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**LOCAL SCOUR AT
BRIDGE SITES**

Thesis submitted for the degree of Doctor of Philosophy

at the

**SCHOOL OF ENGINEERING
UNIVERSITY OF AUCKLAND**

by

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ABSTRACT.

The problem of local scouring at a circular cylinder in sandy material under threshold conditions was investigated experimentally. The aim of the study was to obtain a better understanding of the mechanism causing scour. Three fixed-bed scour models were constructed: the initial flat-bed model, an intermediate scour model and the final equilibrium scour hole model.

The experimental results have shown that although scour is initiated by the high local shear stresses which result from flow acceleration about the cylinder, the subsequent development of the scour hole is due to the establishment of a strong downflow ahead of the cylinder. The scour hole grows in the form of a frustrum of an inverted cone at a slope angle equal to the dynamic angle of repose of the bed material. Erosion occurs in the bottom part of the scour hole. Bed particles from the upper part of the hole slide down into the erosion area as the slope angle is increased by erosion of material from below. The equilibrium depth of scour is attained when the downflow becomes incapable of further erosion. For a particular bed material the downflow should be primarily a function of the mean approach flow velocity and cylinder diameter. Hence the study has shown that the equilibrium depth of scour should also be a function of these two parameters.

Additional measurements have shown that the horseshoe vortex, which is initially small, roughly circular in cross-section, and comparatively weak, increases dramatically in size and strength as the scour hole forms. During the development of the scour hole, the horseshoe vortex expands and moves down into the hole, increasing its circulation throughout the scour process, but at a diminishing rate. The shape of the vortex follows that of the scour hole-cylinder combination.

Measurements in the wake have added to existing information concerning the shedding and convection of wake vortices in shear flow. The results obtained are consistent with the occurrence of span-wise cells of constant shedding frequency, separated at the discontinuities by longitudinal vortices. The vortices accelerate away from the cylinder at speeds initially less than the free stream but becoming constant and approximately equal to the free stream velocity at about 8 cylinder diameters downstream.

Based upon a survey of existing material, a design recommendation for the estimation of local scour depths at bridge piers is also presented.

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CONTENTS.

		Page
CHAPTER 1	INTRODUCTION	1
1.1	Introductory Remarks	1
1.2	Scope of the Investigation	1
CHAPTER 2	LITERATURE REVIEW	3
2.1	The Design Problem	4
2.1.1	Introduction	4
2.1.2	Methods of Scour Estimation	6
2.1.3	The Effect of Flow Depth	27
2.1.4	Comparison of Scour Equations	28
2.1.5	Case Histories of Scour at Bridge Sites	33
2.1.6	Field Data Needs	51
2.1.7	Methods of Reducing Scour	53
2.2	Analytical Attempts to Determine Scour Depth	55
2.2.1	Shen et alia	55
2.2.2	Carstens	56
2.2.3	Bonasoundas	57
2.2.4	Tarapore	58
2.2.5	Folguera et alia	59
2.3	Measurements near the Bed	60
2.3.1	Introduction	60
2.3.2	Threshold of Motion	60
2.3.3	Analysis of Forces	62
2.3.4	Statistical Character of Instantaneous Hydrodynamic Forces	64
2.3.5	Measurement of Boundary Shear Stress	65
2.4	Flow Near the Base of a Pier	67
2.4.1	The Horseshoe Vortex	67
2.4.2	Vertical Flow in front of the Pier	67
2.4.3	Analysis of the Flow about a Circular Cylinder Mounted on a Flat Plate	69
2.4.4	Experimental Data pertaining to the Flow at the Base of a Cylinder	71
2.4.5	Flow immediately behind the Cylinder	73
2.5	Flow in the Wake of a Cylinder in Shear Flow	73
2.5.1	Vortex Shedding Frequency	73
2.5.2	Vortex Shedding Frequency from a Bluff Body in Shear Flow	74
2.5.3	Effect of Scour Hole Formation on the Shedding Process	78

	page	
2.5.4	Three-dimensionality in the Wake of Bluff Bodies	78
2.5.5	Additional Wake Measurements	78
2.6	Anemometry	81
2.6.1		81
2.6.2	Errors in Operation	81
2.6.3	Probe Contamination	82
2.6.4	Methods of Overcoming Probe Contamination	82
2.7	Hydrogen-Bubble Method	83
2.7.1	Introduction	83
2.7.2	Basis of Technique	84
2.7.3	Quantitative Measurements	84
2.7.4	Advantages and Disadvantages of the Hydrogen-Bubble Technique	85
CHAPTER 3	PRELIMINARY INVESTIGATION	86
3.1	Choice of Bed Material and Flow	87
3.1.1	The Laboratory Equipment	87
3.1.2	Bed Material	87
3.1.3	Flow	88
3.2	Establishment of Scour Holes	89
3.2.1		89
3.2.2	The Establishment of Fixed-Bed Models	89
3.2.3	Observations during the Scour Process	90
3.2.4	Geometry of the Scour Holes	93
3.3	Preliminary Experimental Data	95
3.3.1	Scour Depth versus Time	95
3.3.2	Approach Flow Velocity	97
3.3.3	Flow Depths	101
3.3.4	Distribution of Particle Sizes in the Scour Hole	101
3.4	Measurement of Turbulence Spectra	103
3.4.1	Anemometry	103
3.4.2	Magnetic Tape Recording	104
3.4.3	Bandpass Filters	104
3.4.4	Analytical Justification of the Method Used for the Calculation of Spectral Density Functions	106
3.4.5	PDP12 Digital Computer	109
3.4.6	Digital Analysis	109
3.4.7	Variation of RMS Velocity with Time	112
3.4.8	Spectra of Turbulence for the Approach Flow	114
3.5	The Hydrogen-Bubble Generator	114
3.5.1	Design of a High-Voltage Pulse Generator	114
3.5.2	Light Source	117
3.5.3	Photographs of the Approach Flow	119
CHAPTER 4	MEASUREMENTS AT THE BED	120
4.1	Mean Velocity Magnitudes and Directions at the bed	121
4.1.1	Experimental Technique	121
4.1.2	Presentation and Discussion of Experimental Results	121
4.2	Turbulence Measurements at the Bed	125
4.2.1	Experimental Technique	125
4.2.2	Experimental Results and Discussion	128
4.3	Shear Stress Measurements at the Bed	136
4.3.1	Experimental Technique	136
4.3.2	Experimental Results and Discussion	139

	page
4.4 Summary of Experimental Results	143
CHAPTER 5 THE HORSESHOE VORTEX	144
5.1 Mean Velocity Measurements	145
5.1.1 Experimental Technique	145
5.1.2 Experimental Results	146
5.2 Flow Visualisation	161
5.2.1 Experimental Technique	161
5.2.2 Visualisation Results	161
CHAPTER 6 WAKE MEASUREMENTS	164
6.1 Mean Velocity Measurements	165
6.1.1 Experimental Technique	165
6.1.2 Experimental Results	165
6.2 Turbulence Measurements	166
6.2.1 Experimental Technique	166
6.2.2 Experimental Results	169
6.3 Temporal Cross-Correlation Measurements	170
6.3.1 Experimental Technique	170
6.3.2 Experimental Results	171
6.4 Spatial Cross-Correlation Measurements	187
6.4.1 Experimental Technique	187
6.4.2 Experimental Results	187
6.5 General Discussion of Results	190
CHAPTER 7 GENERAL DISCUSSION AND CONCLUSIONS	191
7.1 Design Recommendations	191
7.2 Experimental Conclusions	192
7.2.1 Initialization of Scouring	192
7.2.2 The formation of the Scour Hole	192
7.2.3 The Development of the Scour Hole	193
7.2.4 The Horseshoe Vortex	194
7.2.5 The Flow in the Wake	194
7.2.6 The Region of Horseshoe Vortex - Wake Vortex Interaction	195
BIBLIOGRAPHY	196
APPENDIX	208
TABLE A1	209
TABLE A2	218