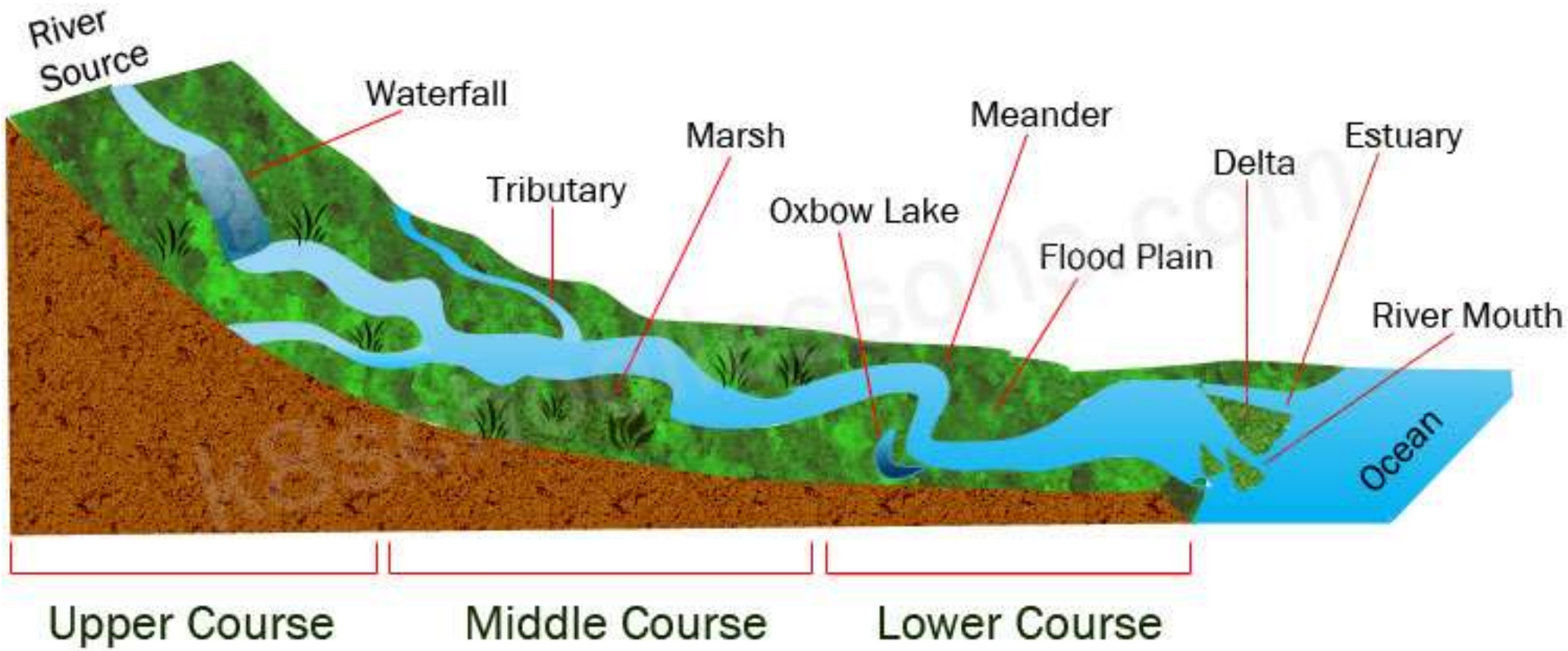
River stages and need of river training

A river originates from mountain and reaches the sea. If passes through various stages as explained below:

- Rocky or incised stage
- Boulder stage
- Alluvial stage
  - ✓ Aggrading
  - ✓ Degrading
  - ✓ Stable
  - ✓ Braided
  - ✓ Meandering
- Deltaic stage
- Tidal stage



Estuary (the tidal mouth of a large river, where the tide meets the stream.)

Rocky or incised stage

- First stage and river takes from mountain and hilly region.
- Flow channel is formed by the process of degradation
- Bed slope of River reaches are highly steep 1:100 to 1:500 and flow velocity is also very high
- Ideal stage for dam construction
- Water is clear

no river training

Boulder stage

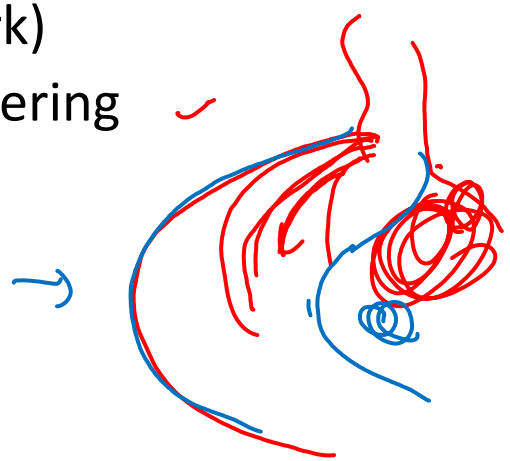
- Second stage and river flows from rock to boulder
- River in this stage consists of mixture of boulders, gravels and sand deposits
- Bed slope is steep but less than rocky stage i.e. 1:500 to 1:1000.
- Rivers have straighter courses.

Trough stage

- Also known as alluvial river
- Bed slope is flatter 1:1000 to 1:2000
- Most suitable location of Headworks

River in flood plains are further classified as:

- ✓Aggrading (Deposition in river bed)
- ✓Degrading (Erosion of river bed)
- ✓Stable (neither silting nor scouring)
- ✓Braided (forms many branches within channel network)
- ✓Meandering



Delta stage

- River, before joining sea gets divided into branches forming triangular shaped delta
- The velocity of rivers approaching sea gets reduced
- Channel gets silted and water level rises forming new channel branches
- The branches multiply in number as river approaches sea

Tidal stage

- Tail reaches of river adjoining the sea are affected by the tides
- The sea and ocean water enters the river during flood tide and goes out during low tide
- The periodic rise and fall in water level takes place

River training works:

- Structure constructed in the river so as to guide and regulate the flow of a river in a desired way
- River training work is generally required when the river is meandering type.
- Meandering occurs due to scouring on convex face and silting on concave face.
- Meandering of river occurs due to dominant discharge (1/2 to 2/3 of peak discharge)

Meander length: Axial length of one meander

Meander Width/Belt: Distance between outer edge of loop

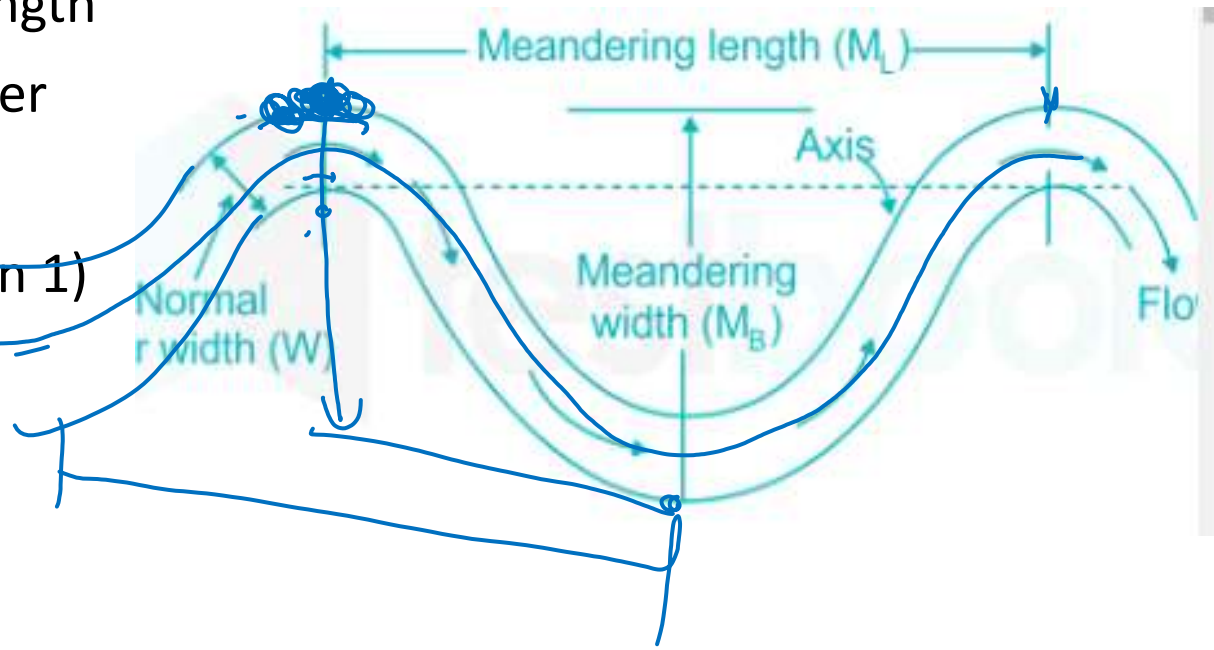
Meander Ratio: Ratio of meander width to meander length

Sinuosity: Ratio of actual length to straight length of river

- It's value is always greater than 1

Turtuosity: It measures degree of sinuosity.(greater than 1)

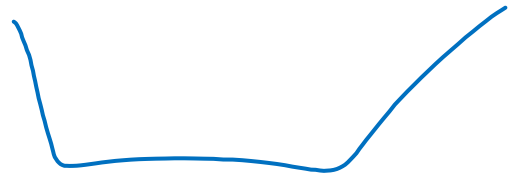
When a river starts meandering, the sediment carrying first decreases and ultimately increases



Types of river training works

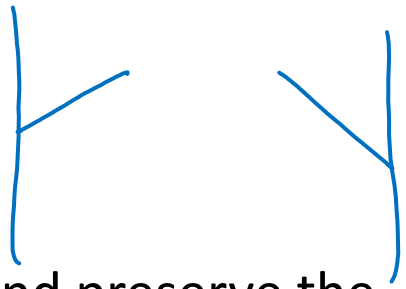
High water training or training for discharge

- The primary purpose is to control flood
- Flood is controlled by providing sufficient river cross section for safe passage of maximum flood
- E.g marginal bund



Low water training or training for depth

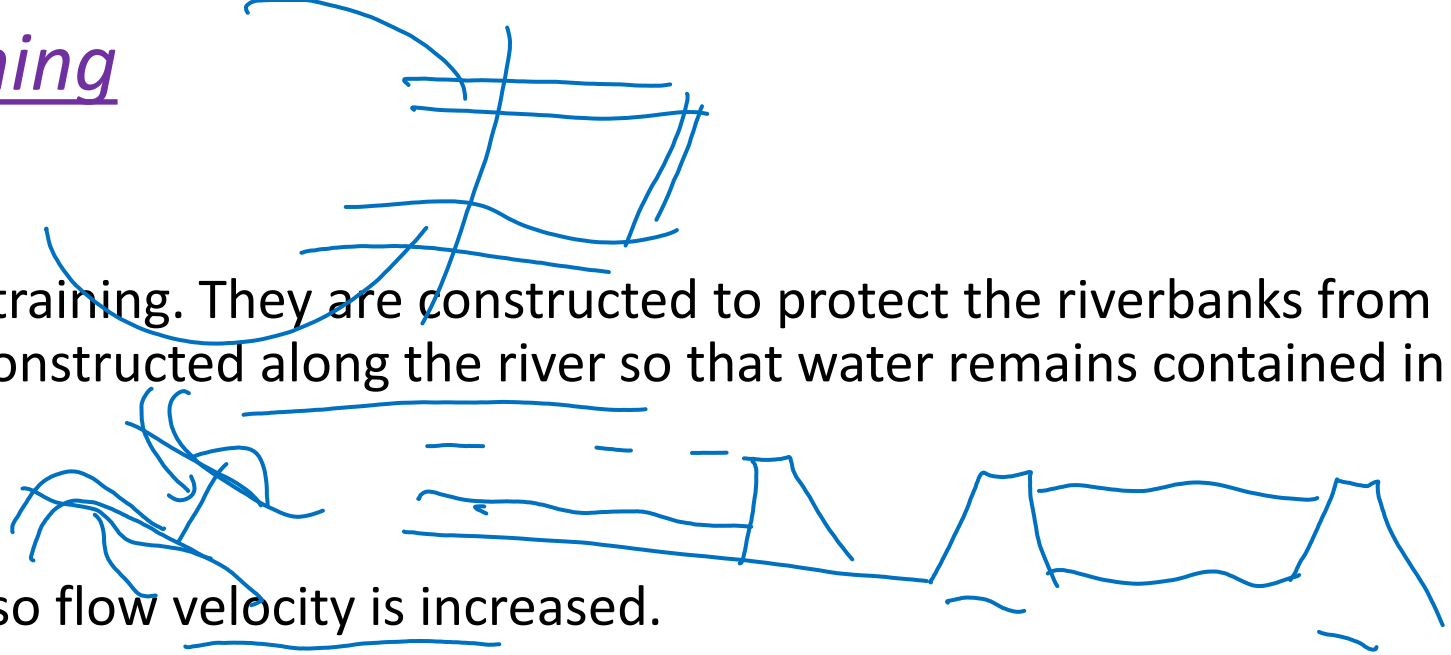
- The primary purpose is to provide sufficient water depth for navigation
- E.g groynes, bandalling



Mean water training or training for sediment

- The primary purpose is to efficiently dispose suspended and bed load and preserve the channel geometry
- Example: Check dams

Methods of river training



1. Marginal embankments or leeves

- Levees construction is a method of river training. They are constructed to protect the riverbanks from flooding. It is basically an embankment constructed along the river so that water remains contained in between the levees during flooding.

Effects of levees construction

- It reduces the width of the river stream, so flow velocity is increased.
- It contains the flood water in between the levees only, which increases the discharge.
- It increases the water surface elevation during flooding.
- It decreases the flood storage as maximum flood water becomes the part of discharge.

2. Guide banks or guide bunds

- Structures constructed to give direction to river.
- Also called as Bell bund.

Components of guide bank and their design

Waterway

The clear waterway is given by Lacey's regime equation.

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

This value is increased by 20 % extra for pier thickness)

Length of guide bank

(Recommended by Gale)

Total length of guide Bank u/s

= 1.25 L for Q up to 20,000 cumecs

=1.50 L for Q > 20,000 cumecs

Length of guide bank d/s

= 0.25 L

Where, L= length of structure

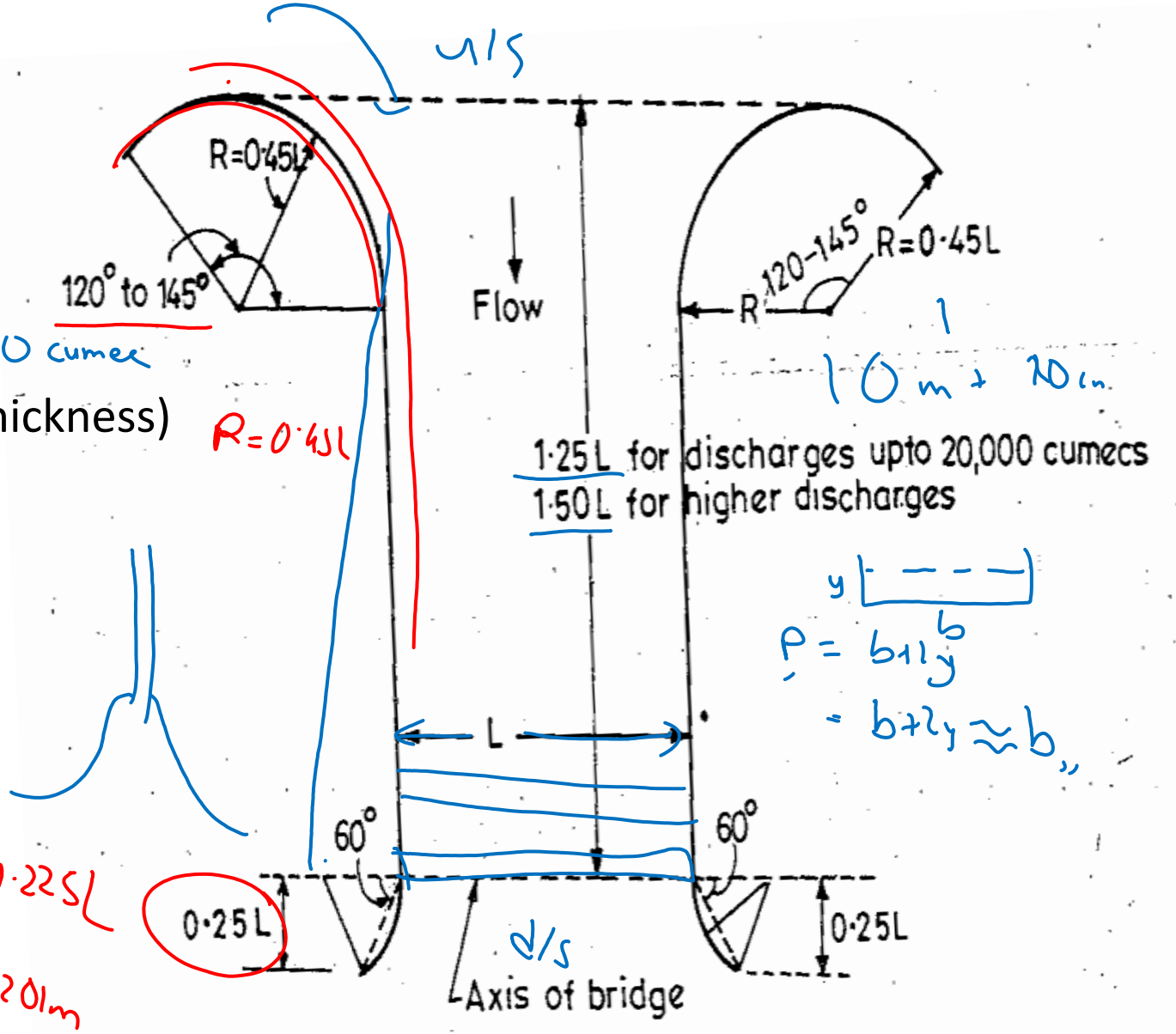


Fig. 8.16. Gale's recommendations for guide banks.

Radius of curve head of guide bank (u/s and d/s)Launching apron

Generally, Radius R for u/s head = 0.45L

Radius of d/s head is kept to one half

of the d/s head radius = 0.225 L

Shank portion

Straight portion of guide bank is called shank.

Cross Section of bund

The top width of the guide bank should not be less than 4 m.

Side slope should not be steeper than 2:1.

Minimum free board of 1.2 to 1.5 m is generally provided.

Slope protection (Stone pitching)

- Side slope of guide bank is pitched with stone

Thickness of stone pitching is calculated as:

$$t = 0.06Q^{1/3} \ (parameters\ in\ SI\ unit)$$

When the slope is protected against scouring, pitching is extended beyond the toe of bed in the form of packed stones known as Launching apron.

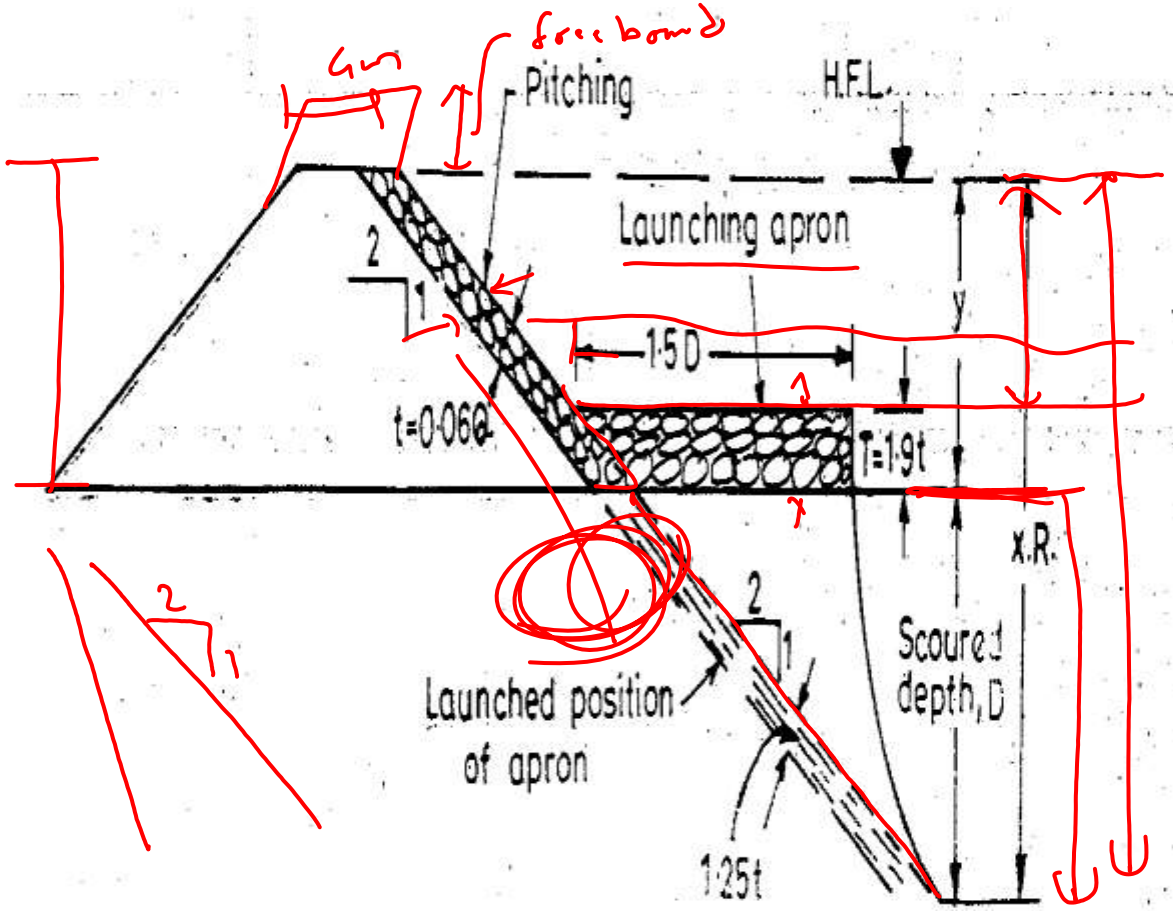


Fig. 8.21. Launching apron details.

Design considerations,

Width of the launching apron = 1.5*Scour depth (D)

Where, scour depth = x* Lacey's Scour depth=x*R_r'

$$R = R_r' = 0.473\left(\frac{Q}{f}\right)^{\frac{1}{3}}$$

Location	Values of x,
Noses of guide bank	2.25
Transitions from nose to straight part	1.5
Straight	1.25

Note: Scour depth is measured from water surface level

So, scour depth below original ground level (D)=x*R-water depth about bed(y)

Also, thickness of unlaunched apron is given by (T)= 1.9t

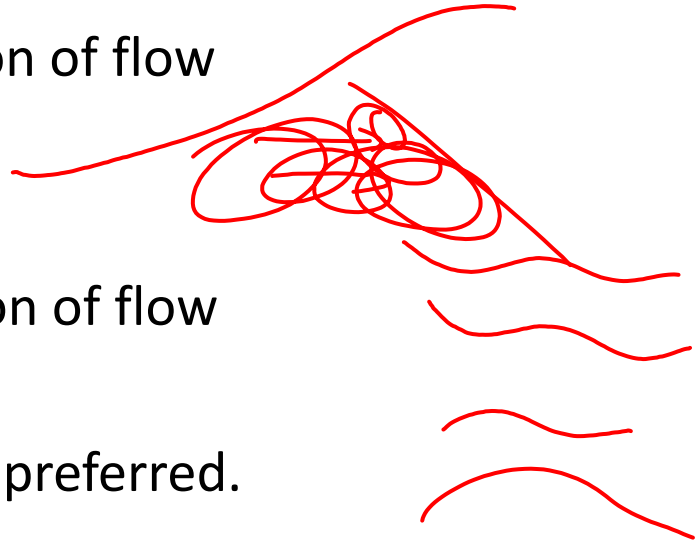
3.Spurs or groyne

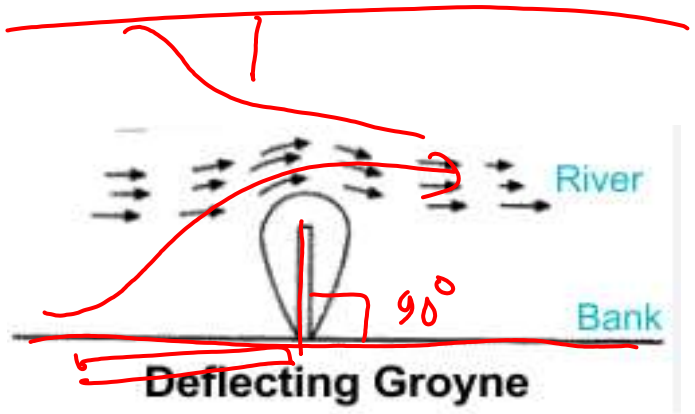
- Structures constructed transverse to the direction of river flow
- Also called transverse dykes
- Main function is bank protection
- Generally designed for 50 year return period flood.

Depending upon the function spurs are classified as:

a.Normal spur/Deflecting spur:

- Spur perpendicular to the direction of flow
- Mostly used spur in Nepal

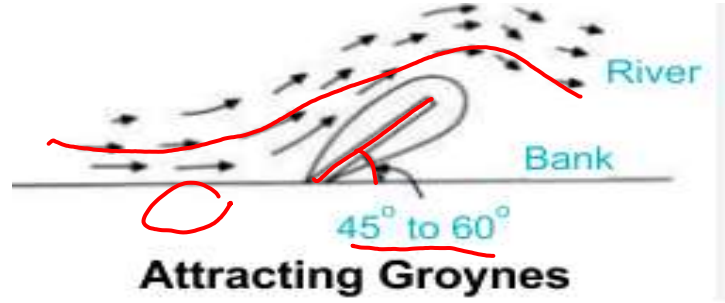




Deflecting Groyne

b. Attracting spur:

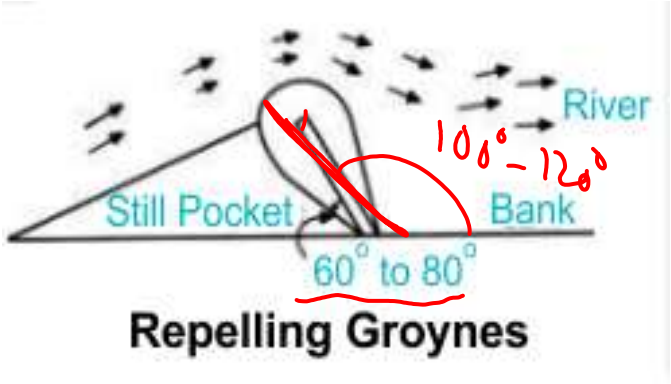
- Spur at acute angle to the direction of flow
- Points downstream (45^0 to 60^0)
- Attracting spurs are generally not preferred.



Attracting Groynes

c. Repelling spur:

- Spur at obtuse angle to the direction of flow
- Points upstream (60^0 to 80^0)
- They are more effective than attracting spurs



Repelling Groynes

Some other spurs are:

Deheny's spur: T-shaped spur

Hockey Groynes: Curve shaped groynes

Permeable spur: Allows Significant flow through them

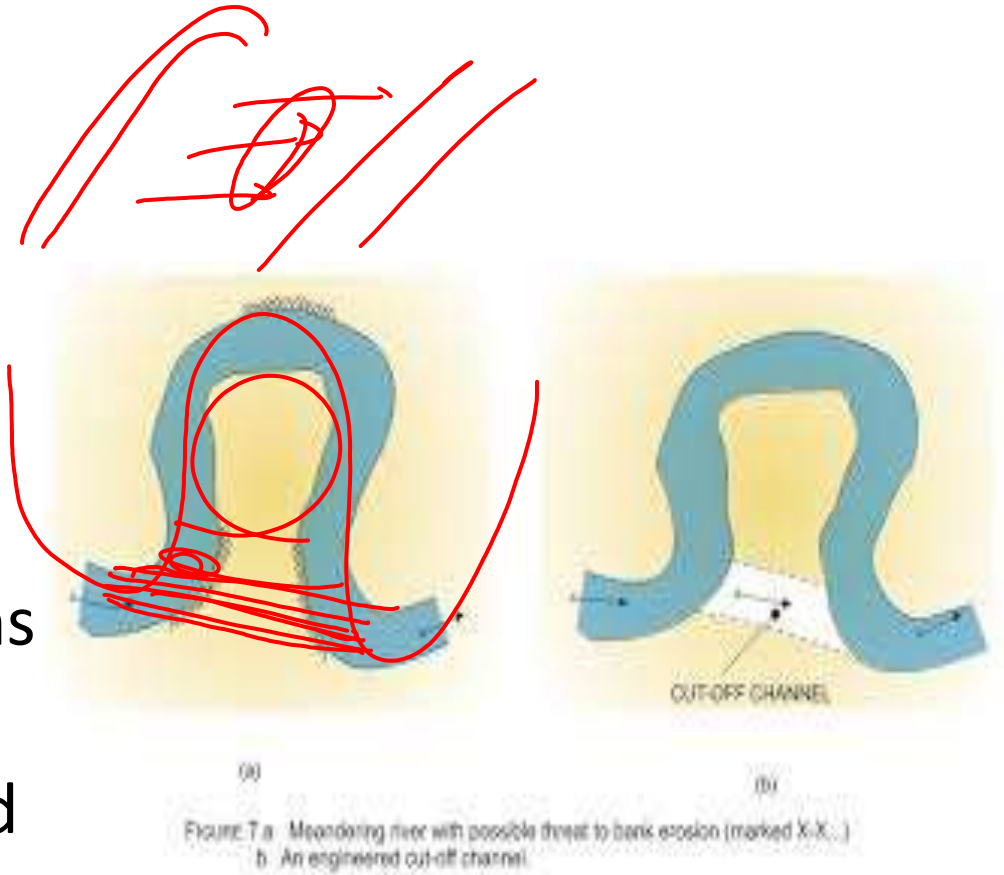
Impermeable spur: Do not allow significant flow through them

4 Artificial cutoff

-Meandering river attains straight reach by means of cutoff

-May be developed by itself or artificially induced

-Meandering increases length of river whereas cutoff decreases length of river



(a) (b)

Figure: 7 a Meandering river with possible threat to bank erosion (marked X-X...)
b An engineered cut-off channel

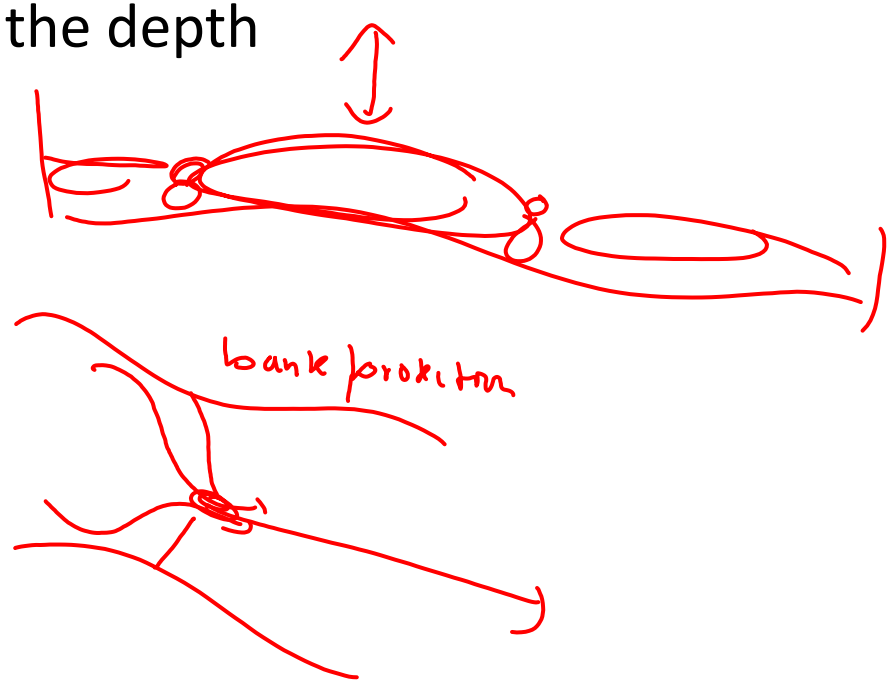
5. Pitched Island:

- Pitched island is an artificially created island in the river bed.
- It is protected by stone pitching from all sides.

6. Bandalling

- It is one of the method of confining low water in a river to increase its depth.
- Bandalling is the frame of bamboos driven into the soil and kept at certain angle to flow direction to decrease the channel width and increase the depth

Fig. Bandalling



Watershed Management

- Watershed management can be defined as the process of water and landuse management to improve the quality of the water and other natural resources within the watershed by managing the use of those land and water resources in an effective way.
- Main objective of watershed management is the efficient use of all available resources.

Principles/objectives of watershed management:

- Conservation of soil, plant and water resources of the watershed.
- Utilization of land
- Erosion control
- Flood control
- Efficient drainage of excess water
- Groundwater recharge

Factors affecting watershed management:

- Topography
- Area
- Shape
- Landuse
- Soil type
- Climate