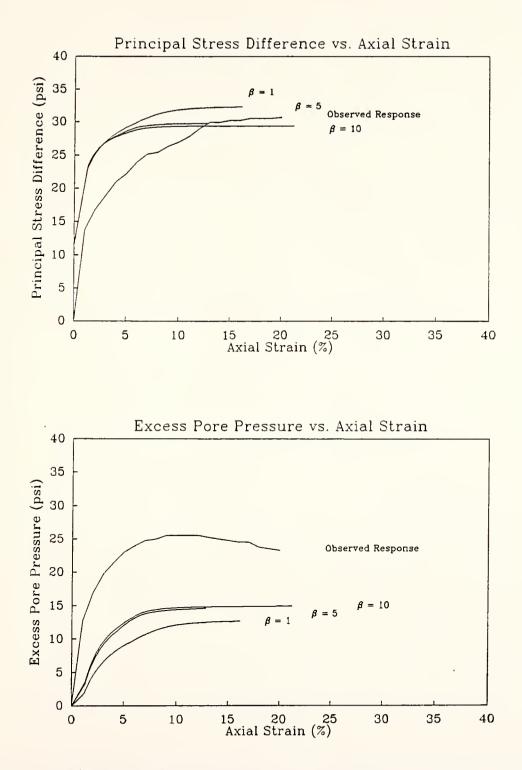


Figure A.4.1 - Effect of the Pore Pressure Response Factor on the Principal Stress Difference and Excess Pore Pressure vs. Axial Strain

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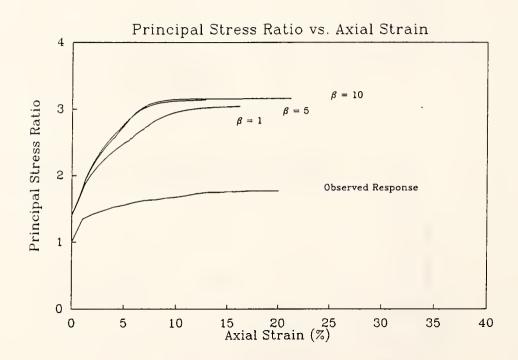


Figure A.4.2 - Effect of the Pore Pressure Response Factor on the Principal Stress Ratio vs. Axial Strain

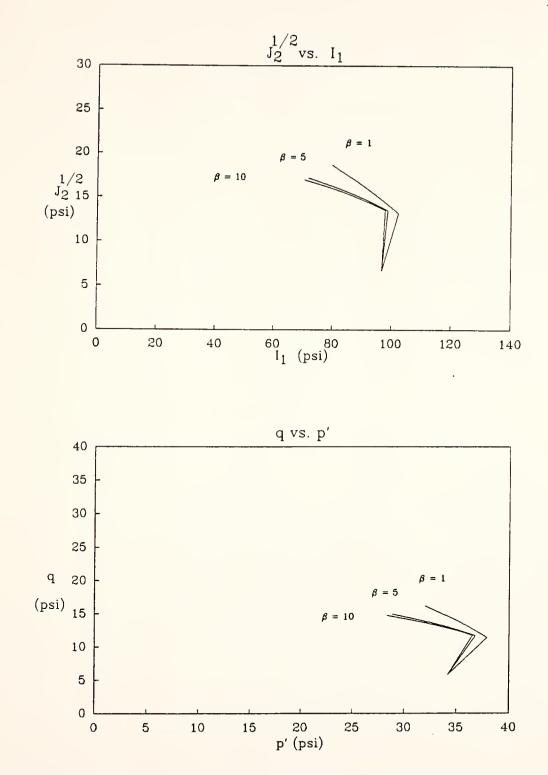


Figure A.4.3 - Effect of the Pore Pressure Response Factor on location of the Cap in the $J_2^{1/2}-I_1$ Space and on the q-p' Diagram

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A.5 - Case 5

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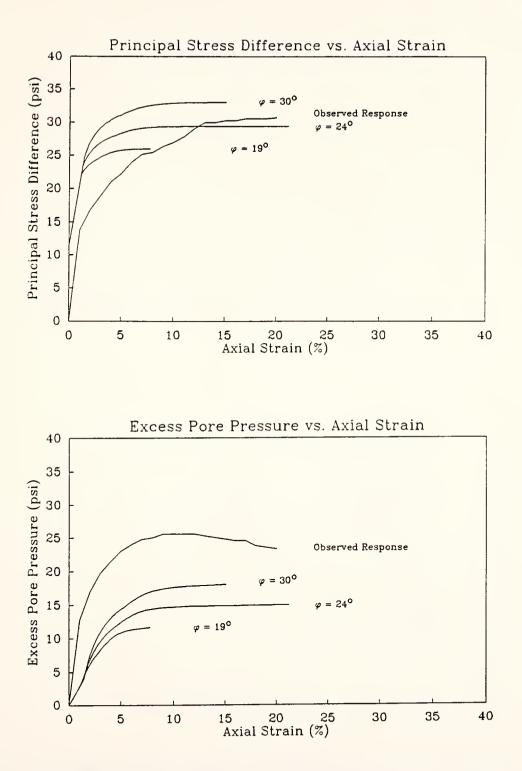


Figure A.5.1 - Effect of the Angle of Internal Friction on the Principal Stress Difference and Excess Pore Pressure vs. Axial Strain

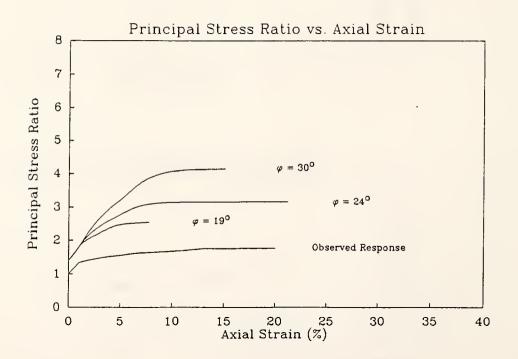


Figure A.5.2 - Effect of the Angle of Internal Friction on the Principal Stress Ratio vs. Axial Strain

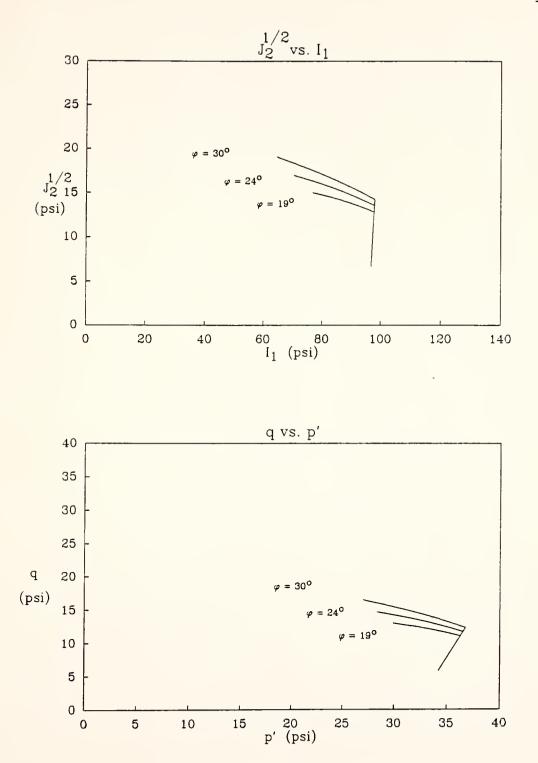


Figure A.5.3 - Effect of the Angle of Internal Friction on location of the Cap in the $J_2^{1/2}-I_1$ Space and on the q-p' Diagram

A.6 - Case 6

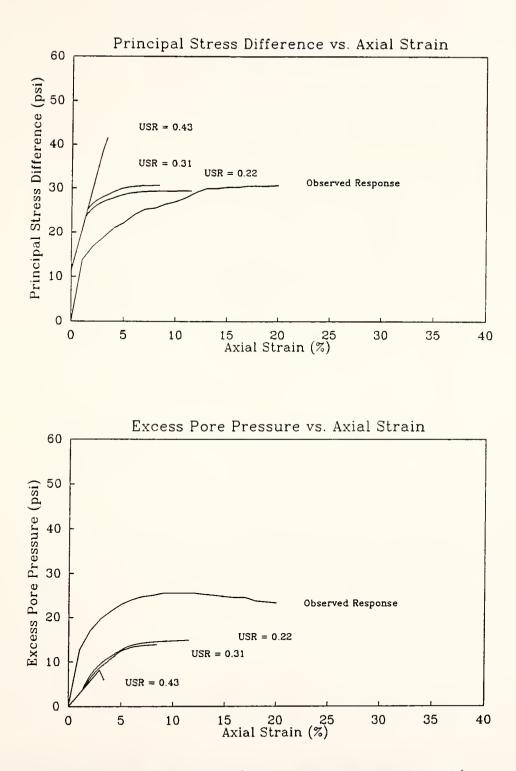


Figure A.6.1 - Effect of the Undrained Shear Strength Ratio on the Principal Stress Difference and Excess Pore Pressure vs. Axial Strain

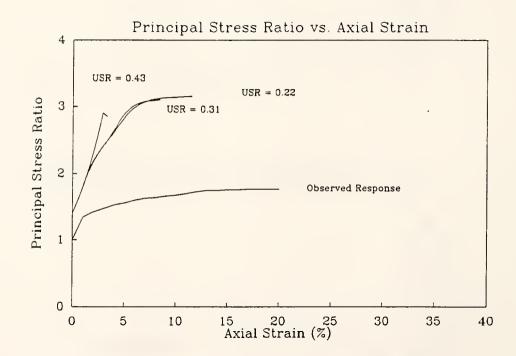


Figure A.6.2 - Effect of the Undrained Shear Strength Ratio on the Principal Stress Ratio vs. Axial Strain

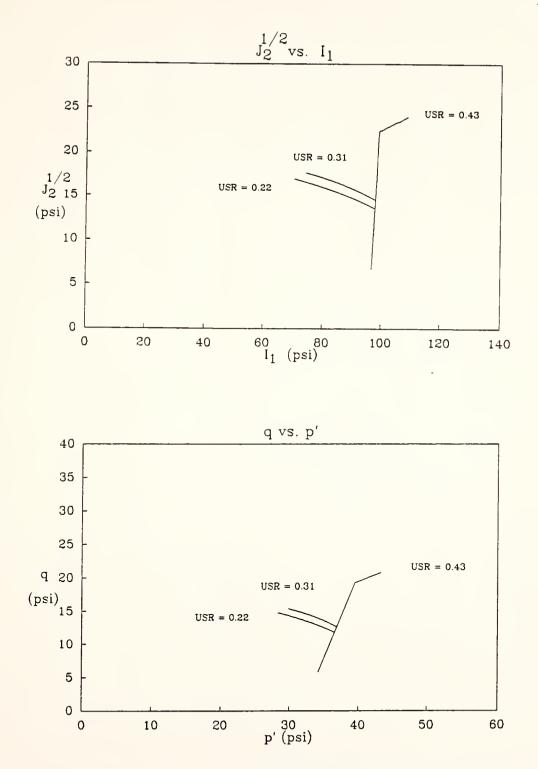


Figure A.6.3 - Effect of the Undrained Shear Strength Ratio on location of the Cap in the $J_2^{1/2}-I_1$ Space and on the q-p' Diagram

A.7 - Case 7

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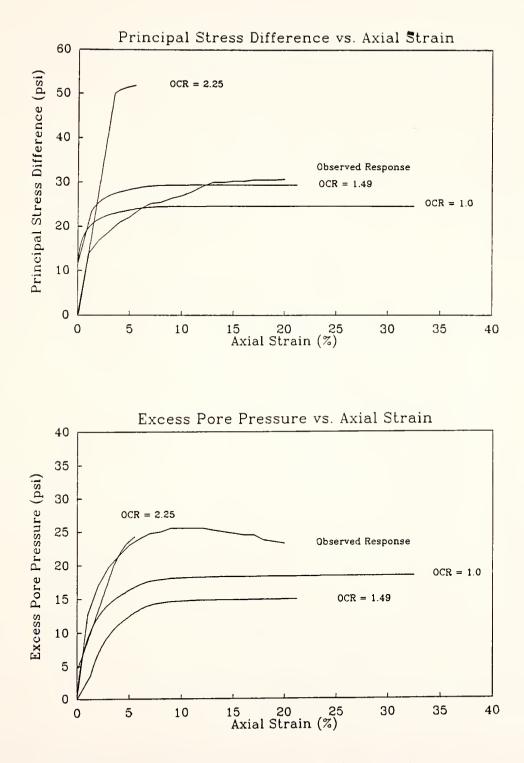


Figure A.7.1 - Effect of the Over-consolidation Ratio on the Principal Stress Difference and Excess Pore Pressure vs. Axial Strain

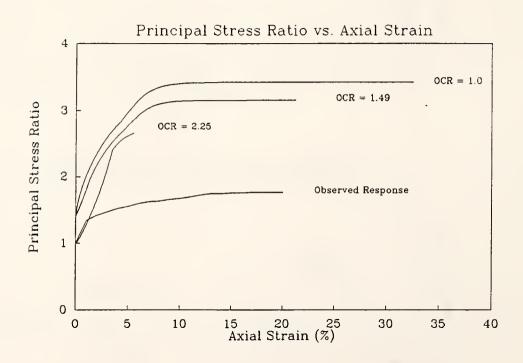


Figure A.7.2 - Effect of the Over-consolidation Ratio on the Principal Stress Ratio vs. Axial Strain

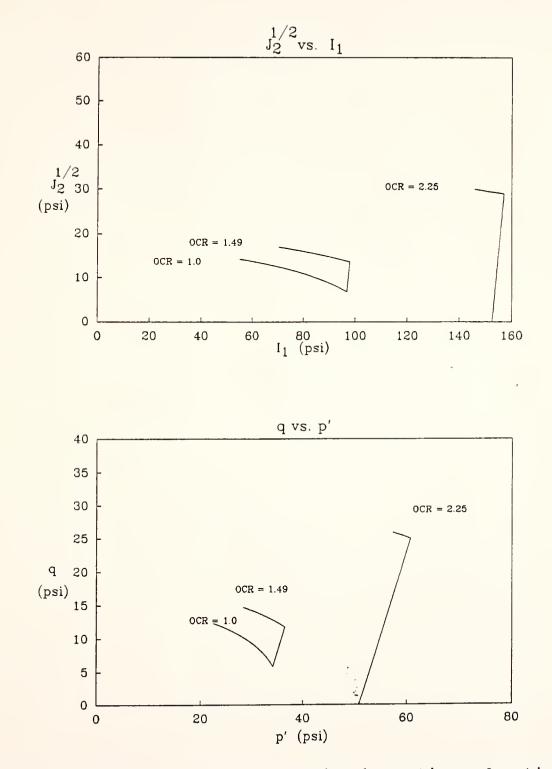


Figure A.7.3 - Effect of the Over-consolidation Ratio on location of the Cap in the $J_2^{1/2}-I_1$ Space and on the q-p' Diagram

APPENDIX B

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Computer disk with input data files

APPENDIX C

List of References

Holtz, R.D., and Kovacs, W.D. (1981), <u>An Introduction to</u> <u>Geotechnical Engineering</u>, Prentice-Hall, Inc., New Jersey, 733 pp.

Huang, T.K., and Chen, W.F. (1990), "Simple Procedure for Determining Cap-Plasticity-Model Parameters," <u>Journal of</u> <u>Geotechnical Engineering</u>, ASCE, Vol. 116, No. 3, pp. 492-513.

Huang, T.K., and Chen, W.F. (1991), "Embankment Widening and Grade Raising on Soft Foundation Soils: Computer Program Implementation," <u>Report No. CE-STR-91-3</u>, School of Civil Engineering, Purdue University, West Lafayette, Indiana, January, 244 pp.

Huang, T.K., Chen, W.F., and Chameau, J.L. (1990), "The Application of Cap-Plasticity-Model to Embankment Problems," <u>Report No. CE-STR-90-21</u>, School of Civil Engineering, Purdue University, West Lafayette, Indiana, 37 pp.

Humphrey, D.N. (1986), "Design of Reinforced Embankments," <u>Report No. JHRP-86-16</u>, Joint Highway Research Project, School of Civil Engineering, Purdue University, West Lafayette, Indiana, October, 423 pp.

Kulhawy, F.H., and Mayne, P.W. (1990), "Manual on Estimating Soil Properties for Foundation Design," <u>Research Project 1493-</u> <u>6</u>, Prepared for Electric Power Research Institute, Prepared by Cornell University, Geotechnical Engineering Group, Ithaca, New York, August.

Ladd, C.C., Foote, R., Ishihara, K., Schlosser, F., and Poulos, H.G., (1977), "Stress-Deformation and Strength Characteristics," State-of-the-Art Report, <u>Proceedings of the</u> <u>Ninth International Conference on Soil Mechanics and</u> Foundation Engineering, Tokyo, Vol. 2, pp. 421-494.

Ludlow, S.J., Personal data base - "Engineering Properties of Soils,".

Ludlow, S.J., Chen, W.F., Bourdeau, P.L., and Lovell, C.W., (1991), "Interim Report: Embankment Widening and Grade Raising on Soft Foundation Soils: Example 1 - Indiana State Route 55 over Turkey Creek in Lake County, Indiana," <u>Report No. JHRP-91-18</u>, Joint Highway Research Project, School of Civil Engineering, Purdue University, West Lafayette, Indiana, December, 56 pp.

Nwabuokei, S.O., (1984), "Compressibility and Shear Strength Characteristics of Impact Compacted Lacustrine Clay," Ph.D. Thesis, Purdue University, West Lafayette, Indiana.

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