

## Table of Contents

Introduction.....	1
Liquefaction .....	1
The Simplified Procedure.....	2
Soils with Fines Contents Greater than 5%.....	3
Seismic Compression .....	5
Equivalent Number of Cycles .....	5
Additional Observations.....	5
Post-Liquefaction Settlement.....	7
Literature Review .....	7
Lee and Albaisa (1974).....	7
Tatsuoka et al. (1984).....	8
Tokimatsu and Seed (1987).....	8
Nagase and Ishihara (1988) .....	9
Ohara and Matsuda (1988) .....	10
Ishihara and Yoshimine (1992) .....	11
Soydemir (1994).....	12
Matsuda and Nagira (1998) .....	12
Shamoto and Zhang (1998) .....	12
Shamoto et al. (1998).....	13
Zhang et al. (2002).....	13
Wu et al. (2003).....	14
Wu and Seed (2004) .....	15
Cetin et al. (2009a) .....	15
Cetin et al. (2009b) .....	15
Dashti et al. (2010) .....	16
Yi (2010a).....	16
Detailed Presentation of State of Art/State of Practice .....	17
Tokimatsu and Seed (1987).....	17
Ishihara and Yoshimine (1992) .....	21
Shamoto et al. (1998) and Shamoto and Zhang (1998).....	25

Zhang et al. (2002).....	31
Wu and Seed (2004) .....	35
Cetin et al. (2009).....	37
Yi (2010a).....	40
Seismic Compression.....	43
Literature Review.....	43
Whitman and Ortigosa (1969).....	43
Silver and Seed (1971) .....	43
Youd (1972).....	44
Silver and Seed (1972) .....	44
Pyke et al. (1975).....	44
Tokimatsu and Seed (1987).....	45
Chu and Vucetic (1992).....	46
Pradel (1998) .....	46
Stewart et al. (2001).....	47
Whang (2001).....	47
Stewart et al. (2002).....	47
Stewart and Whang (2003).....	48
Hsu and Vucetic (2004).....	49
Whang et al. (2004) .....	49
Stewart et al. (2004).....	50
Sawada et al. (2006) .....	51
Duku et al. (2006).....	51
Duku et al. (2008).....	51
Yi (2010b).....	52
Chen et al. (2012) .....	52
Detailed Presentation of State-of-Art/State-of-Practice.....	53
Tokimatsu and Seed (1987).....	53
Pradel (1998) .....	58
Stewart and Whang (2003).....	60
Stewart et al. (2004).....	66

Duku et al. (2008).....	68
Yi (2010b).....	70
Chen et al. (2012) .....	73
Final Remarks .....	79
Summary of Methods .....	79
Available Software .....	81
LIQUFAC.....	81
Shake 2000 .....	81
Liquefy Pro.....	82
WSLiq.....	83
LiqIT .....	83
References.....	85
Appendix A – List of Variables .....	94
Appendix B – SPT Corrections and Conversions.....	101
Japanese SPT Blow Count Conversion.....	101
Relation Between Relative Density and SPT Blow Count .....	101
SPT Correction Factors .....	102
Appendix C – The Simplified Procedure.....	104
Cyclic Resistance Ratio, CRR.....	104
Cyclic Stress Ratio, CSR.....	104
Magnitude Scaling Factors .....	108
Overburden Correction Factor, $K_{\sigma}$ , and Static Shear Stress Correction Factor, $K_{\alpha}$ .....	109
Liquefaction Susceptibility.....	110
Appendix D - Lateral Displacement Estimation.....	112
Hamada et al. (1986) .....	112
Youd and Perkins (1987).....	112
Shamoto et al. (1998) .....	112
Rauch and Martin (2000) EPOLLS Model .....	117
Youd et al. (2002).....	118
Zhang et al. (2004) .....	118
Idriss and Boulanger (2008).....	121

Appendix E - Equations for Small-Strain Shear Modulus, $G_{max}$ .....	123
Appendix F - Alternate Robertson and Wride Procedure .....	126
Appendix G - Case History- Miller Farm .....	129
Earthquake and Site Details .....	129
Post-Liquefaction Settlement .....	130
Tokimatsu and Seed (1987).....	137
Ishihara and Yoshimine (1992) .....	141
Shamoto et al. (1998) and Shamoto and Zhang (1998).....	145
Zhang et al. (2002).....	151
Wu and Seed (2004) .....	156
Cetin et al. (2009) .....	158
Yi (2010a).....	162
Seismic Compression .....	163
Tokimatsu and Seed (1987).....	164
Pradel (1998) .....	170
Stewart and Whang (2003).....	173
Stewart et al. (2004).....	180
Duku et al. (2008).....	182
Yi (2010b).....	184
Chen et al. (2012) .....	185
Summary .....	191
Estimated Post-Liquefaction Settlements.....	191
Estimated Seismic Compressions.....	191