

CONTENTS:

ABSTRACT	6
INTRODUCTION.....	8
1. SEDIMENT TRANSPORT IN OPEN CHANNEL	
1.1. Bed formation.....	10
1.2 Sediment properties.....	12
1.2.1 Particle size distribution.....	12
1.2.2 Angle of Repose.....	13
1.3 Forces acting on a Sediment particle.....	14
1.4 Sediment transport mechanisms.....	15
1.4.1 Bed-Load Transport.....	15
1.4.1.1 Threshold of sediment bed motion.....	17
1.4.1.2 Bed-load transport rate.....	19
1.4.2 Suspended-load transport.....	19
1.4.2.1 Inception of suspended load motion.....	20
1.4.2.2 Suspended sediment transport rates.....	21
1.5 Scour.....	21
1.6 Local Scour.....	22
1.6.1 Flow Field.....	23
1.6.2 Clear-water and Live-Bed scour.....	26
1.6.3 Estimation of Local scour depth.....	27
1.6.4 Obstacle size and flow depth.....	28

1.6.5 Pier and Abutment Alignment and Shape.....	29
1.6.6 Sediment Size.....	31
1.6.7 Sediment Gradation.....	32
1.6.8 Flow Intensity.....	33
1.6.9 Approach Channel Geometry.....	34
1.7 Local Scour Countermeasures.....	34
1.7.1 Armoring Countermeasures.....	34
1.7.1.1 Riprap.....	35
1.7.2 Flow-altering countermeasures.....	36
1.7.2.1 Spur Dikes.....	36
1.7.2.2 Bendway weirs.....	37
1.7.2.3 Submerged Vanes.....	38
1.7.2.4 Guide Banks.....	38
1.7.2.5 Rectangular Slot.....	38
1.7.2.6 A Collar around a pier.....	39
1.7.2.6 .1 One pier with a collar.....	41
1.7.2.6 .2 Two piers in line with continuous collars.....	42
1.7.2.6 .3. Two piers in line with continuous collars and riprap.....	42
1.7.2.7 Splitter Plate and Threaded Pile.....	42
1.7.2.8 Sacrificial Piles.....	44

2. EXPERIMENTAL SET UP AND PRELIMINARY TESTS

2.1. Sketch of experimental facility.....	47
2.2. Set up the channel and sediments.....	48
2.2.1. Channel lay out and parameters.....	48

2.2.2. Sediments.....	51
2.3. Calibration of the channel.....	53
2.3.1. Measurement of channel bed elevation.....	53
2.3.2. Calibration of the piezometers.....	55
2.4. Preliminary Tests.....	56
2.4.1. Velocity measurements	55
2.4.1.1. Measuring tools.....	57
2.4.1.2. Test procedure.....	58
2.4.2. Profiles of free surface.....	63
2.4.3. Q-Qc Test.....	65
2.4.3.1. Test procedures.....	66
2.4.2.3.2. Profiles of free surface.....	68
2.3.2.3. Results.....	69
2.5 Abutments used in scour tests.....	71
2.6. Trial Scour Test.....	73
2.6.1.tools.....	73
2.6.2 Scour Test procedure.....	78

3. Scour Countermeasures Analysis

3.1. Unprotected Abutments.....	80
3.1.2. Scour Depth with time.....	80
3.2. Effect of protection.....	84
3.2.1. Description of the Abutments.....	84
3.2.2. Scour Depth with time.....	84

3.2.2.1 Scour Depth with time for Series A.....	83
3.2.2.2 Scour Depth with time for Series B.....	89
3.4. Scour depth with respect to the space between elements	
3.4.1. Scour Depth vs. Space at Nose (N).....	96
3.4.2. Scour Depth vs. Space at Wall (W).....	97
3.4.3. Scour Depth vs. Space at Downstream Corner of Abutment(D)..	99
3.5. Percentage of reduction found.....	101
CONCLUSIONS.....	106
REFERENCES.....	108
ANNEX1.....	110
ANNEX2.....	114