Chapter – 6

Conclusions and Scope of future study

6.1 General

A slender structure placed in flow path of a channel section changes the flow field around it and consequently affect the channel boundaries. If the channel boundary is erodible one, the flow field developed around slender structure influence the shape of the boundary of the channel section with time. The influence may be on bed or channel bank or both bed and channel bank that depends on the size and shape of the structure that creates obstruction in flow path and dimensions of channel section.

In the present study, experimental and numerical model study has been carried out for better understanding of the flow field around slender (Pier) structure mounted on rigid and erodible channel bed. The effect of shape, sizes and numbers of slender structure on flow field is studied for both rigid and erodible channel section. A field study is carried out at Varanasi on River Ganga to observe the change of morphology of river course after construction of Viswasundari Bridge to know the effect of bridge piers on river flow.

Based on the present experimental investigation and field study, the following conclusions may be drawn.

6.2 Concluding Remarks

1. Flow behavior around structural obstruction in open channel or river flow is a complex natural phenomenon. When the slender structure kept vertical on erodible channel bed scouring take places and scour hole form surrounding it.

2. The change of flow field around the structure enhances the erosion and deposition of soil particles around it. Strong pressure field on the upstream face of a slender structure causes a strong vortex system moving in the downstream direction. The vortex is caused by strong pressure field in front of the structure. The vortex at upstream face and sides develop large shear on the boundary and causes scour. Deformations of the flow field around obstacles generally increase the local bed shear stress resulting in an enhancement of the sediment transport.
3. Exact scour depth varies with the kinematics and dynamic boundary condition hence estimating the exact values of scour depth in field are not only difficult but a complex task.
4. The experiment in the channel has a full control on all the parameters, resulting in the data which may not be calculated in the field at any cost. The depth of scour hole around pier depends on soil properties of the channel bed, shape and size of the pier, Froude number of flow.
5. Experiments are carried out for different laboratory pier model to study the scouring effect on different shape and size of slender structure. The study reveals that equilibrium scour depth mainly depends on the shape of structure, depth of flow, velocity of water and grain size of bed material.
6. The equilibrium scour depth around rectangular pier is more compared to cylindrical pier and it is approximately 8 to 10 % for similar flow boundary conditions and characteristic dimension of the structure. The equilibrium scour depth for oval shape pier is 5 to 7% more compared to cylindrical.
7. Comparative analysis revealed that pier fitted with collar reduces the temporal scouring effect about 40% when the collar size used three times the diameter of the pier.
8. Bigger size collar is impractical and may reverse effect the scouring. In bridge pier construction, the collar may be used for reducing the scouring effect. The fluid-structure interaction force on concentric collar is very complex and the design of collar needs special attention during its construction.

9. The condition for most efficient channel section in rigid boundary channel is proposed for multiple barriers in flow path. The depth to width relationship depends on the number of equal spacing barrier and on increasing the obstruction factor the depth of flow decreasing.
10. The numerical model reveals that there should a minimum gap between multiple piers to avoid interference of the piers in flow field. The ratio spacing of piers to diameter of piers and should be greater than 2.33 for cylindrical pier. At low velocity there is no interference between the piers.
11. The erosion and deposition also depends on the manmade obstruction in the river course which influence the river dynamic. It is observed from sinuosity data of River Ganga that sand deposition varies year to year in two consecutive bends.
12. From year 2001 to 2012, siltation happened on bend1 side approximately 0.44km^2 and bvend2 side is 0.17km^2 and perimeter of silt deposition changes by 711.56m for bend 1 and 212.01m for bend 2.
13. The sinuosity in the River Ganga decreases from 1.66 to 1.26 in last 10 years and sand deposition also changes over time. This implies that the channel morphology of River is changing continuously.

6.3 Scope of Future study

In the present investigation, the flow behavior around slender structure is studied experimentally and analytically. The flow behavior around structure is complex phenomenon. The problem may be investigated further for:

- Numerical modeling of flow field around slender structure taking effect of scour hole formation with time.
- Numerical modeling of vortex flow around different shape of structure.
- Conceptually design of scour protection devices.
- Development of transfer functions from model scale to reality and verification of these functions with field data.