TO STUDY THE CHANNEL MIGRATION PATTERN FOR REALIGNMENT OF AMOCHHU RIVER

Choning Dorji[1],Kinzang Wangdi[2], Kinley Jamtsho[3]
Department of Civil Engineering and Architecture, College of Science and Technology
Royal University of Bhutan, Rinchending, Phuntsholing, Bhutan
* E-mail: edc2011005@cst.edu.bt[1], edc2011018@cst.edu.bt[2], 2010046@cst.edu.bt[3]

Abstract

River systems had been a complex profile of studies concerning the interests of many branches of detailed investigation and research works. A detailed study of a river system profits human with many natural resources that can be exploit and utilized. Limited studies carried out along the river stretch earlier were for flood mitigations and river training feasibilities. The river's behavior pose threat to livelihood in the current city and a quantifiable solution to the growing demand of the city for land needs to be addressed. In order to accomplish the objectives satellite photographs of different years were compared to determine the channel migration pattern. Hydraulic data were compared with the satellite photographs concluding that the river in itself was adjusting to its stability along the course of time. With respect to the normal discharge observed the river system a suitable channel is delineated for the normal flow condition. On the other hand during peak flood observed at a return period of fifty years (according to DHI) another channel is assigned for accommodating the worst flood situation. These channels are supported with safety measures of standard river training structures suitable for the river system. With the installation of such channels along the river bank a huge amount of land can be reclaimed to meet predicted land demand of the growing Phuentsholing city and safety concerns.

1. INTRODUCTION

The Amochhu River flows out from Tibet into the Chumbi Valley and swiftly through western Bhutan before broadening near Phuentsholing. The River stretches 9 kilometers in Phuntsholing catchment starting from Doyagang Bridge to the river mouth of Omchu. River has significant amount of floodplains which can potentially be reclaimed for the expansion of Phuntsholing town however due unpredictable behavior of the river the land has been left unproductive. City is already facing accommodation issues with restricted area in the present location. Taking all the uncertainties that shall arise in future the study has mainly focused on rechanneling of the amochhu for the purpose of land reclamation.

The main objective of the project is to identify the most profitable bed for the Realignment of Amochhu River for the purpose of land reclamation.

Other sub- objective of the study includes:

1. To study the channel migration pattern.
2. To assess the effect of stability of the river bed and banks on lateral channel migration and channel widening and narrowing.
3. To recommend suitable river training structures and bank protection works.
4. To determine the total area of Land reclaimed.

2. METHODOLOGY

GIS software was used to study the channel migration pattern of the river for the different

time series. The design analysis is all based of the discharge and the rainfall data interpretation for past ten years. The historical data such as flood which occurred in 1998 was also used for the designing the river channel. After rechanneling the river through the profitable river bed, the suitable recommendations of the bank protection were made.

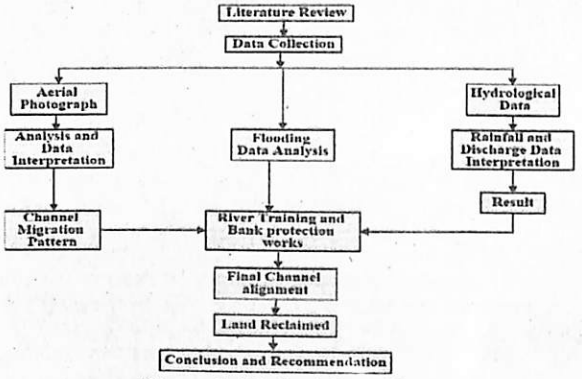


Figure 1: Methodology Chart

2.1 Channel Migration

The Amochhu River is classified as the meandering river due to its sinuous property. The river doesn't travel in the straight course rather it take different course every year. Due to the variation in the river discharge, sediment carrying capacity of the river and the influence from the catchment area, very high channel migration has been observed.

To study the channel migration pattern of Amochhu River aerial photographs has been compared. Comparative studies has been done on the aerial photograph of the different time series. Images from 2004 to 2015 were available for the studies. The desk study was mainly carried out with help of GIS.

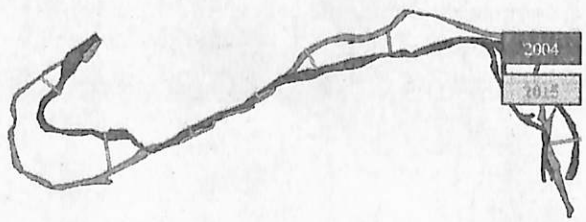


Figure 2:Channel pattern of Amochhu River (6th, Dec, 2004, 19th Dec 2015)

The channel migration pattern drawn from the various image interpretation from year 2004 till 2015, showed a very large channel migration. The river has tendency to shift either to the right side and the left side of the bank due to its high shear strength parameter. Owing to this fact it is very important for the proper channelization of the river and for the protection of habitats of the both human and the animal on the downstream side during the high flood season.

3. Results

3.1 River Re-channeling under normal flow condition

Analyzing the data from maximum Discharge value and rainfall value from the discharge data and maximum velocity value obtained after doing the floating method we have decided the width of the channel for the rechanneling of the river for the maximum discharge under normal flow conditions. Maximum discharge of river under normal condition = 1526 (2007) cumec.

Velocity of the river under the normal flow condition (determined by floating method) = 1.926 m/sec.

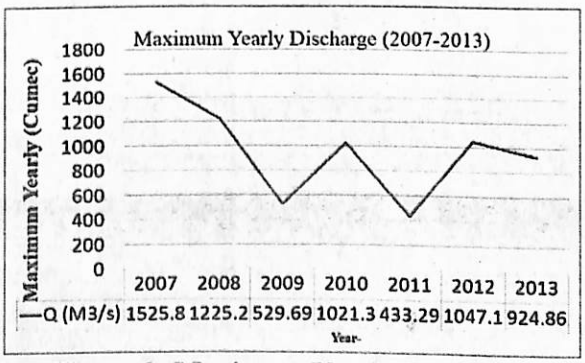


Figure 3: Maximum Yearly Discharge

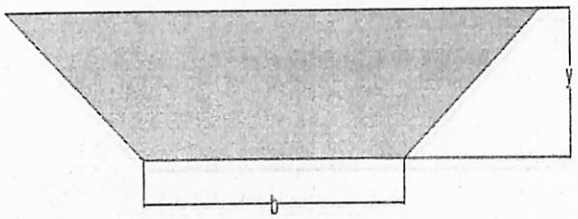
Using Lacey's wetted perimeter formula

$$P = 4.75\sqrt{Q} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots i$$

$$A = Q/V \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots ii$$

$$P = 4.75\sqrt{1526}$$

$$A = 1526/1.926 = 792.31\ m^2$$



Providing the slope of 6H: 1V

Figure 4: Cross section of the pilot channel

A= by+ 2(0.5*6yxy)

A=y (b+6y).....iii

P= 12.1y+b.....iv

Putting equation (IV) in equation (iii)

y=4.7m,

Increasing the height up to 6.5m

We get b approximately equal to 100 m

y=6.5 m

b=100 m

3.2 Channel width under high flood condition.

From the flood simulation done by DHI at a return period of 50 years, the maximum discharge of river at abnormal flood condition = 5900 cumec

The maximum velocity = 4 m/s

Using Lacey's wetted perimeter formula again

Y = 4.35m, increasing the height up to 5m

We get B approximately equal to 300m

B = 300m

Y = 5 m

30m buffer zone is provided at the either side of the bank.

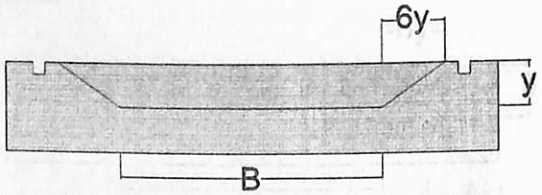


Figure 5: Cross section of the river channel for the accumulation of high flood

3.3 River alignment

After designing the channels for both the conditions, a conceptual image is portrayed below.

Figure 6: The map showing the stabilized channel under normal flow and during the maximum flood level

3.4 Suitable Methods of River Training Works

The planning and design of river training works was done by empirical methods and on the intuitive judgement of engineers. The method of river training applicable depends mainly on the type and sediment load. To resist high flow velocities and prevent undermining by scour in the river bed commonly used methods of river training works are as follows:

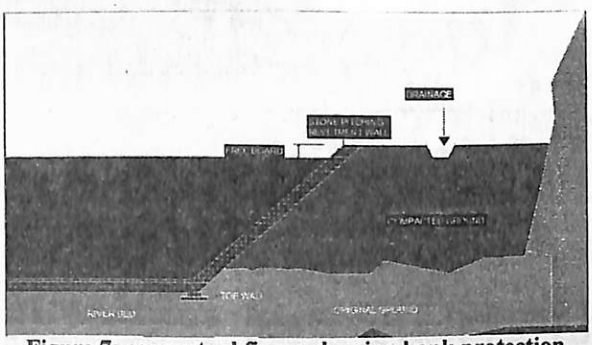


Figure 7: conceptual figure showing bank protection works

1. Gabion Revetments
2. Stone pitching
3. Guide Banks

3.5 Land Reclamation

The reclamation method adopted was by river training the Amochhu. With construction of the river training structure for a channel width of 300m and height of 5 m the land will be protected from worst expected flood.

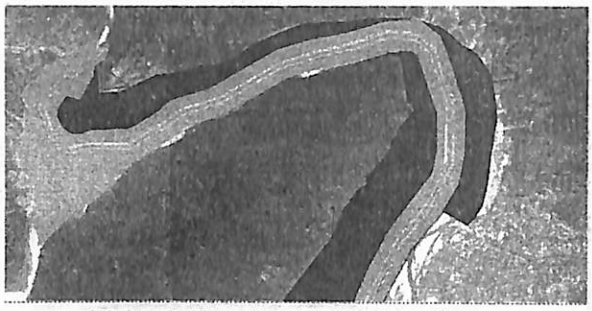


Figure 8: Map showing Reclaimed area

Total river length of 9 km
Total area reclaimed of 847.53 Acres

4. Conclusion

The project was undertaken to study the possibility of re-channeling of the Amochhu River for the purpose of land reclamation. The channel for a very long time had been adjusting itself towards stability changing its course at different interval of time. Surveys and field samples were collected to determine the most stable bed along the flood plain using shear stress equation. To stabilize the channel, only the soil strength parameters were not sufficient enough to prove the stability of the channel. Certain geomorphic and hydraulic parameters had to be taken into consideration with historical characters of the river owing to the maximum flood recorded and parameters derived from flood models of previous studies. With the relocation of the channel the sinuosity of the river was will be reduced to 1.2 from 1.9 and the flood plain reclaimed were calculated to be 847.3 acres. The design of Spurs, Gabion, ripraps, guide-banks are also presented as river training and bank protection works. These structures and river stabilization can be supplemented with sediment dredging system in the downstream phase of the channel area. On the other hand the area can be added with recreational facilities and flood forecasting and early warning systems to reduce flood risks.

5. Recommendations

Future researchers can focus on the following scopes

1. Most of the sediment studies carried out in this project are derived based on the empirical methods and relations developed in similar rivers of other parts of the world. A sediment gauging station can be installed and sediment characteristics of the river can be studied and monitored on daily basis to make further studies easier and reliable.

2. There are not much utility of the sediment deposited along the river course. It will be very beneficial for the future researchers to develop a technique to dredge these sediment with technical implementation. Future studies can focus on a prominent structural solution to dredge sediments downstream.

3. Future studies can be made on the different types of sediment present in the river course and derive utility of those sediments in different areas such as agriculture, construction industries and purification plants which are incorporated as rapid or slow filtration of water.

6. Acknowledgement

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