

**STUDY OF SCOURING USING DIFFERENT
CONFIGURATION OF L-SHAPED GROYNES IN
OPEN CHANNELS**

A DISSERTATION

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE
OF

MASTER OF TECHNOLOGY
IN
HYDRAULICS AND WATER RESOURCES ENGINEERING

Submitted by:

DEVESH TYAGI
2K16/HFE/07

Under the supervision of

Dr. T.VIJAYA KUMAR



DEPARTMENT OF CIVIL ENGINEERING

DELHI TECHNOLOGICAL UNIVERSITY

(Formerly Delhi College of Engineering)

Bawana Road , Delhi-110042

MAY, 2018

DELHI TECHNOLOGICAL UNIVERSITY
(Formerly Delhi College of Engineering)
Bawana Road, Delhi-110042

CANDIDATE’S DECLARATION

I Devesh Tyagi, Roll no.2K16/HFE/07, student of M.Tech (Hydraulics and Water Resources Engineering) hereby declare that the project dissertation titled “Study of Scouring Using Different Configuration of L-shaped Groynes in Open Channels” which is submitted by me to the Department of Civil Engineering, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technology, is original and not copied from any source without proper citation. This work has not previously formed the basis for the award of any Degree, Diploma Associateship, Fellowship or other similar title or recognition.

Place : Delhi

Devesh Tyagi

Date :

DEPARTMENT OF CIVIL ENGINEERING

DELHI TECHNOLOGICAL UNIVERSITY

(Formerly Delhi College of Engineering)

Bawana Road, Delhi-110042

CERTIFICATE

I hereby certify that the Project Dissertation titled “Study of Scouring Using Different Configuration of L-shaped Groynes in Open Channels” which is submitted by Devesh Tyagi, Roll no.2K16/HFE/07, Department of Civil Engineering, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technology, is a record of the project work carried out by the student under my supervision. To the best of my knowledge this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere.

Place : Delhi

Date :

Dr. T.Vijaya Kumar

SUPERVISOR

Associate Professor

Department of Civil Engineering

Delhi Technological University

Delhi-110042

ABSTRACT

Groynes are the hydraulic structures extended laterally from banks of the river channel in to the main flow. The principal uses of groynes are as river training structures to centralize the main channel and providing protection from erosion to stabilize the river bank. They deflect or attract the flow away from the bank or toward the bank depending upon the concerned direction of their installation. Based on the shape of spur dikes in plan, different kinds of spur dikes can be recognized for eg. “straight”, “T-shaped” and “L-shaped”. So far a good number of works have been devoted to the study of “straight” spur dikes mainly aimed at investigating sediment erosion around them. There is however an absence of sufficient published works about the study of sediment transport around the “T-shaped” and “L-shaped” groynes specially when they are provided in a series. This study was aimed at better understanding of the applicability of the L-shaped groynes in providing protection from local scour in the channel and to distinguish the pattern of sediment uplift and deposition due to variation in flange portion of the groynes.

A physical model of a river channel was constructed in the Hydraulics Laboratory of Delhi Technological University. The model consisted of a sand bed laid out in a hydraulic flume and a series of groyne models made up of wood, placed to determine the trend in scour pattern around them. Three different forms of L-shaped groynes were used in the study with the basic difference in the projection of flange portion only. Spacing and projection length of groynes were taken as per Indian Standard-8408:1999 as they play an important role in the uplift of sediment particles in groyne field.

A digital velocity meter was used to measure the velocity during the test runs. Sand used for imitating the river was analyzed for its particle size distribution and a subcritical flow was maintained through out the test run. It was observed that keeping the flange centrally symmetric with the web protects both the upstream and downstream portion of the channel and only the region at the tip of groynes faces a threat of the scouring.

For the groynes with flange portion completely towards upstream direction, the upper reaches of the channel will face the erosive action of the flow and latter part of the channel will be quite stable against the scour. Lastly with the flange portion in downstream direction the scour will be higher towards the downstream direction and the upper reaches of the channel will remain protected. One more important point was observed that magnitude of scour was highest for the groynes in which the flange portion was towards the downstream direction and lowest for the upstream ones.

Conclusively it is stated that configuration of flange does affects the scour and creates obstruction for the flow which results in the increased scour along the direction of flange in the channel. It has been concluded that positioning of flange plays major role in scouring pattern. For protecting the upper reaches of channel, flanges should be provided towards downstream direction and vice versa.

By the use of the data of the present experimental work a basic outline has been formulated for providing the L-shaped groynes in open channel which is satisfactory as per the earlier works.

ACKNOWLEDGMENT

I take this opportunity to thank my parents for their never ending and unconditional love and support at every step of my life. I also express my thankful regards to Dr. T.Vijaya Kumar (Associate Professor, Department of Civil Engineering, DTU) for his continuous guidance and encouragement throughout the course of this project work. His thoughtful and constantly improving supervision will be very helpful for me in future.

I am also thankful to all the faculty members of Hydraulics and Water Resource Engineering Department in Civil Engineering Department, Delhi Technological University for their valuable and improving suggestions which helped in framing the scope and possible aspects of the project work.

I specially thank Ms. Ankur Tyagi for her continuous help and encouragement at every step and my friends Lokesh and Akshay for their support and positive criticism throughout this work.

DEVESH TYAGI

Roll No - 2K16/HFE/07

Hydraulics and Water Resources Engineering

Department of Civil Engineering

Delhi Technological University, Delhi

CONTENTS

Candidate's Declaration	ii
Certificate	iii
Abstract	iv
Acknowledgement	vi
Contents	vii
List of Tables	ix
List of Figures	x
Abbreviations and Symbols	xiii
CHAPTER 1: INTRODUCTION	1
1.1 General	1
1.2 River Training	2
1.2.1 Introduction	2
1.2.2 Types of River Training Works	3
1.3 Erosion and Scouring	5
1.4 Groynes	9
1.4.1 Types of Groynes	9
1.4.2 Effect of groynes on flow field	13
1.5 Design of Groynes	16
1.5.1 Length	16
1.5.2 Spacing	16
1.5.3 Height	17
1.5.4 Permeability	17
1.5.5 Orientation of Groynes	18
1.5.6 Crest level and Crest Shape	19
1.6 Maintenance Aspects of Groynes and Other River Training Works	19

CHAPTER 2 : LITERATURE REVIEW	21
2.1 Introduction	21
2.2 Past Studies	21
2.3 Objective of Present Study	36
CHAPTER 3: EXPERIMENTAL SETUP AND METHODOLOGY	37
3.1 Introduction	37
3.2 Materials and Methods	37
3.2.1 Hydraulic Flume	38
3.2.2 Sediment used as bed material	38
3.2.3 Sieve Analysis	40
3.2.3.1 Sand in its initial state	40
3.2.3.2 Sand retained in the channel after the flow	41
3.2.3.3 Sand eroded from the channel during the flow	42
3.2.4 Digital Velocity Meter	44
3.2.5 Groynes models used	46
3.2.6 Point Gauge and Measuring Scale	48
3.3 Experimental Setup	49
3.4 Flow Conditions	55
3.5 Methodology	58
CHAPTER 4: RESULTS AND DISCUSSION	59
4.1 Introduction	59
4.2 Experimental Observations	59
4.2.1 Velocity-Scour depth variation	60
4.2.1.1 Test Run 1: Flange portion in central position (TG)	61
4.2.1.2 Test Run 2: Flange portion towards upstream direction (LU)	65
4.2.1.3 Test Run 3: Flange portion towards downstream direction (LD)	70
4.2.2 Comparison of scour depth for different forms of groynes	74
CHAPTER 5 : CONCLUSION	76
CHAPTER 6 : REFERENCES	78

LIST OF TABLES

Table 3.1: Sieve Analysis of sand used as bed material in its natural state	40
Table 3.2: Sieve Analysis of the sediment retained in the channel after the flow	41
Table 3.3: Sieve Analysis of the sediment which got eroded during the flow	42
Table 4.1: Observation table for Test Run – 1 (TG - groynes)	62
Table 4.2: Observation table for Test Run – 2 (LU - groynes)	66
Table 4.3: Observation table for Test Run – 3 (LD - groynes)	71

LIST OF FIGURES

Figure 1.1: Meander loop in a river	3
Figure 1.2: Sketch showing features of meander loop formation	4
Figure 1.3: Illustrative sketch for erosion and scour	6
Figure 1.4: Different types of scour	7
Figure 1.5: Sketch showing the local scour	8
Figure 1.6: Classification of groynes on the basis of their functions	10
Figure 1.7: Classification of groynes on the basis of their inclination and head shapes	11
Figure 1.8: Concrete made straight groynes in a river bend on Gamka river	12
Figure 1.9: Schematic diagram showing flow lines in groyne field	14
Figure 1.10: Sketch showing the parameters that affects the functioning of groynes	19
Figure 3.1: Hydraulic Flume used in study	38
Figure 3.2: Particle size distribution of sediment used as bed material in its natural state	41
Figure 3.3: Particle size distribution of sediment retained in the channel after the flow	42
Figure 3.4: Particle size distribution of sediment eroded out from the channel during the flow	43
Figure 3.5: Digital Velocity Meter to measure the Flow Velocity	44
Figure 3.6: Rotating Propeller of Digital Velocity Meter	45
Figure 3.7: Digital display unit of Velocity Meter	46
Figure 3.8: Groyne model used in Test Run-1 (TG)	47
Figure 3.9: Groyne model used in Test Run-2 (LU)	47
Figure 3.10: Groyne model used in Test Run-3 (LD)	48
Figure 3.11: Point Gauge used in the study for measurements	49

Figure 3.12: Illustrative sketch of experimental setup for Test Run-1 (TG-groynes)	50
Figure 3.13: Image showing experimental setup before Test Run-1 (TG-groynes)	51
Figure 3.14: Illustrative sketch of experimental setup for Test Run-2 (LU-groynes)	51
Figure 3.15: Image showing experimental setup before Test Run-2 (LU-groynes)	52
Figure 3.16: Sketch showing experimental setup for Test Run-3 (LD-groynes)	52
Figure 3.17: Image showing experimental setup before Test Run-3 (LD-groynes)	53
Figure 3.18: Image showing projection of groynes in Test Run-2	54
Figure 3.19: Image showing projection of groynes in Test Run-3	54
Figure 3.20: Image showing the regime of channel bed	55
Figure 3.21: Initiation of uplift of sediment around the groynes	56
Figure 3.22: Image showing submergence of groynes during the flow	56
Figure 3.23: Image showing erosion of sediment in the groyne field	57
Figure 3.24: Image showing recirculation of flow in between two groynes in Test Run-3	57
Figure 4.1: Velocity measurements using Digital Velocity Meter flow probe	60
Figure 4.2: Image showing the channel bed after Test Run-1	61
Figure 4.3: Variation of Scour Depth with Velocity for TG groynes	62
Figure 4.4: Scour formation around TG-1	63
Figure 4.5: Scour formation around TG-2	63
Figure 4.6: Scour formation around TG-3	64
Figure 4.7: Scour formation around TG-4	64
Figure 4.8: Scour formation around TG-5	65
Figure 4.9: Image showing the channel bed after Test Run-2	66
Figure 4.10: Variation of Scour Depth with Velocity for LU groynes	67

Figure 4.11: Scour formation around LU-1	68
Figure 4.12: Scour formation around LU-2	68
Figure 4.13: Scour formation around LU-3	69
Figure 4.14: Scour formation around LU-4	69
Figure 4.15: Image showing the flow profile during Test Run-3	70
Figure 4.16: Variation of Scour Depth with Velocity for LD groynes	71
Figure 4.17: Scour formation around LD-1	72
Figure 4.18: Scour formation around LD-2 and LD-3	73
Figure 4.19: Scour formation around LD-4	73
Figure 4.20: Scour formation around LD-5	74
Figure 4.21: Comparison of scour depth for different groynes	74

ABBREVIATIONS AND SYMBOLS

TG - Groynes with Flange portion in center

LU - Groynes with flange portion towards upstream

LD - Groynes with flange portion towards downstream

Fr - Froude's number