24.2 Sketching of Composite Water - Surface Profiles

Characteristics of water-surface profiles in prismatic channels have been discussed in the previous sections. However, in real life, a channel system may have variable cross section or bottom slope. Also, it may have several control sections. A control section is a section at which there is a unique relationship between the depth and discharge. For example, weirs, sluice gates and spillways are control sections. They create sub critical flows on the upstream side when they are performing under free flow conditions. However, sub critical flow conditions occur on the downstream side also, if the control structure is submerged or drowned. Similarly, critical depth occurs in the vicinity of a free overfall in a mild channel. This acts as a downstream control for sub critical flows since there is a unique relationship between the flow depth and the discharge when the flow is critical. Critical flow conditions also occur at the entrance to a steep channel if the water level in the lake or reservoir which is feeding the channel is higher than the level of CDL at that point.

Steps outlined below are followed to sketch the composite water surface profiles in a series Channel system.

- Compute normal and critical depths for each reach of the channel system based on specified flow rate, roughness coefficient, slope of the reach, and the channel cross section.
- Plot the channel bed, the normal depth line (NDL) and the critical depth line (CDL) for each reach in the system.
- Mark the control sections i.e., identify the sections where (i) the flow passes through a critical depth (ii) the flow is expected to occur under uniform conditions, and (iii) there is a control structures such as a weir, a sluice gate, and a spillway. It may be noted that uniform flow conditions occur in long prismatic channels, far away from control sections. Critical depth occurs at (i) the free overfall, and (ii) the entrance to a steep channel from a lake, when the water level in the lake is above the the elevation of the CDL at the entrance. Critical depth also occurs when channel bed slope changes from mild to steep.

- Starting from each control point, sketch the appropriate water surface profile depending on the zone in which the depth at the control section falls and the nature of the slope.
- Qualitatively locate the hydraulic jumps wherever the flow changes from supercritical to sub critical. For example, if there is a sluice gate at the downstream end of a steep channel, the flow is sub critical on the upstream side of the gate. However, if the channel is long, flow is supercritical far away from the gate on the upstream side. Therefore, a hydraulic jump occurs in such a channel (Figure 24.1 b). Also, on the downstream side of a sluice gate on a long mild channel, the flow is supercritical immediately downstream of the gate. However, far away from the gate on the downstream side, flow is subcritical. Therefore, a hydraulic jump occurs in such a case also (Figure 24.1 a).