

Abstract

INVESTIGATIONS OF SUCTION CAISSONS IN DENSE SAND

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Byron Walter Byrne
Magdalen College, Oxford
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Offshore structures are used in a variety of applications ranging from the traditional oil and gas extraction facilities to emerging renewable energy concepts. These structures must be secured to the seabed in an efficient and cost effective manner. A novel approach is to use shallow inverted buckets as foundations, installed by suction, in place of the more usual piles. These foundations lead to cost savings through reduction in materials and in time required for installation. It is necessary to determine how these foundations perform under typical offshore loading conditions so that design calculations may be developed. This thesis presents experimental data from a comprehensive series of investigations aimed at determining the important mechanisms to consider in the design of these shallow foundations for dense sand.

Initially the long term loading behaviour (e.g. wind and current) was investigated by conducting three degree of freedom loading $\{V:M/2R:H\}$ tests on a foundation embedded in dry sand. The results were interpreted through existing work-hardening plasticity theories. The analysis of the data has suggested a number of improved modelling features. Cyclic and transient tests, representing wave loading, were carried out on a foundation embedded in an oil saturated sand. The novel feature of the cyclic loading was that a 'pseudo-random' load history (based on the 'NewWave' theory) was used to represent realistic loading paths. Of particular interest was the tensile load capacity of the foundation. The results observed suggested that for tensile loading serviceability requirements rather than capacity may govern design. Under combined-load cyclic conditions the results indicated that conventional plasticity theory would not provide a sufficient description of response. A new theory, termed 'continuous hyperplasticity' was used, reproducing the results with impressive accuracy. Surprisingly, under the conditions investigated, loading rate was found to have a negligible effect on response.

Table of Contents

ABSTRACT

ACKNOWLEDGEMENTS

NOTATION

CHAPTER ONE - FOUNDATIONS FOR OFFSHORE STRUCTURES

1.1	Introduction.....	1.1
1.2	Offshore Structures	1.1
1.2.1	Deep Foundations	1.2
1.2.2	Shallow Foundations	1.3
1.2.3	Definitions of Foundation Loading.....	1.4
1.2.4	Current Understanding of Shallow Foundation Response to General Loading.....	1.5
1.3	Suction Caissons	1.11
1.3.1	Field Trials	1.12
1.3.2	Project Usage	1.13
1.3.3	Perceived Problematic Areas	1.15
1.3.4	Capacity	1.16
1.3.5	Summary of Calculations For Performance in Sand.....	1.18
1.3.6	Recent and Current Research Effort WorldWide	1.22
1.4	Outline of Current Work	1.23
1.4.1	History of Shallow Foundation Research at Oxford.....	1.23
1.4.2	Description of Current Research and Thesis Outline	1.24
1.5	Potential Applications	1.25
1.5.1	Renewable Energies Structures.....	1.25

CHAPTER TWO - DESCRIPTION OF EXPERIMENTAL TECHNIQUES

2.1	Background	2.1
2.2	Mechanical and Electronic Apparatus	2.2
2.2.1	Loading Rig.....	2.3
2.2.2	Data Acquisition System.....	2.3
2.2.3	The Transducer System and Typical Calibration	2.4
2.2.4	Control of Rig.....	2.7
2.2.5	Sample Containment, Loading Rig Attachment and Plumbing.....	2.9
2.3	The Foundations	2.9
2.4	The Sand Specimens	2.10
2.4.1	Carbonate Sand	2.10
2.4.2	Dry Dense Sand	2.12
2.4.3	Saturated Dense Sand	2.12
2.5	Typical Dry Sand Testing Procedures	2.18
2.6	Typical Saturated Sand Testing Procedures	2.20
2.6.1	From Wave Mechanics to Soil Mechanics	2.20
2.6.2	State of the Art Modelling of Extreme Events.....	2.21
2.6.3	Novel Geotechnical Storm Loading	2.22

CHAPTER THREE – FOOTING BEHAVIOUR ON DRY SANDS

3.1	Summary.....	3.1
3.2	Foundation Behaviour on Very Dense Sand.....	3.1
3.2.1	Vertical Loading Behaviour and Interpretation of Hardening Law.....	3.1
3.2.2	Swipe Testing of Flat Footings	3.3
3.2.3	Swipe Testing of Skirted Footings.....	3.11
3.2.4	Behavioural Changes due To Skirt Depth.....	3.14
3.2.5	Elastic Behaviour	3.15
3.3	Foundation Behaviour on Loose Uncemented Carbonate Sand.....	3.17

3.3.1	Vertical loading.....	3.17
3.3.2	Swipe testing.....	3.17
3.3.3	Hardening and Flow.....	3.19
3.4	The Current State of the Plasticity Model.....	3.21
3.5	Implications for Offshore Design.....	3.24
3.5.1	Effects of Scale.....	3.24
3.5.2	Positive Quadrant Negligibly Affected by Change in Skirt Depth.....	3.25
3.5.3	The Concept of Safety Factors.....	3.25
3.5.4	Development of Numerical Models for Use within Structural Analyses Packages.....	3.25
3.6	Concluding Remarks.....	3.26

CHAPTER FOUR – CYCLIC AND MONOTONIC VERTICAL LOADING

4.1	Introduction.....	4.1
4.2	Experimental Results.....	4.2
4.2.1	Introduction to Typical Cyclic Loading Results.....	4.3
4.2.2	A framework for analysing results.....	4.4
4.2.3	The Effect of Loading History.....	4.7
4.2.4	Scaling and further remarks on loading rate.....	4.9
4.2.5	An Empirical Framework for Prediction of Response.....	4.10
4.2.6	Partially Drained Loading Rates - Monotonic Pull Tests.....	4.12
4.2.7	Comparison of Pull tests and Cyclic Loading Results.....	4.16
4.2.8	Comparison with results from El-Gharbawy (1998).....	4.17
4.3	Concluding Comments.....	4.17

CHAPTER FIVE – CYCLIC AND MONOTONIC COMBINED LOADING

5.1	Introduction.....	5.1
5.1.1	Drained Monotonic Moment Behaviour at Low Vertical Loads.....	5.1
5.1.2	Field Scale Testing.....	5.3
5.2	Cyclic Experimental Results.....	5.3
5.2.1	Cyclic Loading.....	5.4
5.2.2	A Manageable Representation of the Data.....	5.4
5.2.3	Response to Initial Cyclic Loading.....	5.5
5.2.4	Cyclic Loading at Different Constant Vertical Loads.....	5.6
5.2.5	Comparison of Monotonic tests and Cyclic Loading Results (Masing Behaviour).....	5.6
5.2.6	Normalisation of Experimental Data.....	5.8
5.2.7	Theoretical Framework for Modelling of Cyclic Loading.....	5.9
5.2.8	Basic 'Continuous Hyperplasticity' following Puzrin and Houlsby (1999).....	5.11
5.2.9	An Extended 'Hyperplasticity' Model for Footings on Sand.....	5.16
5.3	Concluding Comments.....	5.18

CHAPTER SIX - CONCLUDING REMARKS

6.1	Introduction.....	6.1
6.2	Technological Developments.....	6.1
6.3	Original Contributions.....	6.3
6.4	Future Directions.....	6.5
6.4.1	Further research on circular footings on granular materials.....	6.5
6.4.2	Theoretical Modelling of Cyclic Loading.....	6.6
6.4.3	Physical and Numerical Modelling of Offshore Structures.....	6.6
6.5	Conclusion.....	6.7

REFERENCES

TABLES

FIGURES

APPENDIX A - COLLECTION OF REFERENCES RELEVANT TO SUCTION CAISSONS

APPENDIX B - DETERMINATION OF $\{dw, du, 2Rdq\}$ FROM THE SMALL LVDTs