

Table of Contents

Preface	ii
Kurzfassung	iii
Abstract	iv
Table of Contents	i
List of Figures	iii
List of Tables	viii
List of Notations	ix
1 Introduction	11
1.1 Motivation	11
1.2 Objectives	13
1.3 Methodology	14
2 State of the Art Review	16
2.1 Non-breaking Wave Loads on a Single Slender Pile	16
2.1.1 Morison Equation	16
2.1.2 Experimental Studies on Drag and Inertia Coefficients	18
2.2 Breaking Wave Loads on a Single Slender Pile	20
2.3 Wave Loads on Pile Groups	24
2.3.1 Small Scale Experimental Studies on Wave Loads on Pile Groups	25
2.3.2 Large Scale Experimental Studies on Wave Loads on Pile Groups	35
2.3.3 Summary and Implications for the PhD Study	48
2.4 Efficient Computational Tool for Data Analysis	50
2.5 Specification of Objectives and Methodology	51
3 Small Scale Model Tests – Phase I: Scale Effect Study	54
3.1 Down-scaling of GWK tests	54
3.2 Reproduction of Selected GWK Tests in the LWI Wave Flume	58
3.2.1 Regular Non-breaking Waves	59
3.2.2 Focused Breaking Waves	63
3.3 Comparative Analysis of GWK and LWI tests (Scale Effects)	67
3.3.1 Regular Non-breaking Wave Loads on a Single Pile	67
3.3.2 Focused Breaking Wave Loads on a Single Pile	72
3.3.3 Pile Group Effect	73

3.4	Summary of Key Results	78
4	Small Scale Model Tests – Phase II: Systematic Parameter Study.....	80
4.1	Model Set-up	80
4.2	Wave and Structural Conditions	83
4.2.1	Wave Conditions.....	83
4.2.2	Pile Group Configurations	86
4.3	Pile Group Effect	87
4.3.1	Effect of KC Number.....	87
4.3.2	Effect of Reynolds Number	93
4.3.3	Effect of Wave Steepness	95
4.3.4	Effect of Relative Water Depth.....	97
4.3.5	Pile Group Effect at Different Elevations	99
4.4	Tentative Wave Load Formulae using Multiple Regression Model (MRM)	100
4.5	Summary of Key Results	108
5	Artificial Intelligence-based Wave Load Formulae for Prediction of Wave-induced Forces on Pile Groups	110
5.1	M5 Model Tree (M5MT).....	110
5.1.1	M5 Model Tree Algorithm.....	110
5.1.2	Strengths and limitations of M5 model tree algorithm	112
5.2	Genetic Programming (GP)	113
5.2.1	Principle of Genetic Programming (GP).....	113
5.2.2	Strengths and Limitations of Genetic Programming GP	118
5.3	Hybrid M5MT-GP model system.....	118
5.4	M5MT-GP Model for Development of Wave Load Formulae.....	123
5.4.1	Data Classification using M5MT.....	123
5.4.2	Development of Wave Load Formulae using GP	130
5.4.3	Validation of the developed M5MT-GP-based formulae	142
5.4.4	Pile Group Effect due to Focused Breaking Waves.....	143
5.5	Summary of Key Results	146
6	Summary and Outlook	149
6.1	Summary of Key Results	150
6.1.1	Reproduction of GWK Tests in the LWI Flume: Scale Effects.....	150
6.1.2	Effects of Wave and Structural Parameters on Pile Group Effect.....	151
6.1.3	Computational AI-based Tool for the Analysis of Laboratory Data	152
6.1.4	New Set of Wave Load Formulae, Applications and Limitations	152
6.1.5	Pile Group Effect for Focused Breaking Waves.....	154
6.2	Outlook	154
	References	156