

## Channel Changes in the Flood

There are some invisible changes occur in the river whenever flood occurs. Due to flood some rivers change their direction of flow and some rivers go on the process of siltation.

### Stage discharge diagram

Discharge: Measured as Cubic meter/hour of hydrograph.

Stage: Height of water in the river. Not the depth of the water. The height of water level with respect to mean sea level.

When the flood starts water level and amount of discharge start to increase. Stage reaches at rising stage. Here  $Q_{max}$  and  $h_{max}$  do not coincide. When the graph reaches  $h_{max}$  then the falling stage starts.

**Usefulness of stage discharge diagram:** In hydrograph the Q value is measured in cubic meter/hour. But during flood the measurement of Q in such unit is not so easy. Hence stage discharge diagram serve the best to determine the value of Q. In the river where we want to draw the stage discharge diagram the discharges are measured at different stages and eventually plotted on a plain graph paper.

Measurement of discharge is not so easy .But stage can be measured very easily. So, if there is a built in stage discharge diagram for a cross section we can get the value of Q by measuring stage only .

How to determine the height of an embankment?

An embankment should be strong enough and sufficiently high so that the water do not overflow. From the stage discharge graph of the particular cross section where the embankment has to be built we get different value of  $h_{max}$  corresponding to different return period T . Now a graph can be plotted taking  $h_{max}$  and corresponding return period as parameters. From this graph a safe value of  $h_{max}$  is determined considering some options. If there is a nuclear power plant in the neighborhood of the embankment then the  $h_{max}$  is determined so that the possibility to reach the  $h_{max}$  is the least per year. Again the variations of the datum has to be considered. So to determine the height of an embankment the  $h_{max}$  with a specific return period is taken and a safety height (normally 1m-2m)is added which is known as free board.

So, Embankment height= $h_{max}$  within a specific return period + free board(1m-2m)

Due to flood the cross sectional area of rivers are changed. How?

There are four diagrams for a specific cross section of a river. From Sep 09 to Sep 30 the value of Q increases 10 times and from Sep 30 to Oct 14 Q again increases 10 times. Again from Oct 14 to Oct 26 the value of Q further decreases for 10 times. From Sep 09 to Sep 30 the river is on rising stage. When the flood starts at Sep 09 different kinds of materials that come to the river through surface runoff is accumulated and deposited under the river. From Sep 30 to Oct 14 discharge increases, so stage also rises. As we know  $Q=A v$  ; where A is the cross-sectional area perpendicular to the direction of flow

and  $v$  is the velocity. As a result,  $A$  and  $v$  both increase. With the increase in velocity  $v$ , the competence and capacity also increase. So the flow of water can bear more soil. With increase in velocity saltation occurs. As a result drainage scouring occurs. So the river bed deepens. At the fourth stage from Oct 14 to Oct 26,  $Q$  decreases. So velocity as well as competence and capacity decrease. So the suspended particles will be again accumulated. The particles of greater size will accumulate at first, then the smaller ones. As a result the stage and depth again decrease.

### **Concept of equilibrium and graded stream**

Equilibrium or graded stream is that kind of stream of which inflow and out flow of load is equal. That means the amount of sediment being output is equal to the amount of input sediment. So equilibrium is a balanced condition. Let us assume a specific portion of river say 3km-4km in length. If the accumulated bed material in the upstream is equal to the material that erodes away from the downstream then we can call this stream in equilibrium. A stream in equilibrium is called a graded stream. But this does not mean that the same material that is accumulated in the upstream again erodes through the downstream. There are some dynamics through which streams maintain their equilibrium state. Actually a stream maintains its equilibrium by maintaining its slope. Here according to stage discharge diagram, at the starting flood as  $Q$  increases so a large amount of sediment is accumulated in the upstream. So obviously a large amount of material has to be discharged to maintain this equilibrium. But internally only a single parameter, slope changes to maintain this equilibrium. If the incoming sediment at the upstream increases then the river deposits this sediment at the upstream so that the slope difference between upstream and downstream increases. So velocity increases due to steeper slope. As  $Q=A v$ ;  $Q$  also increases. So a greater  $Q$  washes away a large amount of sediment. This is how a graded stream maintains this equilibrium sediment in=sediment out.

Factors controlling equilibrium of a stream:

(1) Stream discharge

(2) Sediment discharge and size of the particles:

(3) Slope:

(4) Channel shape: Width/Ratio

### **Consequences of slope adjustment**

Accumulated at the upstream of a river. So materials are deposited in two sides of river. So the cross sectional area of the river decreases. As  $Q$  increases to compensate for  $A$  the velocity  $v$  increases. So the bottom of the river is corroded. So the rivers become narrow and deep.

If the materials are stored in the river bed, then the cross sectional area again decreases. So the velocity increases and hits the sides of the river and bank erosion of river occurs. So the rivers become wide and shallow gradually.

#### Longitudinal profile of a stream

The longitudinal section of a river is called the longitudinal of a stream. Most of the Bangladeshi rivers are originated from Himalayan range. More the height of the river bed from the base level ,more erosion.