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

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

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DECLARATION

I hereby declare that, this is my own work and this thesis does not incorporate without acknowledgement of any material previously submitted for a Degree or Diploma in any other university or Institute of higher learning to the best of my knowledge and belief. It does not contain any material previously published or written by another person except where the acknowledgement is made in text.

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The above candidate has carried out research for the Master's thesis under my supervision

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Dr. L.I.N. De Silva   Date

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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 m^3 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

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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