MUZAFFARPURINSTITUTE OF TECHNOLOGY, MUZAFFARPUR
B.Tech 8th Semester Mid-Term Examination, 2019
River Hydraulics and Sediment Transport (011x35)
(Civil Engineering)

Full Marks: 20

SOLUTION

1. Chose the correct option for the following

(a) Structure which can be used for measuring the discharge of small streams are

(i) Dam

(ii) Spillway

(iii) Notch, weir, flumes and drops

(iv) None of the above.

Ans: (iii) **Notch, weir, flumes and drops**

(b) Geomorphology is a branch of physiography which deals with the

(i) Lands of earth surface

(ii) Water of sea

(iii) Young stream

(v) None of these

Ans: (i) Lands of earth surface

(c) Sinuosity of the river is

(i) $\frac{\text{Length of stream channel}}{\text{Length of straight line distance}}$

(ii) $\frac{\text{Length of straight line distance}}{\text{Length of stream channel}}$

(iii) $\frac{\text{Width of straight line distance}}{\text{Length of stream channel}}$

(iv) None of the above

Ans: (i) $\frac{\text{Length of stream channel}}{\text{Length of straight line distance}}$

(d) Guide banks are made for

(i) Confining the river to a reasonable width

(ii) For diverting the river towards one bank

(iii) For attracting the river towards one bank

(iv) None of the above

Ans: (i) Confining the river to a reasonable width

(e) Aggrading river are

(i) Silting rivers

(ii) Scouring rivers

(iii) Rivers in regime

(iv) Meandering rivers

Ans: (i) Silting rivers

2. What is cut-off and explain the reasons for the development of cut-off.

Ans:

CUT-OFF

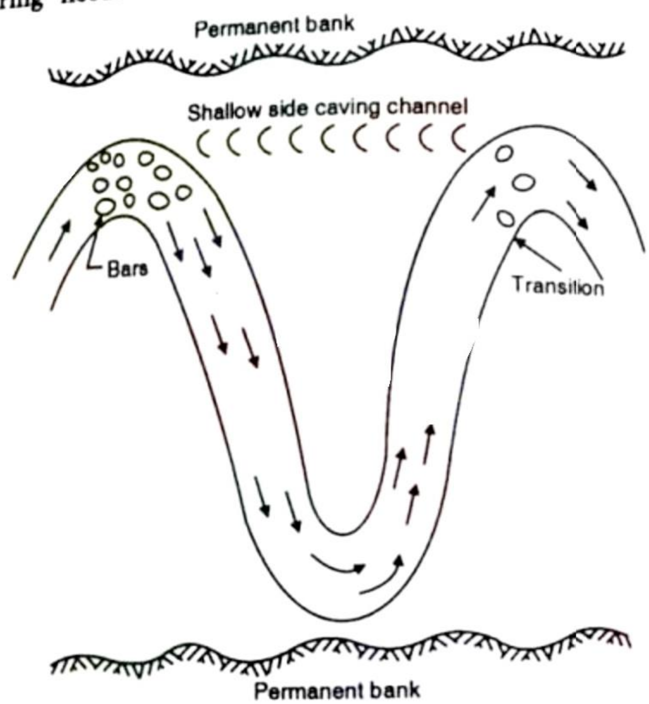
When the meandering of a river develops to the extreme conditions in the shape of horse-shoe bends, the land between them gradually reduces to a narrow neck which may be cut-off by natural flow during floods.

Cut-off may be *defined* as a process by which an alluvial river flowing allowing curves of bends abandons particular bend and establishing its main flow along a comparatively straight and shorter channel.

Development of cut-off

The following reasons are generally assigned for the development of cut-off.

1. ***Development of bars at inflection.*** Formation and growth of bars at inflection retard the flow through main channel and induce flow through already existing shallow side channels. The main channel flowing with reduced discharge continues to silt whereas side channel increases in size to accommodate more and more of discharge and ultimately forms into a cutoff.



DEVELOPMENT OF CUT-OFF

2. ***Formation of drops at the junction of main channel*** **with** ***side channels.*** The side channel usually has a lower velocity and smaller length with the same head difference as the channel. It, therefore, joins the main channel at a local drop. This local drop cuts back into the side channel and helps in development of a cutoff.

3. ***Unfavourable cross-section and steep slope*** The unfavourable cross-section and steep slope of the side channel may generate such velocities which may erode the bed and bank of the side channel to constitute the principal course of the river.

4. ***Bank erosion.*** The river increases its curvature by erosion of concave banks. The erosion might occur to such an extent that the arms of a loop with a narrow neck cut into one another and cutoff occurs.

5. ***Duration of flood.*** The duration of flood should be sufficient so that stream may erode its bed and banks.

3. Design a guide bank required for a bridge on river having the following particulars:

Design flood discharge =50000 cumecs

Silt factor =1.10

Bed level of river =130.00 m

High flood level = 140.00 m

Ans:

$$Q = 50000 \text{ cumecs} \;;\; f = 1.10$$

$$\text{Lacey's water way} = 4.75\sqrt{50000} = 1062 \text{ m.}$$

Provide 20% more length to account for thickness of piers and end contracti due to piers and abutments

$$= 212 \text{ m}$$

$$\text{Gross length between banks} = L = 1274 \text{ m}$$

$$\text{Upstream length of guide bund} = \frac{5}{4}L = \frac{5}{4} \times 1274 = 1592 \text{ m}$$

$$\text{Downstream length of guide bund} = \frac{L}{4} = \frac{1}{4} \times 1274 = 318 \text{ m}$$

$$\text{Radius of u/s curved head} = 0.45\,L = 573 \text{ m.}$$

The u/s end of the guide bank may, therefore, be curved by 145° with a radius of 573 m.

Radius of d/s curved head may be kept as 287 m with an angle of 60° at the centre.

Cross section of guide bund

The given H.F.L at the bridge site = 140.0 m

Assuming free board = 1.5 m.

Level of top of guide bund equals 141.5 m. To be more safe and making an allowance for further settlement etc., let us adopt the top level of bund as 142.00 m.

Height of bund above river bed = 142.0 − 130.0 = 12.0 m.

Keep the top width of bund as 4 m and the side slope may be kept as 2 : 1.

The stone pitching and a launching apron must be provided on the slope on water side for the entire length of the bund. However the rear side also will be pitched for curved portions of the bund.

Design of stone pitching and apron

The thickness of stone pitching is given by

$$T = 0.06\,[Q]^{1/3} = 0.06\,[50000]^{1/3} = 2.21 \text{ m.}$$

This can be kept 1.0 m above H.F.L. *i.e.* upto level 141.00 m.

$$\text{Depth of scour } R = 0.47\,[Q/f]^{1/3} = 0.47\left(\frac{50000}{1.1}\right)^{1/3} = 16.77 \text{ m.}$$

For straight reach of guide bund,

Maximum scour $= 1.25\,R = 1.25 \times 16.77 = 20.97$ m

R.L. at maximum anticipated scour $= 140 - 20.97$

$= 119.03$ m

Depth of maximum scour $D = 130 - 119.03$

$= 10.97$ m

Length of apron $= 1.5\,D = 1.5 \times 10.97$

$= 16.45$ m

For curvilinear transition portion of guide bund,

Maximum scour $= 1.5\,R = 25.16$ m

R.L. of maximum scour $= 140 - 25.16 = 114.84$ m

Depth of maximum scour $D = 130 - 114.84$ m

$= 15.16$ m

Length of apron $= 1.5\,D = 1.5 \times 15.16$

$= 22.74$ m

Thickness of launching apron $= 1.9\,T = 1.9 \times 2.21 = 4.2$ m

4. Analysis for annual flood series of a river yielded a sample mean of 900 m^3/s and standard deviation of 400 m^3/s. Estimate the design flood of a structure on this river to provide 90% assurance that the structure will not fail in the next 50 years. Use Gumbel's method and assume the sample size to be very large.

Ans:

$\overline{x} = 900$ m^3/s and $\sigma_{n-1} = 400$ m^3/s

Reliability $R_e = 0.90 = (1 - 1/T)^{50}$

$\left(1 - \frac{1}{T}\right) = 0.90^{1/50} = 0.9978$

$T = 475\ years$

$x_T = \overline{x} + K\sigma_{n-1}$

$K = \frac{y_T - 0.577}{1.2825}$

$y_T = -[\ln.\ln \frac{475}{475-1}] = 6.16226$

$K = \frac{6.16226-0.577}{1.2825} = 4.355$

$x_T = 900 + 4.355 * 400 = 2642$ m^3/s

5. What is meandering? Explain basic factors controlling process of meandering

Ans:

River meandering: A river that winds a course not in a straight line but in a sinusoidal pattern (Figure 1) is called a meandering river.

Fig: Meandering River

It is the continued action of the secondary flow developed on the river bends that cause further erosion on the outer bank and deposition on the inner bank. The meandering action increases the length of the stream or river and tends to reduce the slope.

BASIC FACTORS CONTROLLING PROCESS OF MEANDERING

The basic factors controlling process of meandering are given below :

1. Valley slope . This is overall slope of terrain traversed by the stream and is measured down the axis of the valley. A change in the valley slope always produces change in the meander pattern.

2. Stream load. Composition of stream load as well as its rate of movement materially affects the meander pattern.

3. Discharge. This concerns seasonal stream flow variations as represented by the average hydrograph. There is a close relationshilp between the rate of discharge and the rate of bed load movement and, therefore, it affects meandering.

4. Bed and side resistance. Boundary resistance are characterised by the nature of materials composing the alluvium, more particularly by its resistance to erosion. Grain size, specific gravity, cohesion and roughness are important factors. Grain sizes may range from large boulders and pebbles in head reaches to fine sand and silt in lower reaches of a river. In a river with gravel and boulder bed, no definite meander pattern is observed as the river has a tendency to form interlaced channels.

6. Define the terms aggrading and degrading type of river with a diagram.

Ans:

Aggrading River: When the sediment transporting capacity of a river at a point becomes less than the sediment load being carried, as a result of reduction the velocity due to an increase in cross section or reduction in slope of the river, the excess sediment get deposited on the river bed. As a result the riverbed rises, the phenomenon being termed as aggradation. Often this phenomenon is noticed on the upstream of a dam (Figure 2), where the velocity of water in the reservoir is reduced as a result of increase in flow depth.

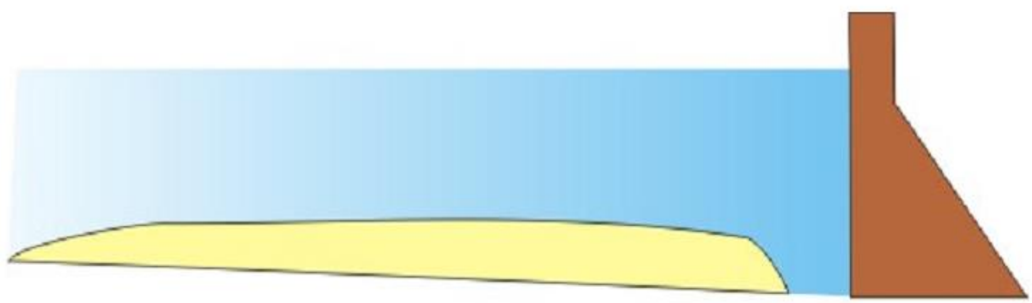


Fig 2: Longitudinal river profile showing sediment deposition on river bed in the reservoir behind a dam.

Degrading River: Channel degradation refers to the general lowering of the bed elevation that is due to erosion. In some cases, the bed material is fine and egradation will result in channel incision as shown in Figure 3.

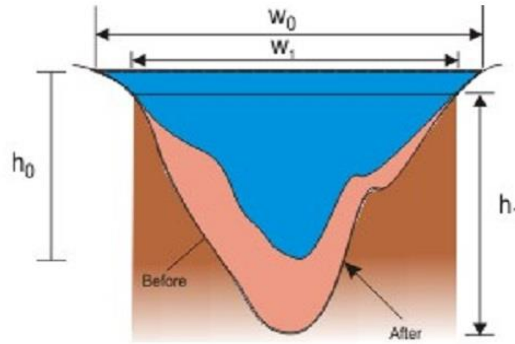


Figure 3 . River cross section for bed degradation. Original river width w_0 and river depth h_0 befor degradation ; After degradation width changed to w_1 and depth to h_1

The phenomenon of degradation occurs when the sediment load being transported by a river is less than sediment transporting capacity of the river and the excess sediment needed to satisfy the capacity of the river will be scoured from erodable riverbed. Degradation results in channel incision and milder slopes, often this phenomenon is observed downstream of a dam constructed on a river (Figure 4).

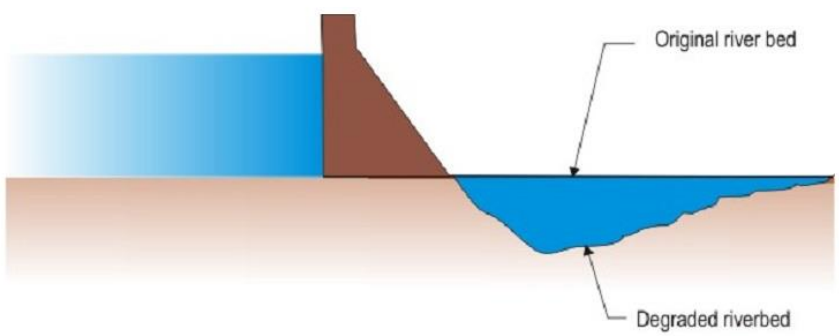


Figure 4. Longitudinal river profile showing river bed degradation along length of river below a dam