

**SOIL-STRUCTURE INTERACTION  
ANALYSIS OF THE STRIP AND  
CIRCULAR FOOTINGS ON SAND**

By  
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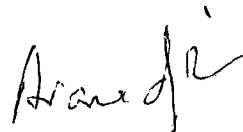
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CERTIFICATE

This is to certify that the thesis entitled 'SOIL-STRUCTURE INTERACTION ANALYSIS OF THE STRIP AND CIRCULAR FOOTINGS ON SAND', submitted by Mr. K.R. ARORA to the Indian Institute of Technology, Delhi, for the award of the degree of DOCTOR OF PHILOSOPHY is a record of the bonafide research work carried out by him. Mr. K.R. Arora has worked under my supervision for the submission of this thesis, which to my knowledge has reached the requisite standard.

The thesis, or any part thereof has not been submitted to any other University or Institution for the award of any Degree or Diploma.



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## ABSTRACT

The use of the conventional method of design of footings is unrealistic for it does not consider the interaction of the footing-soil system. The use of the Winkler model and the linear elastic continuum model in the interaction studies would give only approximate results, for these models do not adequately represent the soil behaviour. Analyses using non-linear stress-strain relationships of soils should give realistic results of the interaction behaviour of the footing-soil system. No systematic investigation has so far been reported on the interaction of the footings on sand, using non-linear stress-strain relationship.

A systematic study has been undertaken to investigate the interaction of the strip and circular footings embedded in sand and that of the circular footing resting on sand. Four different stiffnesses have been considered in each case. Uniformly distributed loading condition for the embedded footings and the central concentrated loading condition for the surface footing have been considered. Finite element method has been used incorporating non-linear stress-strain behaviour of soils. The soil parameters have been evaluated by conducting a number of drained, triaxial tests. A method of analysis has been developed in which soil parameters evaluated from

tests simulating in-situ state of stress conditions and various stress paths due to imposed loading are incorporated. Whereas the standard method of non-linear analysis using Young's modulus and Poisson's ratio or the bulk and shear moduli has been used in the case of embedded footings, for the surface footing the method incorporating the stress-path dependent parameters has been used. Experimental investigations have also been carried out to verify the results of the analysis of surface footings. Five different stiffnesses of the footing have been considered for experimental studies. The experimental set-up has been designed and constructed. Pressure cells have been designed, fabricated and used to measure the contact pressure as well as earth pressure.

From the results of investigations, it has been shown that in the case of embedded footings, the contact pressure distribution shows high pressure at edges as compared to that at the centre of footings. The normalised contact pressure distribution becomes same and uniform at high loads, irrespective of the stiffness of the footing-soil system. The load-settlement curve is almost linear at low loads and at higher loads it becomes non-linear in the case of strip footings. In the case of circular footings, it is non-linear even at low loads. The load-settlement curves are, marginally influenced by the stiffness of the system. However,

the contact pressure distribution, bending moments and differential settlements are shown to be very much a function of stiffness as well as the load level.

From the results of the analysis of the surface circular footings, it has been shown that the contact pressure is maximum at the centre, with zero edge pressure. At higher loads, the normalised contact pressure distribution tends to be same for all stiffnesses. The load-settlement curve is non-linear and is very much influenced by the stiffness of the footing-soil system. The effect of stiffness on differential settlements and contact pressure distribution is significant whereas that on the <sup>normalized</sup> bending moment is relatively small.

The effect of the stiffness of the system in all the cases extends to only shallow depths in the near vicinity of the footing.

Experimental studies on the surface circular footing have shown that the load-settlement curves predicted by the analysis agree very well with those obtained from experiments upto working loads. In general, the predicted normalised contact pressure distribution and the stresses in the soil compare very well with the experimental results.

From these studies it has been found that the method of analysis developed using stress-path dependent soil parameters is a powerful tool for the analysis of soil-structure interaction problems.

## TABLE OF CONTENTS

		<u>Page</u>
	TITLE ..	i
	CERTIFICATE ..	ii
	ACKNOWLEDGEMENTS ..	iii
	ABSTRACT ..	iv
	TABLE OF CONTENTS ..	vii
	LIST OF FIGURES ..	xviii
	LIST OF TABLES ..	xxv
	NOTATIONS ..	xxvi
<u>CHAPTER-1</u>	INTRODUCTION ..	1
1.1	General ..	1
1.2	Conventional Design of Footings ..	2
1.3	Analysis Using Linear Models ..	5
1.4	Analysis Using Non-linear Models ..	6
1.5	Experimental Investigations ..	7
1.6	Presentation ..	8
<u>CHAPTER-2</u>	LITERATURE REVIEW ..	11
2.1	General ..	11
2.2	Footings on Winkler's Foundation ..	12
2.2.1	Winkler's model ..	12
2.2.2	Strip footings ..	14
2.2.3	Circular footings ..	15

		<u>Page</u>
2.3	Footings on Linear Elastic Foundation Medium	.. 16
	2.3.1 Linear Elastic model	.. 16
	2.3.2 Strip footings	.. 18
	2.3.3 Circular footings	.. 20
2.4	Footings on Non-linear Elastic Foundation Medium	.. 27
	2.4.1 Non-linear elastic model	.. 27
	2.4.2 Footings on non-linear elastic model	.. 31
	2.4.2.1 Strip footings	.. 31
	2.4.2.2 Circular footings	.. 32
2.5	Footings on Elasto-plastic Foundation Medium	.. 34
	2.5.1 Elasto-plastic model	.. 34
	2.5.1 Footings on elasto-plastic models	.. 35
2.6	Experimental Studies	.. 37
	2.6.1 Strip footings	.. 37
	2.6.2 Circular footings	.. 39
2.7	Summary and Discussions	.. 42
	2.7.1 Soil models	.. 42
	2.7.2 Interaction studies of footings	.. 44
	2.7.2.1 Strip footings	.. 44
	2.7.2.2 Circular footings	.. 45
2.8	Scope of Study	.. 46

		<u>Page</u>
<u>CHAPTER-3</u>	INTERACTION STUDY OF EMBEDDED STRIP FOOTINGS	.. 47
3.1	General	.. 47
3.2	Footings	.. 48
3.3	Foundation Medium	.. 49
3.4	Evaluation of Soil Parameters	.. 49
3.5	Finite Element Method	.. 54
3.6	Non-linear Analysis	.. 57
3.7	Tangent Modulus	.. 60
3.8	Method of Analysis	.. 63
	3.8.1 Discretization	.. 63
	3.8.2 Analysis	.. 65
3.9	Preliminary Studies	.. 66
	3.9.1 Effect of number of Gauss points	.. 68
	3.9.2 Effect of computation of modulus at Gauss points	.. 69
	3.9.3 Effect of magnitude of load increment	.. 70
	3.9.4 Effect of number of iterations per increment	.. 70
	3.9.5 Effect of joints elements	.. 71
	3.9.6 Analysis using the bulk modulus and the distortion modulus	.. 71

		<u>Page</u>
3.10	Linear Analysis	.. 74
3.11	Results and Discussions	.. 74
	3.11.1 Variation of tangent modulus	.. 74
	3.11.2 Contact pressure	.. 76
	3.11.2.1 Contact pressure distribution	.. 76
	3.11.2.2 Variation of contact pressure at typical points	.. 79
	3.11.3 Effect of the stiffness of the system on the bending moment	.. 81
	3.11.4 Load-settlement curves	.. 83
	3.11.5 Differential settlements	.. 85
	3.11.6 Displacements in the foundation medium	.. 87
	3.11.6.1 Vertical displacements..	87
	3.11.6.2 Horizontal displace- ments	.. 89
	3.11.7 Variation of vertical stresses with depth	.. 92
	3.11.8 Stresses in the foundation medium	.. 96
	3.11.8.1 Vertical stresses	.. 96
	3.11.8.2 Horizontal and shear stresses	.. 96
	3.11.9 Strength mobilisation factors	.. 96
	3.11.10 Stress paths	.. 103

		<u>Page</u>
	3.11.10.1 Elements along horizontal plane ..	103
	3.11.10.2 Elements along vertical plane ..	106
3.12	Conclusions ..	106
<u>CHAPTER-4</u>	<u>INTERACTION STUDY OF EMBEDDED CIRCULAR FOOTINGS</u> ..	<u>110</u>
4.1	General ..	110
4.2	Footings ..	111
4.3	Foundation Medium and Soil Parameters ..	112
4.4	Method of Analysis ..	112
	4.4.1 Discretization ..	112
	4.4.2 Non-linear analysis ..	112
	4.4.2.1 Analysis using E and $\mu$ ..	112
	4.4.2.2 Analysis using the bulk modulus and the deformation modulus ..	113
	4.4.2.3 Comparative study of non-linear analyses using E, $\mu$ and $M_b, M_d$ ..	114
	4.4.2.4 Magnitude of increment, number of iterations, etc. used in analysis ..	116
4.5	Linear Analysis ..	116

		<u>Page</u>
4.6	Results and Discussions	.. 117
4.6.1	Variation of tangent modulus	.. 117
4.6.2	Contact pressure	.. 117
	4.6.2.1 Contact pressure distribution	.. 117
	4.6.2.2 Variation of contact pressure at typical points	.. 121
4.6.3	Effect of the stiffness of the system on the bending moment	.. 121
4.6.4	Load-settlement curves	.. 124
4.6.5	Differential settlements	.. 127
4.6.6	Displacements in soil medium	.. 127
	4.6.6.1 Vertical displacements..	127
4.6.7	Horizontal displacements in Soil Medium	.. 130
4.6.8	Variation of vertical stresses with depth	.. 135
4.6.9	Stresses in foundation medium	.. 137
	4.6.9.1 Vertical stresses	.. 137
	4.6.9.2 Horizontal and shear stresses	.. 137
4.6.10	Strength mobilisation factors	.. 142
4.6.11	Stress-paths	.. 145

		<u>Page</u>
	4.6.11.1 Elements on horizontal plane ..	145
	4.6.11.2 Elements on vertical plane ..	148
4.7	Conclusions ..	148
CHAPTER-5	ANALYSIS USING STRESS-PATH DEPENDENT SOIL PARAMETERS ..	151
5.1	General ..	151
5.2	Limitations of Existing Methods of Non-linear Analysis ..	152
	5.2.1 Incremental method using E and $\mu$ ..	152
	5.2.2 Method using $M_d$ and $M_b$ ..	155
	5.2.3 Method using stress-path dependent parameters obtained from isotropically consolidated samples ..	155
5.3	Basis of the Proposed Method ..	156
5.4	Proposed Method of Analysis ..	159
5.5	Stress-Path Dependent Tangent Moduli ..	161
	5.5.1 Regions ..	161
	5.5.2 Different zones in Region 1 ..	163
	5.5.2.1 Zone 1 ..	164
	5.5.2.2 Zone 2 ..	166
	5.5.2.3 Zone 3 ..	167
	5.5.2.4 Zone 4 ..	168
	5.5.2.5 Zone 5 ..	168

		<u>Page</u>
5.5.3	Different zones in Region 2 ..	170
	5.5.3.1 Zone ..	171
	5.5.3.2 Zone 2 ..	171
	5.5.3.3 Zone 3 ..	173
	5.5.3.4 Zone 4 ..	173
	5.5.3.5 Zone 5 ..	175
5.5.4	Different zones in Region 3 ..	175
	5.5.4.1 Zone 1 ..	176
	5.5.4.2 Zone 2 ..	176
	5.5.4.3 Zone 3 ..	180
	5.5.4.4 Zone 4 ..	180
	5.5.4.5 Zone 5 ..	180
5.6	Determination of Parameters K,n and $R_f$ ..	181
	5.6.1 Different stress paths ..	181
	5.6.2 Determination of modulus values from stress-strain curves ..	184
	5.6.3 Evaluation of parameters K,n ..	186
	5.6.4 Stress-path angle - K and n relationships ..	188
	5.6.5 Evaluation of $R_f$ , $\mu$ and $\phi$ ..	190
5.7	Method of Analysis ..	190

		<u>Path</u>
<u>CHAPTER-6</u>	INTERACTION STUDY OF SURFACE CIRCULAR FOOTINGS	.. 194
6.1	General	.. 194
6.2	Footings	.. 195
6.3	Foundation Medium	.. 196
6.4	Discretization	.. 198
6.5	Method of Analysis	.. 200
6.6	Results and Discussions	.. 202
	6.6.1 Variation of tangent modulus	.. 202
	6.6.2 Contact pressure	.. 202
	6.6.2.1 Contact pressure distribution	.. 202
	6.6.2.2 Variation of contact pressure at typical points	.. 204
	6.6.3 Effect of stiffness of the system on moments	.. 206
	6.6.4 Load-settlement curves	.. 208
	6.6.5 Differential settlements	.. 210
	6.6.6 Displacements in foundation medium	.. 213
	6.6.6.1 Vertical displacements	.. 213
	6.6.6.2 Horizontal displacements	.. 213
	6.6.7 Variation of vertical stresses with depth	.. 216

		<u>Page</u>
6.6.8	Stresses in foundation medium ..	216
6.6.8.1	Vertical stresses ..	216
6.6.8.2	Horizontal and shear stresses ..	219
6.6.9	Development of failure zones ..	219
6.6.10	Stress-paths ..	222
6.7	Conclusions ..	222
<u>CHAPTER-7</u>	<u>EXPERIMENTAL INVESTIGATIONS FOR INTERACTION STUDY OF SURFACE CIRCULAR FOOTINGS</u> ..	<u>228</u>
7.1	General ..	228
7.2	Footing-Sand Bed Systems ..	229
7.3	Foundation Tank ..	229
7.4	Pressure Cells ..	230
7.4.1	General ..	230
7.4.2	Design considerations ..	231
7.4.3	Design of pressure cells ..	233
7.4.4	Calibration of pressure cells ..	235
7.5	Footings ..	237
7.6	Preparation of Sand Bed ..	240
7.6.1	Uniform placement of sand ..	240
7.6.2	Method used in test ..	242
7.7	Embedment of Earth Pressure Cells ..	244

		<u>Page</u>
7.8	Experimental Set-up	.. 247
	7.8.1 Loading arrangement	.. 247
	7.8.2 Dial gauge arrangement	.. 247
	7.8.3 Arrangement for measurement of contact pressure	.. 247
	7.8.4 Arrangement for measurement of Earth pressure	.. 248
7.9	Experimental Procedure	.. 248
7.10	Results and Discussions	.. 250
	7.10.1 Load-settlement curves	.. 250
	7.10.2 Contact pressure distribution	.. 256
	7.10.3 Vertical stress distribution along the centre line	.. 258
7.11	Further Parametric Study Using Stress-path Dependent Parameters	.. 260
7.12	Conclusions	.. 261
<u>CHAPTER-8</u>	<u>CONCLUSIONS, SUMMARY AND SUGGESTIONS FOR FURTHER RESEARCH</u>	.. 262
8.1	General	.. 262
8.2	Embedded Strip and Circular Footings	.. 263
8.3	Surface Circular Footings	.. 265
	8.3.1 Analytical studies	.. 265
	8.3.2 Experimental studies	.. 267
8.4	Concluding Remarks	.. 267
8.5	Suggestions for Further Research	.. 269
APPENDIX A	Stiffness matrix of strip footing	.. 271
APPENDIX B	Stiffness matrix of circular footing	.. 274
REFERENCES	.. ..	.. 275
BIOGRAPHICAL SKETCH	.. ..	.. 286