e - ISSN – 2393-9672

European Journal of Environmental Ecology

Journal homepage: www.mcmed.us/journal/ejee

FINER BED LOAD CHARACTERISTICS AND CHANNEL MORPHOLOGY : A CASE STUDY OF A SELECTED REACH OF PANCHANOI RIVER, SUKNA OF DARJEELING DISTRICT, WEST BENGAL

Subhadip Gupta*

Research Scholar of Department of Geography, West Bengal State University, Kolkata, West Bengal, India.

Corresponding Author

Subhadip Gupta
Email:- sg.birati@gmail.com

Article Info

Received 13/06/2015; Revised 29/06/2015
Accepted 11/07/2015

Abstract

Panchnoi is a major right bank tributary of Mahananda River flowing through the Himalayan foothills in Darjeeling dist. The upper part of the catchment is situated in the hilly area but the lower part is on the alluvium fan surface. In this studied stretch, the Rongtong Khola, a major right bank tributary joins the Panchnoi. Detailed geomorphic mapping of the surveyed stretch was done by theodolite tachometry. The long profile and 39 cross profiles were drawn based on the surveyed data. 38 sediment samples were collected along the studied stretch. The finer bed load character reveals that the materials transported by river Panchnoi get more rounded with increasing distance downstream.A negative relationship can be observed between channel width and mean size of sediment and the kurtosis values. Up to the confluence of Panchnoi with Rongtong Khola, the grain size distribution is unimodal which indicates the dominance of a single depositional agent, but after the confluence till the end of the surveyed stretch, the grain size distribution is mainly bi-modal. This may indicate fluctuating energy condition of the depositing medium and the effect of mixing of bed load contributed by the tributary streams.

Since the flow pattern of a river depends on the bed and bank morphology together with its competency and capacity, an attempted has been made in this study to study the geomorphic properties of the river with its bed load character by a micro level analysis.

Keywords: finer bed load, grain size, channel morphology.

INTRODUCTION

Panchanoi, a major right bank tributary of Mahananda River flowing through the Himalayan foothills in Darjeeling district. In this case, a 4 km stretch of the middle course of the Panchanoi river has been studied. A segment of Rongtong khola (near confluence) has also been taken into consideration. The capacity of carrying load is depended on the channel morphology which can be analyzed by the cross sections of the selected reach. The present paper only looks into the finer bed load particles and their spatial differentiation.

Selection of the study area

The studied area is an interesting subject for study for the following reasons -

- Mahananda has a number of tributaries in its upper course like Panchanoi, Babu khola, Shiva khola, Mana khola, Jogi khola etc. But the Panchanoi basin has more physiographic variation than the other upstream tributaries of Mahananda. It has a break of slope at 300 m which divides the 70 sq. km. basin area of Panchanoi into two broad physiographic divisions (hill and plain). Thus Panchanoi basin shows significant altitudinal variation within a relatively small basin area.

- A part of the Siliguri-Darjeeling connecting road and Siliguri-Darjeeling toy train track (lying on the downstream Panchanoi basin area) has been affected by the monsoonal discharge of Panchanoi. The old Panchanoi rail bridge was damaged due to enormous scouring at the bottom of the Panchanoi river bridge, mainly in rainy season. A new bridge has already been constructed there but the problem remains as before. These communication lines have a significant role for transportation purpose in this area. It is for that the Panchanoi river basin deserves a detailed study.
- Siliguri is situated near the confluence of the Panchanoi and Mahananda. The interfluve area is heavily populated and the entire area has also experienced a severe flood in the year of 2006. This is one of the reasons for selecting this particular river basin for study.

Figure 1. Part of studied Panchanoi river basin in Matigara block

Objectives

The flow pattern of a river depends on the bed and bank morphology together with its competency and capacity. An attempt has been made in this study to correlate the hydraulic and geomorphic properties of the river with its bed load character. The objectives of the present study are

- To determine the bed load characteristics of studied reach
- To identify the geomorphic characteristics of the studied stretch of Panchanoi.

Methodology

The long profile and 47 cross profiles with detailed geomorphic mapping of the surveyed stretch has been done by theodolite tacheometry along with GPS survey. At the same time 38 sediment samples were collected along this stretch and analysed by standard procedure of dry sieving. For the convenience of study, the collected samples have been subdivided into three segments. Such as- Mahananda sanctuary Sukna entry point to Rongtong confluence reach, from confluence to large meander bend reach and rest of the surveyed part (up to concrete bridge).

Physical set up of studied area

This area constitutes the piedmont plain of Himalayan mountain comprising the Terai region. Basically this is a part of north Bengal plain but the variation of topography and slope from the juxtaposition of hill and plain to the sediments qualifying the depositional characteristics in the studied area. Deposition of silt and clay mixed with pebbles and cobbles are common in the region. The Himalaya forms the frontiers of the Indian subcontinent area geologically a complex chain of mountains. During the stages of its evolution, ergogenic movements comprising of a complex system of faults, folds and thrusts have made the structure so complicated that it is a difficult job for a geologist to correlated the rock formation accurately on a regional scale. The geological formations of the Darjeeling and surrounded area comprise rock of the siwalik, Gondwana, Daling and Darjeeling Gneiss group. The surveyed areas local geology is mostly characterized by the quaternary formation. These belong to the Recent to sub recent stratigraphic material piedmont bogsbelong to the Recent and Sub recent formation. There is occasional older alluvium in upper terraces which might belong to the Pleistocene. Infect the river alluvium i.e. newer alluvium or khader and older alluvium i.e. Bhanger area sediments brought down from the Himalayan foothills since the Pleistocene time. The height and exposure to southern rain-bearing winds determine the distribution of thermal conditions and precipitation. The powerful effects of the monsoon and the configuration of the neighbouring mountains deflect winds and affect local temperature and rainfall.

Findings

The table-1 refers the geomorphic characteristics of studied part of Panchanoi. It has been found that the average width at this studied segment is not less than 12.0 m. and it varies from 13 to 73 m. At the same time, if we consider the bank morphology, it can be said that the studied part of Panchanoi represents an asymmetrical valley profile with non-cyclic terraces. Presence of point bars and mid-channel bars are so significant to highlight the relation between geomorphology and nature of bed-load. The table-2 represents the geomorphic features of studied part of Rongtong khola. It has been found that the average width at this studied segment is more than 20 m. and the depth of the channel varies from 0.8 m. to 3.0 m. At the same time it has also been observed that the depth of the Rongtong khola is inversely related with the channel width. If we consider the bank morphology, it can be said that the left bank is steeper than the right bank in the studied reach of Rongtong khola. The terraces are non-cyclic in nature.

Figure 2. Finer bed load sample collected from upper reach of Panchanoi river bed

Sediment Characteristics

The upper reach is dominated by medium send to fine sand. For the reason bridge obstacle the trend velocity is decline. Near the Mahananda wild life sanctuary Sukna entry point concrete bridge, the deposited materials are sorted moderately well due to the obstacle of concrete bridge, where we observed cobble, pebble and sand simultaneously. In the extreme flood condition the all type of bed load are moved one to another but in the low velocity condition the suspended sediment deposited on the bed load (Figure-4).

Figure 3. Finer bed load sample collected from middle reach of Panchanoi river bed

In the third studied reach, the distribution of finer grain size sediment is mixed type in nature. Source of sediment is not only bed load but also the eroded bank materials. The bi-modal distribution indicates the two different depositional phases. Near the large mid-channel bar, the distribution of sediment is mainly bimodal in nature due to influence of energy of Panchanoi main, sub-channel and as well as Rongtong khola (Figure-4).

Figure 4. Grain size distribution of finer bed load samples from Panchoni and Rongtong Khola

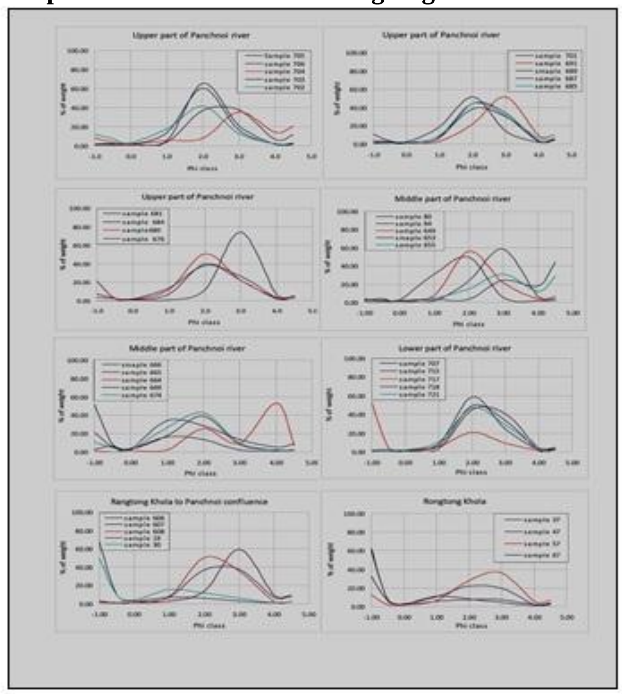

Figure 5. Finer bed load analysis by dry sieving method

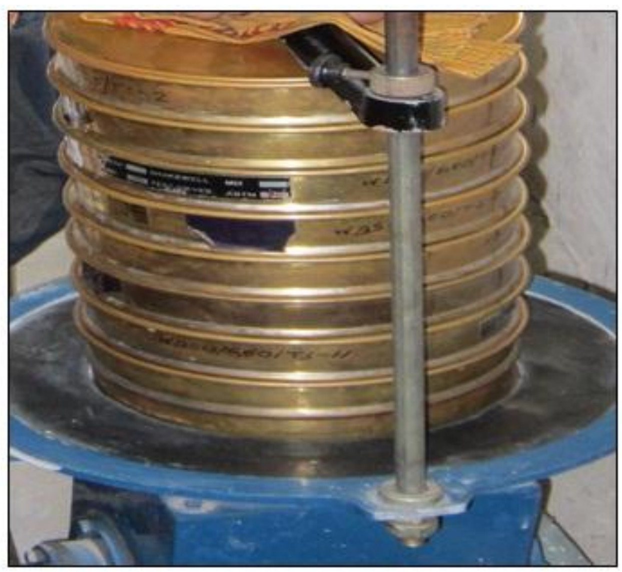

Table 1. Characteristics of cross-sections of selected part of river Panchanoi

Profile no.	Length of profile (in m.)	Type of left bank	Type of right bank	Nature of terrace	Channel width (in m.)	Depositional feature
2	85	Moderately steep	More steeper	Non -cyclic	29	Point bar is observed
5	54	More steeper	Moderately steep	Non -cyclic	36	Mid –channel bar is seen
6	68	Moderately steep	Gently steep	Non -cyclic	20	Point bar is observed
7	88	Very steep	Moderately steep	Non -cyclic	33+40=73	Mid –channel bar is seen
14	84	More steeper	Gently steep	Non -cyclic	7+6	Mid –channel bar is seen
15	122	Moderately steep	More steeper	Non -cyclic	40	Point bar is observed
17	75	Very steep	Moderately steep	Non -cyclic	70	---
18	90	Gently steep	Moderately steep	Non -cyclic	45	Point bar is observed
19	75	Very steep	Very steep	Non -cyclic	73	---
24	45	More steeper	Moderately steep	Non -cyclic	31	---
26	38	Moderately steep	More steeper	Non -cyclic	21	---
28	85	Moderately steep	More steeper	Non -cyclic	9+10=19	Mid –channel bar is seen
29	87	Very steep	Very steep	Non -cyclic	52+15=67	Mid –channel bar is seen
35	63	Very steep	Moderately steep	Non -cyclic	35	Point bar is observed
36	73	Moderately steep	More steeper	Non -cyclic	60	Point bar is observed
38	110	Moderately steep	More steeper	Non -cyclic	39	---
39	61	Moderately steep	More steeper	Non -cyclic	43	---

*calculation done by author by primary field survey

Figure 5. Meander reach under study

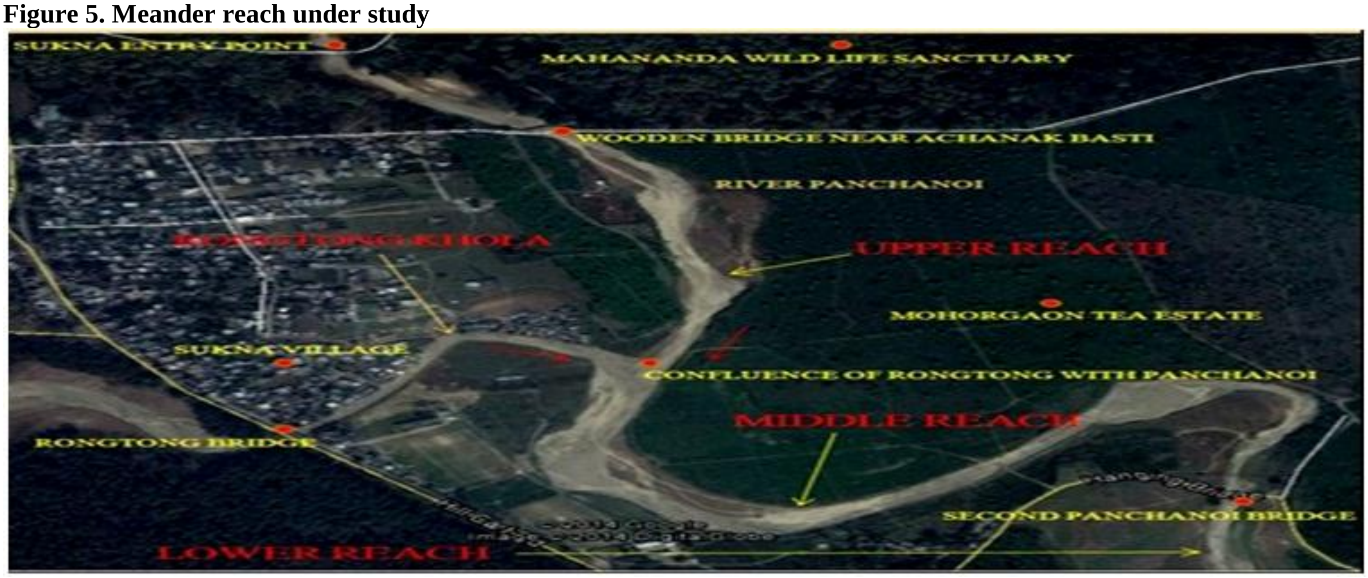

Table 2. Characteristics of cross-sections of selected part of Rongtong khola

Profile no.	Length of profile (in m.)	Type of left bank	Type of right bank	Nature of terrace	Channel width (in m.)	Depth of channel (in m.)
B	17	Protected by concrete wall				3.0
D	23	Protected by concrete wall				1.7
F	31	More steeper	Moderately steep	Non -cyclic	26	0.8
H	29	Moderately steep	Moderately steep	Non -cyclic	22	1.2

*calculation done by author by primary field survey

Table 3. Nature of bed-material (finer)

Studied Reach	Location	Nature of Distribution with sample no.	Associated Energy	Dominant Particle
Upper Reach	Panchanoi – Sukna entry point to confluence with Rongtong	Leptokurtic-702,703,704,705,706, 707	Panchanoi main stream	Medium sand
Middle Reach	Panchanoi –confluence to large meander	Mesokurtic-664,666,669 Leptokurtic-665,674	1.Panchanoi main and sub channel 2.Panchanoi and Rongtong	Medium and very coarse sand
Lower Reach	Panchanoi –large meander to concrete bridge	Leptokurtic-07,715,718,721 Mesokurtic-717	Panchanoi main and sub channel	Fine and medium sand

*source- primary field survey

The finer sediment which is observed in downstream is mainly concentrated between medium sand to find sand. The finer sediment distribution is bimodal in the studied reach of Rongtong due to presence of a concrete bridge as obstacle and also by the creation of helical flow in this segment. Here sediment is dominated by the coarse sand beside significant amount of fine and very fine sand (Figure-4).

CONCLUSION

The relatively coarser particles (granules, Very coarse sand, coarse sand) are showing better correlation with width of the channel. The relation is more prominent at the following three studied locations. The point bars formed by lateral accretion have coarser materials, where the finer particles are winnowed away. At locations where mid-channel bars have formed, the channel has bifurcated and mid-channel bars have developed when the width is much more compared to depth. In that case, velocity decreases and coarser particles are deposited at bed. Near the confluences an increase in channel width in this reach is observed at confluence where mixing of bed load of tributary streams occur. Sudden reduction in velocity leads to dumping of materials at bed.

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