ISSN: 2395 - 2180

Available online at http:// www.ijemmr.co.in

International Journal of Engineering, Management & Medical Research (IJEMMR)

VOL - 6, ISSUE - 8, AUGUST - 2020

Boundary Shear Stress Distribution in Smooth and Rough Open Channel Flow

[1] SANDIP PURUSHOTTAM PAULZAGAD , [2]NAMRATA CHOUBEY

1. SCHOLAR, DEPARTMENT OF ARGICULTURE ENGINEERING, SWAMI VIVEKANAND UNIVERSITY SGAR, MP
2. ASST. PROF. DEPARTMENT OF ARGICULTURE ENGINEERING, SWAMI VIVEKANAND UNIVERSITY SGAR, MP

ABSTRACT –

Boundary shear distribution in open channel flow is a crucial issue for river engineer and researchers working in this area. An experimental investigation has been carried out to measure the boundary shear stress distribution along the wetted perimeter of the smooth and rough channel using piston tube technique the accuracy of the method has been compared and checked with another convention method, NDM, VDM, MPM, Velocity Profile Method and energy gradient approach. The boundary shear along the bed and wall of the channel are different for different flow depth and for different roughness conditions. The percentage of boundary shear carried by the wall and bed has been analysed and found to depends on upon non-dimensional geometry and hydraulic parameters such as Aspect ratio, Reynolds number and Froude’s number. A multi linear regression model has been applied to predict the boundary shear distribution for bed. The equation is useful to calculate the roughness coefficient (friction factor) of the wall and bed of the channel separately, which further determines the composite roughness of the open channel flow accuracy. The methodology has been applied successfully to calculate the stage discharge relationship of the open channel flow. The methodology has been validated against other experimental data, other researcher’s models and NaturalRiver.

Key words: Boundary shear stress distribution; Piston tube Technique; Aspect Ratio; Reynolds Number; Froude’s number; Roughness Coefficient; Composite Roughness

1. Introduction

1.1 Overview

Survive without water is not possible if there is not the availability of plentiful of fresh water. As the river is regarded as the main source of waterfor flourishing the life of each living being so itis considered as important for day to day functioning of every ecosystem.The river attracts the strong attention and interest of engineersandscientists.

The river is the basic source of providing a water supply for irrigation, industrial consumption, domestic and transportation etc.Rivers are great significancein geographically, biologically, historically and socially.Despite the fact that it contains around 0.0001% of total amount of water in the planet at any time, rivers areessential transporters of water and supplements to region all around the earth. It is the critical component of the hydrology cycle, acting as a drainage channel of surface water; the world's rivers drain almost 75% of earth's land surface. They also provide method of transportation to endless organisms; they leave important stores of sediments, for example, sand and rock; they shape boundless floodplains where a number of our urban communities are developed; and their energy gives a significant part of the electrical vitality we use in our regular lives. Rivers are fundamental to large numbers of the natural issues that worry society and they are concentrated on by an extensive variety of specialists including hydrologists, engineering andenvironmentalists.

1.2 Open ChannelFlow

Open channel flow is the branch of hydraulic; it is a kind of fluid stream inside a course withhaving a free surface, commonly known as a channel.Open channel flow is driven by gravity force. The channels are made by man is known as artificial Channel. They comprise of irrigation canals, spillways, sewers, culverts, navigation canals, and drainage ditches. These are normallymade in a regular cross-section shape throughout and are thus prismatic channel. The channel which consists of both main channel and floodplains is generally called compound channel. They are of different cross-sectional geometry like rectangular, trapezoidal or nor uniform in configuration.

When there was a flow in the natural or main-made channel exceeds the depth of the main channel, the remainwater can be carry by floodplains of the river but the hydraulic conditions in the river and floodplains are different so that the mean velocity in the main channel and floodplains are different.

The importance of modelling the in bank flow (i.e. flow within the main channel) correctly, as the flow is always present in the main channel except in flood case when the flow goes to floodplains. Some of the flow mechanisms in the simple and compound channel are same, but in some cases flow characteristics can be avoided by strong mechanisms due to overtopping of flow from the main channel to floodplains. Flow in the simple rectangular channel is depended on the interface between wall and bed, secondary flow cells.

Examples of open channel flows are

- The common seepage of water through the waterwayframework.
- The flow of water in the sewer of ourhome.
- The flow of water in the waterways, seepage and drains along thestreets.
- The flow of water in the chutes of waterrides..

An open channel flow may be classified as natural or artificial:

Natural: When open channels have an irregular shape, surface alignment and alignment is known as a natural open channel. e.g. - streams, rivers, waterwaysetc.

Artificial: When open channels are having in regular shape, uniform roughness and alignment. Which are built for the specific purposes, such as irrigation, water power development, water supply etc. are called artificial open channel.

1.3 FlowMechanisms

Flow characters are classified by energy transfer mechanisms as they converted energy from one form to another through the development of vortex structures over various scales. vortices can be generated in open channel flow due to the effect of boundaryshear,vertical and horizontal shear interface, transverse currents and comprehensible structures, but it also depends on upon the cross-sectional geometry of the channel, flow depth and flow characteristics (i.e. laminar or turbulent)

1.4 Types ofFlow

1.4.1 Steady and Unsteady Flow

Flow in thechannel is said to be steady if the flow characteristics at any point do not change with time. However in thecase of prismatic channels the conditions of steady flow may be obtained if the only depth of flow does not change with time. On the other hand, if any flow characteristics change with time the flow is unsteady. Most of the openchannel problems involve the steady of flow under steady conditions. In our experimental investigation the flow is steady.

1.4.2 Uniform andNon- uniformFlows

Flow in a channel is said to beuniform if the depth, slope, cross-section and velocity remain constant over a given length of the channel. Obviously a uniform flow can occur only in theprismatic channel in which the flow will be uniform if only the depth of flow is same at every section of the channel. Flow in channels is termed as non-uniform if the depth of flow changes from section to section. In our experimental investigation the flow isuniform.

1.5 Laminar Flow and TurbulentFlow

1.5.1 Reynolds Number

The flow in channels is also characterised by as laminar, turbulent or in a transitional state, depending on the relative effect of viscous and inertia forces and Reynolds number (Re) is ameasure of this effect. However, the Reynolds no. flow in channels is commonly definedas

$$\frac{\quad}{\quad}$$

Where
is the mean velocity of flow
is the hydraulic radius of the channel crossection ν is the
dynamic viscosity of water.

On the basis of experimental data it has been found that up to Re equal to 500 to 600, the flow in channels may be considered to be laminar and for Re greater than 2000, the flow in the channel isturbulent.

1.5.2 FroudeNumber:

Gravity is a predominant force in the case of channel flow. As such, depending on the relative effect of gravity and inertia forces the channel flow may be designated assubcritical, critical or super critical. The ratio of the inertia and the gravity forces is another dimensionless parameter called Froude number (F_r) which is defined as

$$\sqrt{\quad}$$

Where:

is the mean velocity of flow, is the acceleration due to gravity, is the hydraulic depth of channel section which is equal to /, is the wetted area, is the top width of the channelsection at the freesurface.

When:

=1, critical flow

>1, supercritical flow

<1, subcritical flow

1.6 Geometric Properties Necessaryfor Analysis of Open ChannelFlow

For analysis various geometric properties of channel cross-section are required. The commonly needed geometric properties are shown below:

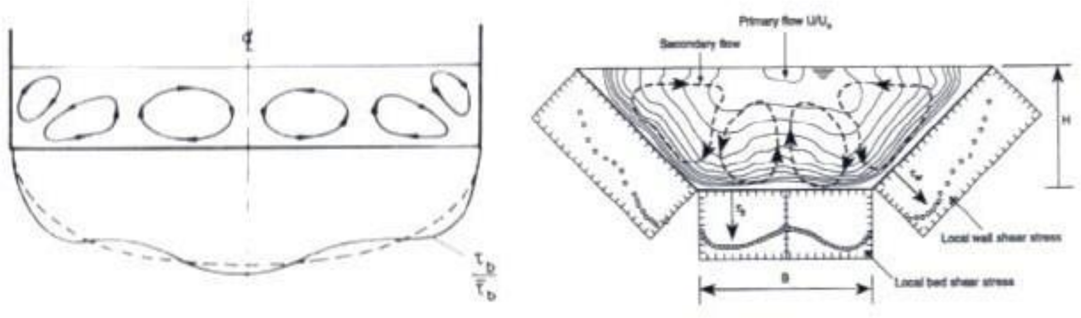
- Depth , Area ,Wettedperimeter
- Hydraulicradius --------------The ratio of area to wetted perimeter i.e./
- Hydraulic mean depth - Is the ratio of area to surface width of channel i.e./
- Aspect Ratio – The ratio of bottom width to depth of channel i.e./

1.7 Boundary Shear StressDistribution

Boundary shear stress is a critical parameter in an open channel flow in order to model the evolution of the shape of the natural river channels; it is necessaryto find out the distributions of boundary shear stress in the vicinity of the river bank. Boundary shear distribution depends on upon the secondary flow cells, the shape of thecross-section and non-uniform roughness distribution around the wetted perimeter of the channel. The importance of boundary shear stress distribution was demonstrated by the use which is made of the local or mean boundary shear stress in may hydraulic equations concerning resistance,sediment,dispersion or cavitation problem.

Boundary shear is a fundamental problem in hydraulics that gives the attention of many researchers. Different researchers carried out the experimental work in different condition are straight square ducts (Gessner 1964); rectangular ducts (Knight & Patel 1985; Rhodes & Knight 1994); rectangular open channels (Rajaratnam; Tominagaetal.1989) and rectangular compound open channels (Rajaratnam&Ahmaid 1981; TominagaandNezu 1991). Researcher's attempts (Almadi 1979; Knight 1981; Rhodes and Knight 1994) have been made to find out the mathematical expression for lateral boundary shear in rectangular channels.The mathematical expression gives the relation between average boundary shear stress on the wall and bed, not the local boundary shear stress.

Water flows in an open channel it is opposing by the resisting force from side slope and bed of the channel. This resisting force is known as the boundary shear stress. Boundary shear stress is the resultant component of the hydrodynamic forces that acting along the bed of the channel. Boundary shear force distribution along the wetted perimeter of the channel directly depends upon the flow criteria of the channel .Boundary shear stress can help to theanalysis of side wall correlation, sediment transport, dispersion, channel migration, computation of bed from resistance, cavitation and conveyance estimation etc. Shear force, for a uniform steady flow dependsuponthe hydraulic radius, bed slope, and unit weight of water. But the shear forces are not uniformly distributed also for the straight prismatic channel when we consider from a practical point of view, it depends on the geometry of channel, flow condition and roughness factors of the channel. Non-uniformity distribution of shear stress deepened mainly due to the secondary current formed by the anisotropy between vertical and transverse turbulent intensities, that given by Tominagaetal (1989); Knight and Demetriou (1983);andGessner(1973) determined that the when the secondary flow towards the wall boundary shear stress increases and when flows away from the wall shear stress decreases in the channel. The distribution of shear stress along the wetted perimeter of the channel can affect by the presence of secondary flow cell in them a in channel which is given in Fig.1.2.Other parameters that affect the shear stress distribution are theshape of the channel, flow depth, velocity criteria roughness profile of the channel and sediment concentration.



(a)Rectangular Cross-section(Knight et al., 1983) (b) Trapezoidal Cross-section (Knight et al., 1994)

Figure 1.2: Schematic influence of secondary flow cell on boundary shear distribution

1.8 Objectives of CurrentResearch:

The prime aim of this research is to understand the distributions of boundary shear stress in various types of bed i.e., smooth bed, rough small gravel bed in an open channel flow. The objectives of the present work are listedbelow:

- Experimental investigation on boundary shears distribution in an open channel flow.
- To investigate the boundary shear distribution between the bed and wall in smooth and rough open channel flow for different geometry and flowcondition.
- To apply different techniques to measure the boundary shear stress in open channel flow and compare their results with energy gradient approach. Discussion of Merit and Demerit of these approaches under different flowcondition
- To develop an improved mathematical model to predict the boundary shear distribution in bed andwall.
- Validation of purposed model with other data set and compression of the purposed model with the method of D.W. Knight(1984).
- To evaluate the composite roughness to find out the stage discharge of the channel flow by using the boundary shear distributionexpression
- To compare the results of the present work with other researchers model and to validate with data sets of otherresearchers.

1.9 Organization of Thesis:

This project paper is the sequence of 6 main chapters. The general introduction is given in chapter-1, the literature review is conferred in the chapter-2, the experimental setup and procedure are depicted in chapter-3, experimental results and discussions are discussed in chapter-4, Model development are described in chapter-5, Application of model for discharge assessment are describe in chapter 6and at last the conclusions and scope for future work are presented in chapter-7

Chapter-1gives a concise introduction about open channel flow with different types of flows. It comprises of the definition of open channel flow, types of flow, the overall idea about boundary shear stress distribution, and the objective of the current research.

The detailed literature reviews of numerous famous researchers and scientists which are relating to the present project are presented in chapter-2. The chapter highlights the research which is executed the smooth and rough channels relating boundary shear and their distribution.

In chapter-3, the total experimental setup and procedure are explained. This section explains the arrangements of experimental setup and procedure to achieve the observations in experimentalchannel.

In chapter-4, the experimental results about the stage-discharge relationship, Boundary shear distribution by piston tube technique and another convention method, comparison of results with all the method are given in this chapter.

In chapter-5, the behaviour of percentage shear in wall and bed for simple and compound channels, effects of Reynolds number and Froude number for the smooth and rough channel, multi linear regression analysis, and a proposed model for smooth and rough channel given in this chapter.

In chapter-6, how to find out the discharge from purposed model by using the composite roughness models and comparison of purposed model with another model is also given in this chapter

At last in chapter-7, the conclusion reached by present work and scope of future work is listed out.

2.Experimental Setup and Procedure

2.1 Overview

Experimental work on natural rivers was very difficult; so the flow characteristics of a river can be analysed by studying them on a model designed close to natural rivers. In present study boundary shear distribution, velocity of flow, variation of Manning's in different boundary conditions and discharge over different flow conditions in a simple channel are found out, the experiments was carried out in Fluid Mechanics and Hydraulics Laboratory of the Civil Engineering Department at the National Institute of Technology, Rourkela, Odisha, India by changing the roughness of the channel. For the better understand the flow condition in simple channels the experiments was conducted in the laboratory flume.

2.2 Design and Construction of the Channel

The large experimental flume was made up of MS bars, plates and angles with a gear arrangement over an inclined metallic ramp for providing an alongitudinal slope. To keep the flow in subcritical condition, the gear arrangement moves up and down.A large overhead tank made up RCC was constructed on the upstream side of the flume for feeding water into the channels. At the downstream end, a masonry volumetric tank was constructed for measurement of discharge. For providing a continuous water supply an underground sump was present outside of the laboratory and the water from volumetric tank comes to this large sump then feeds totheoverhead tank using centrifugal pumps of capacity 15HP and 10HP. For regulating the flow to be uniform and reduce the turbulence at the entrance region of the flow coming from theoverhead tank, a stilling chamber is provided with a regulating head gate. On the downstream side of the flume, atail gate was fitted to control the depth of flow to be uniform throughout thechannel.

2.3 Construction of RoughChannel

To create small gravel roughened on the main channel the flowing procedure was adopted.

Gravels was glued to the main channel by using adhesive and left for 24hrs to dry. After 24hrs, the excess material was swept out to get uniform roughness in the channel. By this process, the surface area of the main channel of the test reach was roughened.

Figure 3.1:schematic diagram of rough channel

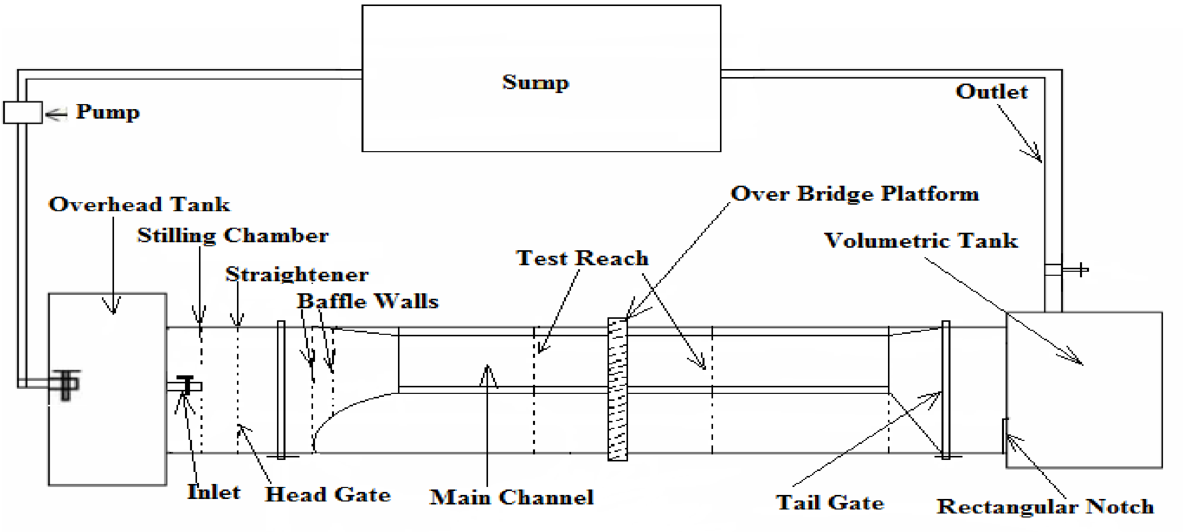


Figure3.2: Schematic drawing of whole experimental setup

2.4 Apparatus and EquipmentUsed

In this research work, point gauge is a measuring device that has least count 0.1 mm , the micro-pitot tube having external diameter 4.7 mm and an inclined manometer was used in the experiments. Velocity and depth of flow in the channel are measured by these devices. In the experiments structure like the stilling chamber, baffle wall, head gate, travelling bridge, tail gate, volumetric tank, sump, overhead tank arrangement, two parallel pumps, water supply device etc. are used. The measuring device and equipments were arranged properly to carry out the experiments in the channel

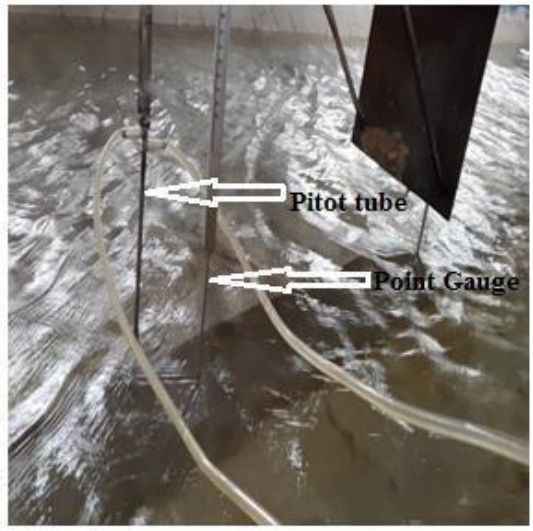


Figure 3.3:(a) Arrangement of Pitot tube and point gaugeFigure 3.3:(b) inclined manometer

2.5 ExperimentalProcedure

Main parameters to measure during the experiment are discharge, bed slope and the velocity. Those are measured in following procedure.

2.5.1 Experimental Channel

The experiment was conducted in a straightsimple channel; having the configuration of the channel is trapezoidal in shape with bottom width 33cm, theheight of 11 cm and side slope of 1V:1H. The longitudinal slope was given 0.001325 for smooth and 0.001 for the rough channel, so that water could flow under gravity. Experiments were carried out inside the channel keeping the geometrical and roughness parameter same for analysis of boundary shear stressdistribution. A typical cross section of the simple channel is shown in Fig 3.4. Detailed geometrical features of experimental channel are given in table1

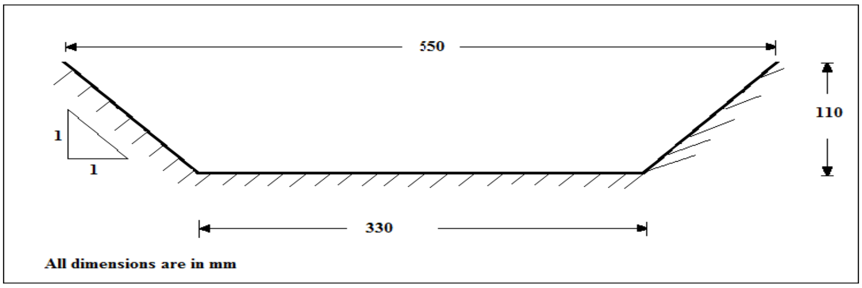


Figure 3.4:Cross sectional view of the simple channe

Figure:3.5(a)PhotosofPumps

Figure:3.5(b) Overheadtan

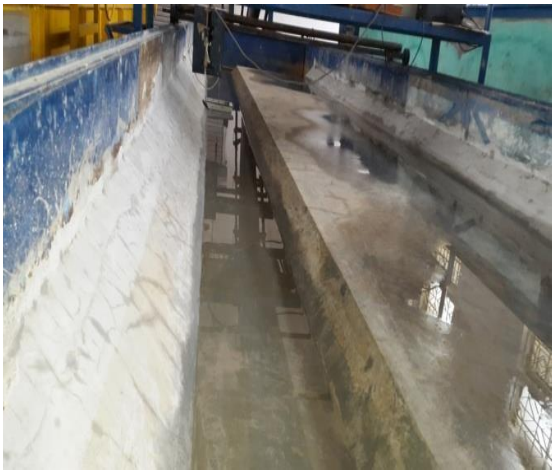


Figure:3.5 (c) TestingChannel(Smooth)

Figure:3.5 (d) Testing Channel(Rough)

Figure :3.5 (e)StillingChamber

Figure:3.5 (f) Volumetrictank

3. Experimental Results and Discussions

3.1 Overview

Chapter 3 describe the procedure of the experiments that carried out in the channel. In this chapter experimental result of the distribution of boundary shear stress along the wetted perimeter of different flow depth has been given. The stage discharge relationship is given in fig3.1.

3.1 Stage DischargeRelationship

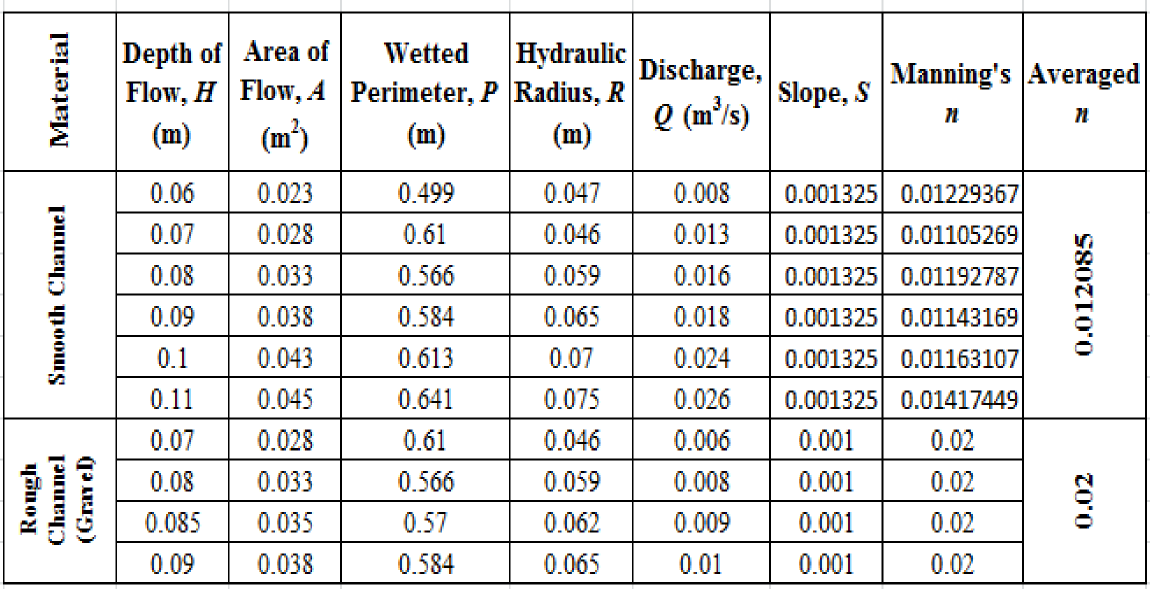
Stage discharge relationship for a straight simple smooth channel and small gravel roughed channel was represented by the H~Q curve in Fig 4.1. It was clearly observed that when flow depths are increases the discharge also increases in channel and relation was found to be power function with highervalue.

(For smooth channel) (3.1)

(For gravel roughed channel) (3.2)

The detail results of flow properties such as depth, area, wetted perimeter, hydraulic radiusand discharge of smooth and rough channels are given in table 4.1

Table:2Detailed results of flow properties of the Experimental Channel

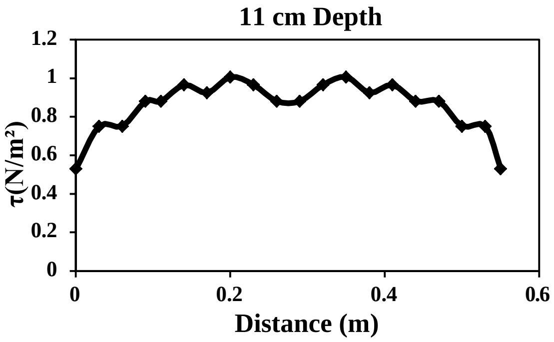


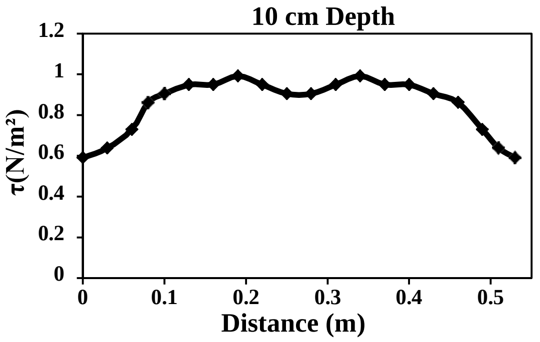
Material	Depth of Flow, H (m)	Area of Flow, A (m^2)	Wetted Perimeter, P (m)	Hydraulic Radius, R (m)	Discharge, Q (m^3/s)	Slope, S	Manning's n	Averaged n
Smooth Channel	0.06	0.023	0.499	0.047	0.008	0.001325	0.01229367	0.012085
	0.07	0.028	0.61	0.046	0.013	0.001325	0.01105269	
	0.08	0.033	0.566	0.059	0.016	0.001325	0.01192787	
	0.09	0.038	0.584	0.065	0.018	0.001325	0.01143169	
	0.1	0.043	0.613	0.07	0.024	0.001325	0.01163107	
	0.11	0.045	0.641	0.075	0.026	0.001325	0.01417449	
Rough Channel (Gravel)	0.07	0.028	0.61	0.046	0.006	0.001	0.02	0.02
	0.08	0.033	0.566	0.059	0.008	0.001	0.02	
	0.085	0.035	0.57	0.062	0.009	0.001	0.02	
	0.09	0.038	0.584	0.065	0.01	0.001	0.02	

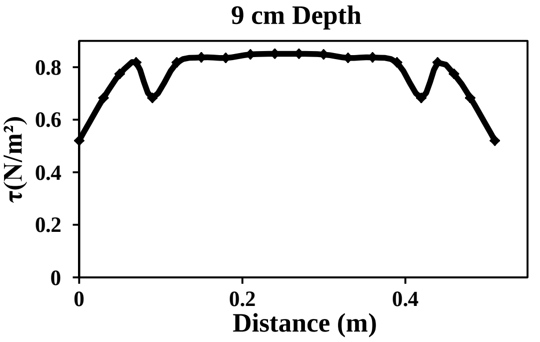
3.2 Boundary ShearMeasurement

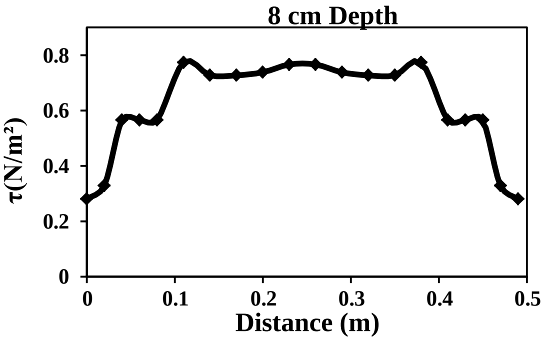
By using Preston tube technique, the boundary shear stresses along the wetted perimeter of the smooth and rough experimental channels have been presentedbelow.

3.2.1 SmoothChannel









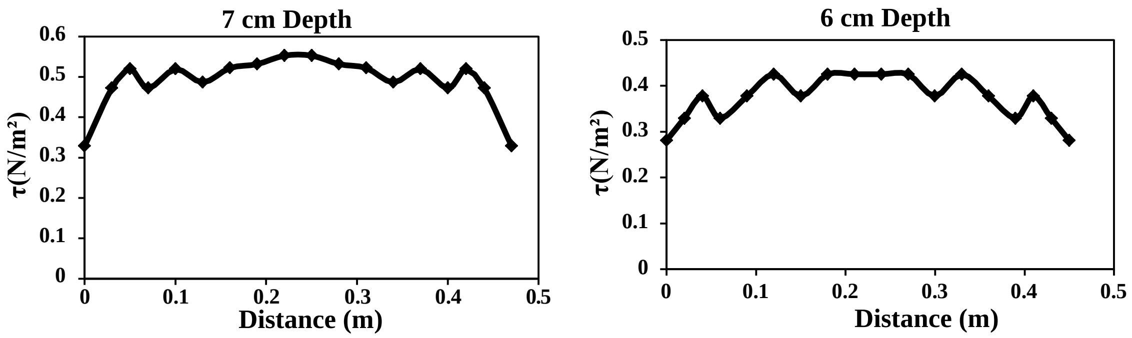


Figure:4.2 Shear stress distribution for smooth simple channel

From above Fig- 4.2 it was clearly observed that the boundary shear stress increases with the increase of flow depth in the channel. Highest shear stress for 11 cm depth is 1.0 N/m^2, for 10 cm depth 0.99 N/m^2, for 9cm depth 0.85 N/m^2, for 8 cm depth 0.76 N/m^2, for 7 cm depth 0.55 N/m^2 and for 6 cm depth 0.42 N/m^2.In the lower depth of flow the shear stress is not constant due to the higher friction between water and channel so that the difference in shear stress is high in transition zone i.e. wall and bedinterface.

3.2.2 RoughChannel

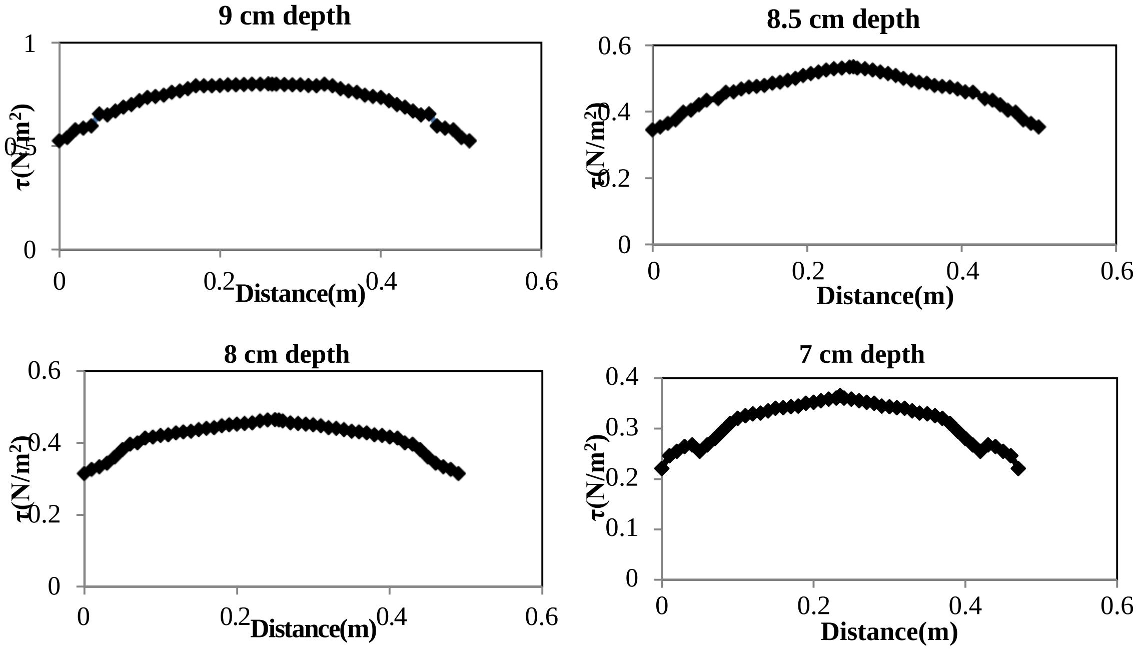


Figure:4.3Shear stress distribution forGravel Rough simple channel

From above Fig-4.3 it was clearly observed that the boundary shear stress increases with the increase of flow depth in the channel. Highest shear stress for 9cm depth is 0.95 N/m^2, for 8.5 cm depth 0.54 N/m^2, for 8 cm depth 0.46 N/m^2 and for 7 cm depth 0.36 N/m^2. Shear stress is not constant due to the higher friction between water and gravel surface of the channel so that the difference in shear stress is high in transition zone i.e. wall and bed interface of the channel

3.3 Theoretical Analysis

3.3.1 Analytical Method For Computation of Boundary Shear Stress Distribution

Different methods for computation of boundary shear stress distribution and mean bed and shear stresses in prismatic open channel flows are compared with experimental data i.e. Vertical Depth Method (VDM), Normal Depth Method (NDM), Merged Perpendicular Method (MPM) and Yang and Lim Method (YLM).

3.3.2 Vertical Division Method(VDM)

- In Vertical Depth Method (VDM) method assumes that the local shear stress on one wetted perimeter point is proportional to the local water depth hi as givenby (4.1)

Where ρ is the water density, *g* is the gravitational acceleration and j is the energy slope

- The VDM method can be applied to arbitrary cross-section shape, but in this secondary method currents and the momentum transfer between the main channel and its floodplains and the roughness distribution along the wetted perimeter is assumed to behomogeneous.
- Lundgren and Jonson (1964) identified that the concept of "vertical depth" is not adapted for calculation of boundary shear stress distribution, especially if the side slope isstepped.

3.3.3 Normal Division Method(NDM)

- They used another method to find the boundary shear distribution is called Normal Depth Method (NDM) in this method only h_i of equation (1) is replaced by so

- equation willbe

(4.2)

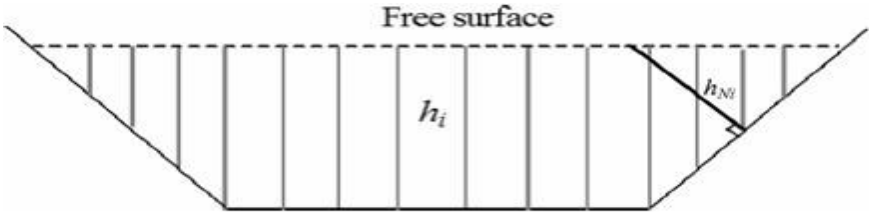


Figure:4.4 Schematic illustrations of the VDM and NDM(Lundgren and Jonson, 1964)

3.3.4 Merged Perpendicular Method (MPM)

- Geometric method was developed by Khodashenas and Paquier (1999) to compute the local shear stress in an irregular cross-section is called Merged Perpendicular Method (MPM, which is an “a cross-sectional region bounded by walls dividing into three sub-areas, corresponding to sidewalls and bed,respectively”

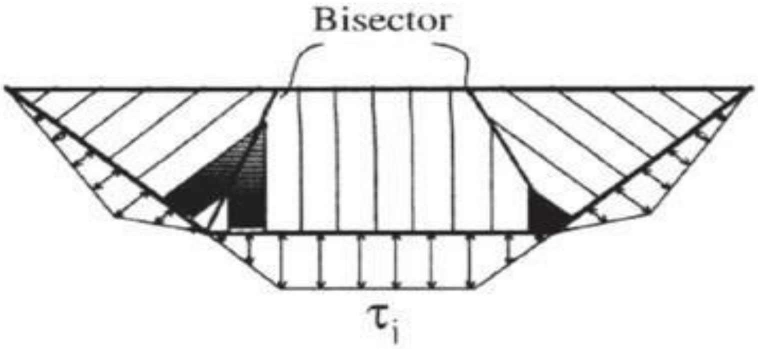


Figure: 4.5 boundary shear variations computed by MPM (Khodashenas and Paquier, 1999)

- *Procedure for computing boundary shear stress in MPMmethod:*

1. Divide the wetted perimeter into smallsegment

2. Draw the mediator of everysegment

3. Every mediator that intersects the previous normal should be merged with it; the two normal will havethesame continuation. They join in a line of order 2. The direction of the new line is computed the by the weighted mean of the angles of the lines thatintersect.

(4.3) –

4. Then, new lines can meet other normal and join into lines of higher order, the angle of which j weighted mean of the angle of the previous lines. The procedure continues to the watersurface

– (4.4)

5. The area between the final lines is computed and shear stress is computed byequation

(4.5)

Where τ = boundary shear stress, = water specific weight, = hydraulic radius computed as the ratio of the area between 2 line to length of corresponding segment, = average energyslope.

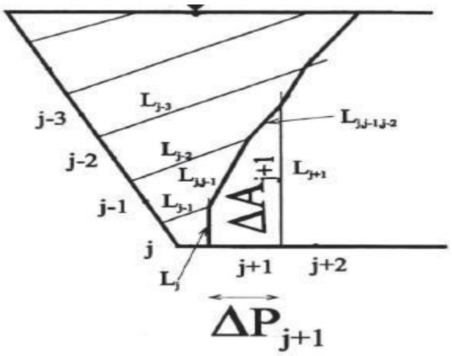


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Figure: 4.6 Area determined by M.P.M(Khodashenas and Paquier, 1999)

3.4 Velocity Profile Method for Computation of Boundary ShearStress

One indirect method uses the graphical plotting of velocity distribution based on the work of Karman and Prandtl. Let *u1* and *u2* are the time-averaged velocities measured at *h'1* and *h'2* heights respectively from the boundary From the closely spaced velocity distribution observed in the vicinity of the channel bed and the wall we can take a difference of *u'* and *h'* between two points 1 and 2 close to eachother.

—— ———— —— (4.6)

() _

Substituting () in equation (4.6) we can rewrite

* —+ (4.7)

——— ———— = the slope of the semi-log plot ofvelocity distributions near the channel bed and the wall.

3.5 Results andComparison

In this chapter the experimental results of the smooth and rough channel are given and the results are compared with different convention method i.e. VDM, NDM, MPM and Velocity profile method are used toknow the behaviour of the boundary shear stress distribution in the channel with the depth of flow and surface condition of the channel. The convention method i.e. VDM, NDM, MPM and Velocity profile method results are compared with Preston tube technique to known the behaviour of boundary shear stress in channelgemotry.

3.5.1 Velocity ProfileMethod

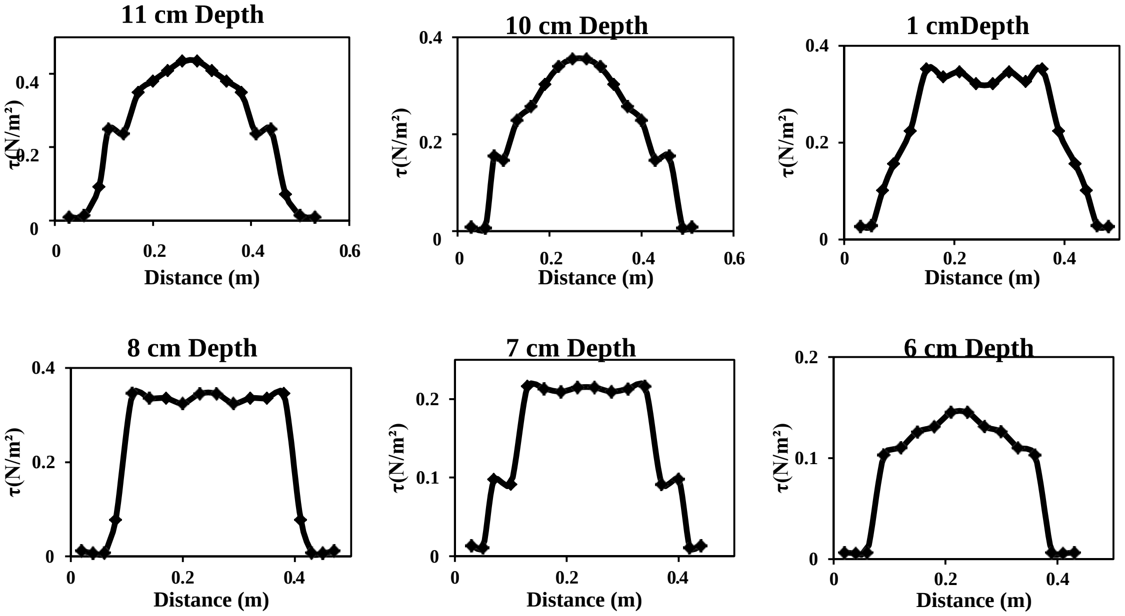

Figure: 4.7 Boundary shear distribution by Velocity profile method

3.6 AnalyticalMethod

3.6.1 Vertical Division Method(VDM)

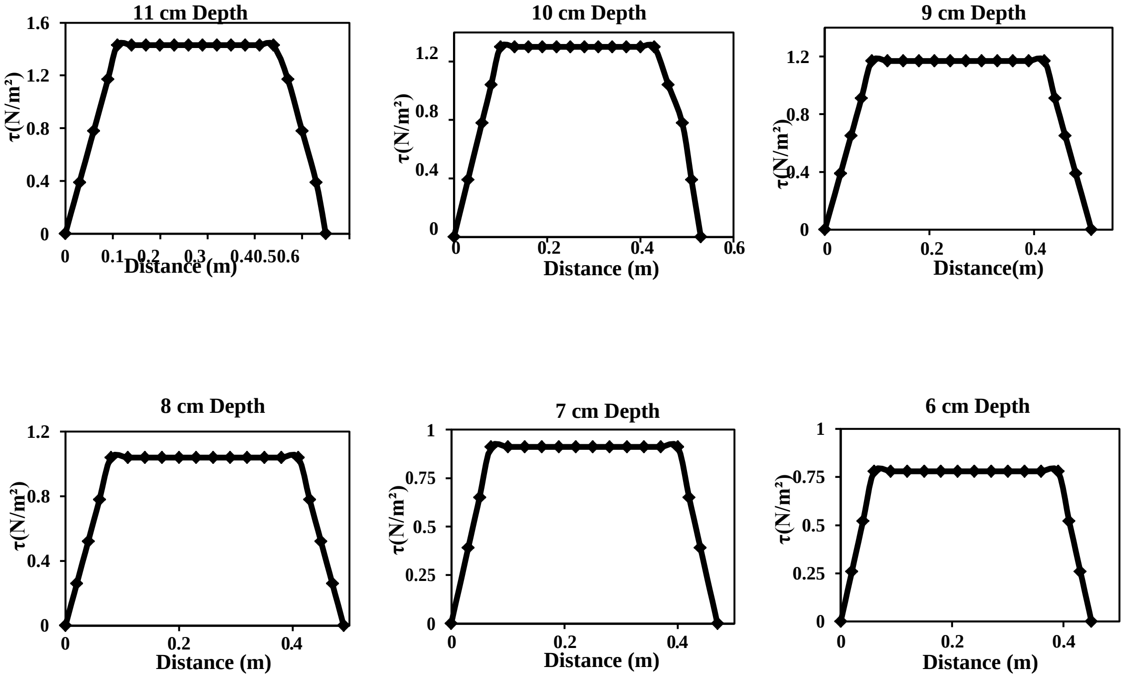

Figure: 4.8 Boundary shear distribution by VDM is presented by , where and are coefficient of regerssion.The trends observed for with are down in nature means when the flow depth rises, the boundary shear distribution on main channel decreases. But the reverse upward curve have been observed for flood plain cases. That means with increase in depth, the flood plain shear also increases causing

4. Conclusions and Scope for Future Work

4.1 Conclusions

- This present research followed by experimental data sets to observe the boundary shear stress distribution and percentage shear force on bed ( ) and wall ( ) in smooth and rough channel. Based on these observations, this research tries to compute the discharge which is the important task for every investigation. Based on this analysis, the following conclusions can be drawn.

- The experimental investigations are carried out in two different channels having different roughness. The measurements of percentage shear force on wall and on bed are taken. Percentage shear force on wall in simple channel (bed and wall having same roughness) provides falling trend where as distribution of shear on wall provides a reverse trend of that. It is concluded that when flow increase the shear stress also increases on bed however decreases on wall. The values of percentage shear on bed and on wall of all the channels having same roughness seems to make onetrend.
- The similar results of with /and with /have been observed for channels where the wall and bed having different roughness all data sets. The distribution in different rough channels is not identical with the magnitude of shear force as this distribution of shear greatly varies with different geometry and roughness.
- The trends observed for with relative flow depth ( ) in compound channels are down in nature i.e., when the flow depth rises, the boundary shear distribution on main channel decreases. But the reverse upward curves have

- been observed for flood plain shear cases. That means with increase in
- depth, the flood plain shear also increases causing reduction in main channel.

- It has been clearly observed that decreases with increase of width ratio( ) but increases with increase of width ratio ( ). That means when channel widens the boundary shear force is reducing on main channel leading to increase in shear on flood plain. The similar identical trends as smooth compound channel have been observed for rough compound channelcases.
- A model has been derived for estimating the percentage shear on bed using multi linear regression analysis where the independent parameters are Reynolds no, Froude's no and flow aspect ratio. By using the proposed model for predicts good results and percentage error has been found minimum as compare to other models of previousinvestigators.
- By using different composite manning's roughness coefficient model,the discharge for all data sets have been computed and found that the predicted discharge are approximately same as the measured value.

- Then the composite roughness associated with different roughness values of subsections have been found out by applying different composite roughness models and found that the Lotter (1933) method can give overall good result with minimum percentage of error for rivermain

4.2 Scope for FutureWork

- The present research is restricted to channels with smooth boundary and rough boundary. So it can be extended to mobile bedcases.
- Only the straight prismatic sections are considered here, so it also extended to a meandering channel having a rough and mobileboundary.
- Incorporating a lot of data sets of various configurations, the accuracy of the present model can beimproved.
- The study can also extend to overbank flows where the complex phenomenon is developed

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