

**APPLICATION OF DYNAMIC AND VIBRO COMPACTION
METHODS FOR DENSIFICATION OF GRANULAR FILL IN
RECLAIMED LAND IN SRI LANKA**

**Amil Indumini Samarasinghe
(168980V)**

**Degree of Master of Engineering in Foundation Engineering and Earth
Retaining Systems**

**Department of Civil Engineering
University of Moratuwa
Sri Lanka
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**Amil Indumini Samarasinghe
(168980V)**

**Thesis submitted in partial fulfilment of the requirements for the degree of
Master of Engineering in Foundation Engineering and Earth Retaining
Systems**

**Supervised by
Dr. L.I.N. De Silva**

**Department of Civil Engineering
University of Moratuwa
Sri Lanka**

DECLARATION

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.....
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.....
Dr. L.I.N. De Silva

.....
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CASE STUDY: APPLICATION OF DYNAMIC AND VIBRO COMPACTION METHODS FOR DENSIFICATION OF GRANULAR FILL IN RECLAIMED LAND IN SRI LANKA

ABSTRACT

In the recent past, Government of Sri Lanka executed a large-scale reclamation project in Sri Lanka to add a brand-new land of 267-hectare to the Capital, Colombo with strategy of converting Colombo as a commercial hub of South Asia. For this project, 72 Million m³ of sea sand which was dredged by Trailing Suction Hopper Dredgers at 10km off from shore of Colombo was placed mainly by hydraulic methods at lower elevation while applying bulldozers at the top. This reclamation material was noted as clean uniform sand and which was under loose to medium dense condition prior to densification.

This sand fill was densified using two methods, namely dynamic compaction and vibro compaction. Dynamic compaction, which is generally considered as one of the most economical sand improving methods, was applied in all areas except vibration sensitive areas at the city end and the areas where deep ground improvement was required for stability of earth retaining structures.

Since settlement of subsoil in the seabed is not critical, the considered major geotechnical issues were achieving of required bearing capacity, shear strength and avoiding possible liquefaction. To sort out all geotechnical issues, sand densification was the only solution. Though there is a very long history for dynamic and vibro compaction methods, still reclamation projects are not pre-planned to utilize the self-compaction achieves during sand placing very effectively, while designs always follow a very conservative approach. Moreover, designs are carried out using pre-defined energy criterions rather than considering existing fill material properties and its pre-compaction condition. Thus, there was a paramount requirement to assess the dynamic and vibro compaction methods for Sri Lankan fill materials and reclamation methods with the intention of optimization of the above compaction methods. In order to optimize dynamic compaction method, the pre-and post-compaction condition (by CPTs) was evaluated by crater depth, net volume changes, influenced depth and related indices, which assess the degree of improvement based on applied

energy. Similarly, densification by vibro compaction was evaluated with respect to the factor such as point spacing, amperage and compaction holding time. In addition, effect such as age of the compacted fill was considered for both dynamic and vibro compaction in this reclamation fill of clean sand.

Finally, verification of densified ground by selecting CPTs at least compacted points with respect to the compaction grids was assessed for both dynamic and vibro compaction to confirm the optimization has no adverse effect on the final design.

Based on the finding of this research, fill material's index properties of Sri Lankan sea sand were determined while being noted that there is no hesitation for applicability of dynamic and vibro compaction for densification. During the analysis it was suggested to modify some correlations derived based on laboratory test data to achieve more realistic output for actual reclamation condition. In addition, design of dynamic and vibro compaction by performance-based method through trial compaction was discussed.

Key words;

Dredging, Dynamic Compaction, Vibro Compaction, Crater Depth, Influence Depth, Ground Improvement Index, Amperage, Compaction Time, Applicability, Verification, Optimization

CONTENTS

ABSTRACT.....	iii
1. INTRODUCTION.....	1
1.1. General	1
1.2. Background	1
1.3. Objectives of the Research	2
1.4. Scope of Work	3
1.5. Outline of the Thesis.....	3
2. LITERATURE REVIEW.....	5
2.1. Off-Shore Reclamation Methods using Sea Sand	5
2.2. Index Properties of Reclaimed Sea Sand.....	7
2.3. Potential Failure Modes in Reclaimed Land fill	9
2.4. Scope of the Improvement in Reclaimed Ground.....	9
2.5. Factors Affecting on the Popularity of Application and Improvements of Efficiency in Sand Densification work	10
2.6. Improvement of Fill Material.....	11
2.7. Design and Acceptance Criteria	11
2.8. Parameters Related to Granular Soil Densification	12
2.8.1 Relative Density.....	12
2.8.2 Compaction Status of Sand fill by Relative Density	15
2.9. Assessment of Potential Liquefaction	16
2.9.1 Soil Behaviour Type (SBT) Index (I_c) and Normalized Cone Resistance (Q_{tn}).....	17
2.10. Methods Apply for Improvement of Reclaimed Sand Fill.....	19
2.11. Dynamic compaction.....	20
2.11.1 Applicability of Dynamic Compaction	21
2.11.2 Main Component of Dynamic Compaction Machine.....	24
2.12. Vibro Compaction.....	24

2.12.1.	Applicability of Vibro Compaction	25
2.12.2.	Use of Brown’s suitability index	27
2.12.3.	Main component of the Deep Vibrators	27
2.13.	Mechanism of Densification in DC and VC	29
2.14.	Compaction Sequence of Dynamic Compaction	32
2.15.	Construction Sequence of Vibro Compaction	33
2.16.	Optimization of Sand Densification	37
2.16.1.	Factors Affecting Dynamic Compaction	37
2.16.2.	Factors Affecting Vibro Compaction	40
2.16.3.	Evaluation of Optimization of Sand Densification for Optimization	46
	Influence Depth	52
	Ground Improvement Index (I_d)	55
2.16.4.	Other Influencing Factors for Optimization of Sand Densification	64
2.16.5.	Evaluation of Densification	66
3.	METHODOLOGY	69
4.	RESULTS AND DISCUSSION	72
4.1.	Evaluation of Properties and Self-Compaction of Sand While Being Reclaimed by Different Methods.....	72
4.1.1.	Index Properties of Reclaimed Sand.....	72
4.1.2.	Self-Densification during Reclamation.....	73
4.1.3.	Evaluation of the Properties of Dredged Sand	75
	77
4.2.	Evaluation of the effectiveness of Dynamic and Vibro Compaction of the Reclaimed Sea Sand Fill	77
4.2.1.	Application of Dynamic and Vibro Compaction	77
4.2.2.	Applicability of Dynamic Compaction for the Project.....	78
4.2.3.	Applicability of Vibro Compaction	79
4.2.4.	Evaluation of Dynamic Compaction in Reclaimed Sea Sand for Optimization	80
4.2.5.	Evaluation of the Effectiveness of Vibro Compaction in Reclaimed Sea Sand for Optimization.....	102
4.2.6.	Ageing Effect on Sand Densified by DC and VC	109

4.3.	Evaluation of Ground Improvement Achieved in Dynamic and Vibro Compaction by CPT ..	109
4.3.1.	Selection of CPT Locations	109
4.3.2.	Summary of CPTs Advanced with Respect to the Vibro Compaction Points	114
5.	CONCLUSIONS	117
	REFERENCES.....	121
A1.	APPENDIX I: Analysis for Properties of Fill Material and Self-Compaction While Placing I	
A1.1	Summary of q_c values in Pre-compaction CPT.....	I
A1.1.	Variation of relative density by different methods	II
A2.	APPENDIX II: Crater Depth Analysis	III
A3.	APPENDIX III: Net Volume Change Analysis at Dynamic Compaction Point.....	VI
A4	APPENDIX IV: Influence Depth and the Parameter “n” For Permanent DC Work.....	X
A5	Appendix V: Evaluation of Vibro Compaction.....	XIII
A5.1	Trial VC Compaction	XIII
A5.2	Evaluation of Compaction (q_c) at Centroid of Three Surrounding Compaction Points with Respect to the Amperage Applied	XIV
A6	APPENDIX VI: Cone Resistance (q_c) Variation at Different Locations with Respect to the Compaction Point.....	XIX
A6.1	In 2000kNm dynamic compaction area	XIX
A6.2	In 4000kNm- dynamic compaction area.....	XXIII
A6.3	In vibro compaction area	XXIV
A7	APPENDIX VII: Age Effect on Sand Densification.....	XXVIII
A7.1	Age effect on Dynamic Compaction	XXVIII
A7.2	Age effect when sand compacted by Vibro Compaction	XXXI

LIST OF FIGURES

Figure 2-1: Sand bottom dumping from TSHD	5
Figure 2-2: Sand Rain bowing from TSHD	5
Figure 2-3: Sand pumping from TSSD	7
Figure 2-4: Sand dumping and moving by earth movers	7
Figure 2-5: Non-normalized SBT chart based on dimensionless cone resistance, (q_c/p_a) and friction ratio, R_f [10].....	8
Figure 2-6: Soil identification of backfill for DC improvement (after Massarch 1991) [11]	8
Figure 2-7: Potential of liquefiable with grain size distribution of soils (Y. Tan 2005) [8]	9
Figure 2-8: e_{max} and e_{min} (for Nevada 50/80 sand) variation against non-plastic fines percentage (Redrawn from Lade et al 1998).....	13
Figure 2-9: Relation between e_{max} and e_{min}	13
Figure 2-10: CRR vs q_{c1} for different soil types [26].....	16
Figure 2-11: Q_{in} vs I_c graph (Robertson: 2016) [19].....	18
Figure 2-12: Suitability of different ground stabilization methods varies grading range of problem soils (Mitchell et al., 1998) [9].....	19
Figure 2-13: Schematic Illustration of deep dynamic compaction (Lukas:1995) [37]	21
Figure 2-14: Grouping of soils for dynamic compaction (Lukas, 1986) [36].....	22
Figure 2-15: Application range of the deep vibratory compaction techniques and liquefiable soils range (Keller; 2012) [48]	26
Figure 2-16: Vibrator Motion and Schematic	28
Figure 2-17: Profile of sand grains rearranged by dynamic compaction	30
Figure 2-18: Axial deformation of confined compactable loose granular soil [54].....	30
Figure 2-19: Wave Propagation due to dynamic compaction (Wood R.D) [55]	30
Figure 2-20: Soil Improvement Descriptive Pattern of by DC (Lukas, 1986) [36]	31
Figure 2-21: Grain rearrangement in Vibro Compaction	31
Figure 2-22: Arrangement of compaction point as first and second pass	32
Figure 2-23: Treatment by each pass	32
Figure 2-24: Dynamic compaction done in the project site	33
Figure 2-25: Construction sequence of vibro compaction	34
Figure 2-26: Process of vibro-compaction and its affection zone.....	35
Figure 2-27: Densification zones resulting from vibrocompaction (Brown: 1977).....	36
Figure 2-28: Vibro Compaction done in Project Area	36
Figure 2-29: Corelation of tamper mass and drop height (Mayne et al.1984)	39
Figure 2-30: Tributary Areas variation with point pattern.....	42
Figure 2-31: Approximate post-compaction relative density variation with tributary area per compaction point (Dobson and Slocombe:1982) [62].....	42
Figure 2-32: Tip resistance (q_c) variation of post- treated CPT with distance from compaction point for two different vibrators (Degan and Hussain: 2001) [62]	43
Figure 2-33: Illustration of vibro float induced the horizontal impacting forces and torsional shear (Green wood :1991)	44
Figure 2-34: Verification of Numerical Model with Experimental Data of Arslan et al. (2007) [66].....	48

Figure 2-35: Normalized crater depth Correlation with drop numbers measured from model test by F. Jafarzadeh and the Equation introduced by Takada and Oshima for different compaction energy levels. [69].....	49
Figure 2-36: Computed and measured crater depths at Nishiro site [70].....	50
Figure 2-37: Relation between normalized crater depth and \sqrt{N}	51
Figure 2-38: Correlation between square root of energy per drop and influence depth (after Leonards et al. 1980) [72]	52
Figure 2-39: Depth improvement as measured at 3m from centre of drop point (Lukas (1995)) [44]	52
Figure 2-40: Depth improvement as measured at 6.1m from centre of drop point (Lukas (1995)) [44]	52
Figure 2-41: Typical Energy -Depth of influence chart for DC (Slocombe, 1993) [75]	54
Figure 2-42: Relationship between improvement depth and normalized compaction energy [69]	55
Figure 2-43: Typical I_d graph with respect to the pass number (Y. Tan et al.2007) [8]	55
Figure 2-44: Variation the vibrator depth, current power consumption of the electric engine, vibrator tip amplitude, angle of phase and pull-down pressure during deep vibrator compaction against time under standard operation mode (Nagy et al. 2017) [80]	57
Figure 2-45: position of eccentric mass with respect to the vibrator contact location.....	58
Figure 2-46: Recorded lateral movement of the tip of vibro probe at the commencement (left) and at the end (right) in the lowering process during the highlighted compaction step in Figure 2-44	59
Figure 2-47: Soil Response of vibro-floatation (civildigital.com) [80]	59
Figure 2-48: Current log recorded during vibro compaction (Degan and Hussin 2001)	60
Figure 2-49: Variation of PPV measured in different distance with respect to the depth (Babak: 2011)...	63
Figure 2-50: Compaction evolution in time of vibration at a point	63
Figure 2-51: Influence of period of sustained pressure on stress ratio causing peak cyclic pore pressure ratio of 100% ([88].....	64
Figure 2-52: Effect of time upon relative improvement in CPT values in sandy soil in	65
Figure 2-53: Sum of coefficients of influence at critical point for triangular spacing pattern	68
Figure 3-1: Flow chart of research.....	71
Figure 4-1: Soil behaviour of filling material in this project as per SBT chart by Robertson et al. (2010) prepared based on pre-compaction CPT data.....	72
Figure 4-2: qc range in pre-compaction CPT curves	74
Figure 4-3: Maximum and minimum D_R values varies with depth in pre-compaction CPTs.....	74
Figure 4-4: SBT chart for dredge sand with compactability envelope.	75
Figure 4-5: Grain size distribution of sand used for port city reclamation.	76
Figure 4-6: I_c Vs Q_{tn} graph for pre-compaction reclaimed sand	77
Figure 4-7: Ground Improvement Areas compacted by different san densification methods	78
Figure 4-8: Applicability of dynamic compaction and vibro compaction.	78
Figure 4-9: Sand behavior within Lukas' Grouping of soils for dynamic compaction.....	79
Figure 4-10: Particle distribution curves range of this reclaimed sand in Keller envelope for vibro compaction.....	79
Figure 4-11: Application of dynamic compaction	81
Figure 4-12: Typical pounder used for dynamic comaction	82
Figure 4-13: Typical dynamic compaction machine used in Port City project.....	82
Figure 4-14: Compaction point arrangement for Trial dynamic compaction by 4000 kNm and 2000kNm	82
Figure 4-15: Ironing tamping pattern in 4000kNm and 2000kNm applied area.....	83

Figure 4-16: compaction pattern in 1000 kNm energy applied area.....	83
Figure 4-17: typical crater seen during dynamic compaction.....	84
Figure 4-18: Crater depth variation with blow number	85
Figure 4-19: Increment in crater depth with respect to blow number.....	85
Figure 4-20; comparison of crater depth found from modified Takada equation.....	87
Figure 4-21: Normalized Crater Depth Vs Blow Number (N).....	88
Figure 4-22: Normalized crater depth variation with \sqrt{N}	89
Figure 4-23: liner variation between Normalized crater depth and \sqrt{N}	90
Figure 4-24: Ground level measured point in perpendicular directions at dynamic compaction point	91
Figure 4-25: Net volume variation with blow number.....	91
Figure 4-26: Net volume increment variation with no of blow	92
Figure 4-27: Comparison in influence depth considering improvement in q_c after applying DC.....	93
Figure 4-28: CPT locations in 4000kNm applied area.....	94
Figure 4-29: CPT locations in 2000kNm applied area.....	95
Figure 4-30: Variation of influence depth with \sqrt{WH} for this study.....	95
Figure 4-31: influenced depth variation with \sqrt{WH} in this study along with previous studies data	96
Figure 4-32: Influenced depth variation with square root of energy.....	97
Figure 4-33: Ground Improvement Index variation with depth in trial area of this study	98
Figure 4-34: Variation of Ground Improvement Index upon target with depth in trial area	99
Figure 4-35: $q_{t-target}/q_{t-pre}$	101
Figure 4-36: Target q_c plotted along with minimum q_c values in pre-compaction CPT	101
Figure 4-37: layout of trial points	102
Figure 4-38: Comparison of achieved compaction (q_c) for different point spacing.....	103
Figure 4-39 : Average compaction (q_c)variation with different spacing.....	104
Figure 4-40: Typical time and amperage consumption curve.....	105
Figure 4-41: Amperage consumption (right) and time consumption (left) with elevation in compaction phase	106
Figure 4-42: Amperage variation during compaction.....	107
Figure 4-43: Cumulative amperage applied within considered elevation.....	107
Figure 4-44: Advanced CPT locations with respect to the compaction points	110
Figure 4-45: Comparison of q_c curves in 2000kNm DC applied area with respect to the compacted points	111
Figure 4-46: Effect of laterally influenced zone in dynamic compaction.....	112
Figure 4-47: Average q_c values of CPT conducted at centroid of nearby compaction points in 4000kNm applied area.....	113
Figure 4-48: achieved q_c improvement in 2000kNm and 4000kNm applied dynamic compaction areas	113
Figure 4-49: Selection of CPT location with respect to the nearby vibro compaction point.....	114
Figure 4-50: q_c variation with CPT location with respect to the compaction point	115
Figure 4-51: Possible variation in laterally influenced zones with change of grid spacing	116
Figure A- 1: Pre-compaction CPT Results	I
Figure A- 2: Variation of DR before compaction by (a) Biryaltseva method (b) Mayne method (c) Tom Lunee method.....	II
Figure A- 3: Cumulative crater depth variation with blow number.....	III

Figure A- 4: Normalized crater depth variation with square root of blow number in 1 st pass of 2000kNm III	
Figure A- 5: Normalized crater depth variation with square root of blow number in 2 nd pass of 2000kNm	IV
Figure A- 6: Normalized crater depth variation with square root of blow number in 1 st pass of 4000kNm IV	
Figure A- 7: Normalized crater depth variation with square root of blow number in 2 nd pass of 4000kNm	V
Figure A- 8: Average normalized crater depth Vs \sqrt{N}	V
Figure A- 9: Crater, heave and net volume variation at A2 point in 4000kNm DC area for 1 st pass	VI
Figure A- 10: Crater, heave and net volume variation at G2 point in 4000kNm DC area for 1 st pass	VI
Figure A- 11: Crater, heave and net volume variation at B1 point in 4000kNm DC area for 2 nd pass	VII
Figure A- 12: Crater, heave and net volume variation at B7 point in 4000kNm DC area for 2 nd pass	VII
Figure A- 13: Crater, heave and net volume variation at F1 point in 4000kNm DC area for 2 nd pass	VII
Figure A- 14: Crater, heave and net volume variation at J7 point in 4000kNm DC area for 2 nd pass	VIII
Figure A- 15: Crater, heave and net volume variation at I2 point in 2000kNm DC area for 1 st pass	VIII
Figure A- 16: Crater, heave and net volume variation at M2 point in 2000kNm DC area for 1 st pass	VIII
Figure A- 17: Crater, heave and net volume variation at L3 point in 2000kNm DC area for 2 nd pass	IX
Figure A- 18: Average net volume variation	IX
Figure A- 19: Net volume increment in ground movement by DC	IX
Figure A- 20: Typical Amperage usage in nearest VC points	XIII
Figure A- 21: (a) Applied amperage (b) Applied average cumulative amperage at each elevation (c) qc variation in the depth at C93	XIV
Figure A- 22:(a) Applied amperage (b) Applied average cumulative amperage at each elevation (c) qc variation in the depth at C95	XIV
Figure A- 23: (a) Applied amperage (b) Applied average cumulative amperage at each elevation (c) qc variation in the depth at C97	XV
Figure A- 24: (a) Applied amperage (b) Applied average cumulative amperage at each elevation (c) qc variation in the depth at C102	XV
Figure A- 25: (a) Applied amperage (b) Applied average cumulative amperage at each elevation (c) qc variation in the depth at AC6	XVI
Figure A- 26: a) Applied amperage (b) Applied average cumulative amperage at each elevation (c) qc variation in the depth at AC29	XVI
Figure A- 27: a) Applied amperage (b) Applied average cumulative amperage at each elevation (c) qc variation in the depth at AC30	XVII
Figure A- 28: a) Applied amperage (b) Applied average cumulative amperage at each elevation (c) qc variation in the depth at AC384	XVII
Figure A- 29: a) Applied amperage (b) Applied average cumulative amperage at each elevation (c) qc variation in the depth at AC386	XVIII
Figure A- 30: Average qc at centroid w.r.t compaction point in 2000kNm DC Area	XIX
Figure A- 31: Average qc at centre w.r.t to compaction points in 2000 DC area	XX
Figure A- 32: qc curves at 1m away from DC points.	XXI
Figure A- 33: qc curve at mid of two 2000kNm DC point	XXII
Figure A- 34: qc at centroid w.r.t. compaction points in 4000kNm DC area	XXIII
Figure A- 35: qc variation at centroid w.r.t. the VC points	XXIV
Figure A- 36: qc at mid of two VC points	XXV
Figure A- 37: qc variation at centre of VC point	XXVI

Figure A- 38; q_c variation at 1m away from a centre of VC point.....XXVII
Figure A- 39: q_c variation when compaction below 2 monthsXXVIII
Figure A- 40: Variation of q_c when compaction below 180 daysXXIX
Figure A- 41: Variation of q_c when compaction above 200 days.....XXX
Figure A- 42: Variation of q_c in different ages.....XXXI

LIST OF TABLES

Table 2-1: Typical relative densities as a result of hydraulic fill [5]	6
Table 2-2: Soil Types identified by SBT	8
Table 2-3: Qualitative Description in compaction for Granular Soil Deposits	15
Table 2-4: Suitability of soil for dynamic compaction (Lukas, 1986).....	23
Table 2-5: Effectiveness of vibrocompaction with soil types (Courtesy; Keller) [48]	26
Table 2-6: Rating for vibrocompaction on S_N (Brown: 1977) [49].....	27
Table 2-8: Guidelines on applied Energy for densifying various soils (Lukas 1986).....	40
Table 2-9: Specifications of several vibrators (Degen and Hussin 2001) [62]	41
Table 2-10: Values of n for various pounders (after Choa et al ; 1997 [1]).....	54
Table 4-1: grading indices of reclaimed sand	73
Table 4-2: Pounder details	80
Table 4-3: Design of Dynamic compaction	81
Table 4-4: Summary of influence depth with respect to the applied energy and estimated n values	94
Table 4-5: Target q_c values applied in different areas of this project.....	100
Table 4-6: Summary of repeated CPTs.....	109
Table 4-7: Summary of advanced CPTs with respect to the compaction points in 2000kNm DC area. ..	111
Table 4-8 : Summary of CPT advanced with respect to the compaction points	115
Table A- 1: Influence depth assessed from CPT results in 4000kNm energy applied area.	X
Table A- 2: Influence depth assessed from CPT results in 2000kNm energy applied area.	XI

LIST OF ABBREVIATIONS

Abbreviation	Description
TSHD	Trailer Suction Hopper Dredger
(D)DC	(Deep) Dynamic Compaction
VC	Vibro Compaction
CPT	Cone Penetration Test
SPT	Standard Penetration Test
SBT	Soil Behaviour Type
MDD	Maximum Dry Density
CC	Calibration Chamber
NC	Normal Consolidation
CRR	Cyclic Resistant Ratio
CSR	Cyclic Stress Ratio
PPV	Peak Particle Velocity
PGA	Peak Ground Acceleration