Lab # 3: Steady Flow Modeling: Modeling Water Surface Profile with a Sinusoidal Bed

Introduction:

Because of continuous sediment movement in river beds, bed levels are changed and formed into different shapes depending on the flow states. These are known as *bed forms*. Typical bed forms are: a) Ripples b) Dunes c) Plane bed d) Anti dunes and e) Chutes and Pools. These bed forms are shown in figure 1.

Ripples (figure 1a) are the bed forms of having small amplitudes and wavelengths. They are nearly sinusoidal and have gentle upstream slope with a relatively higher downstream slope. Dunes (figure 1c) are larger than ripples but smaller than bar or island. Water surface profile is out of phase with the bed level profile. Both ripples and dunes are developed during low flow regime, i.e, *subcritical flow*.

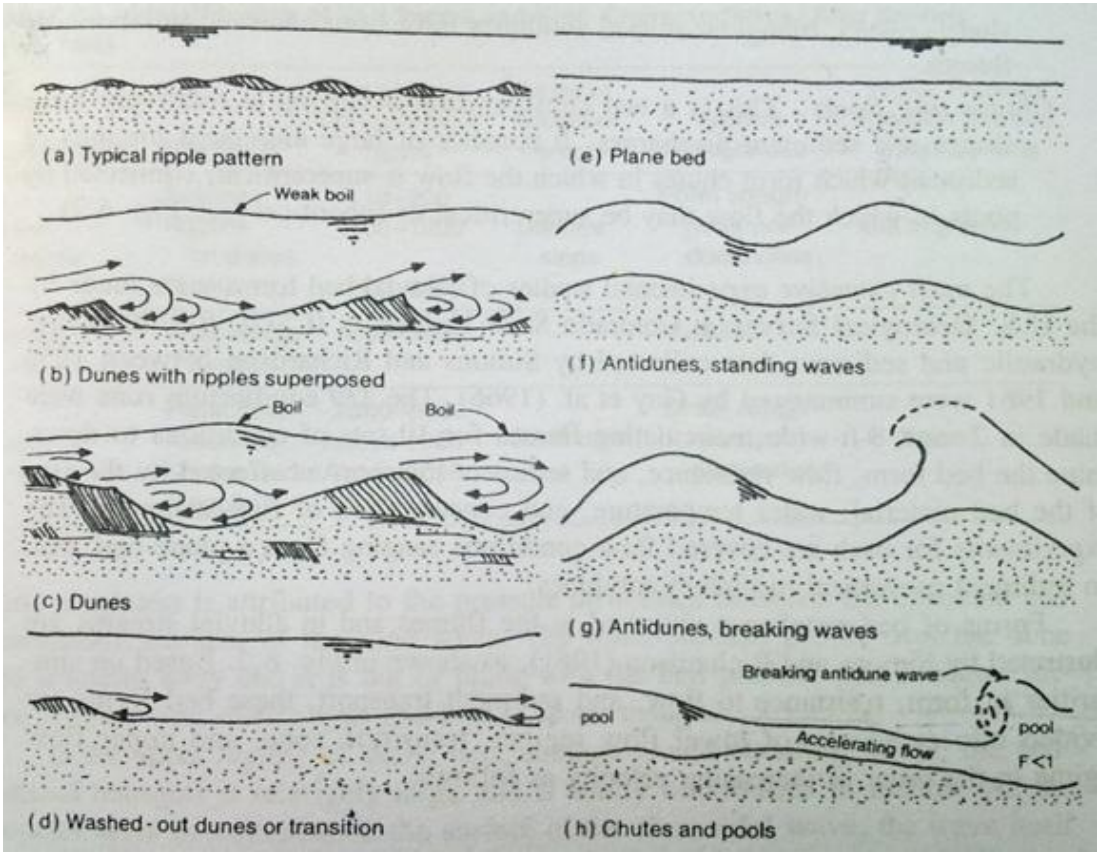


Figure 1: Different bed forms in alluvial channels (after Simons et al., 1966)

As the flow moves towards higher flow regime, bed forms are washed out and formed plane bed (figure 1e). As flow increases and sediment transport continues, antidune bed forms are formed. For this bed form, water surface profile is in phase with bed elevation profile (figure 1f). For rivers with steep slope, such as mountain rivers, alternate deep pool and steep chutes are observed (figure 1h).

Presence of bed forms effect the flow resistance, i.e., roughness. Moreover, water surface profile is also affected by the types of bed forms. For example, in *subcritical* flow regime, water surface elevation becomes out of phase with bed elevation profile. If flow becomes *supercritical*, *hydraulic jump* is formed. These phenomenons can be simulated with the *Gradually Varied Flow* equation as described in the Lab # 2.

Objective of this lab:

In this lab, our main objectives are to understand the effects of bed forms on flow and to be familiar with different components of HEC-RAS. Therefore, in this lab we will simulate water surface profiles due to a sinusoidal bed for a subcritical flow.

Specific Objectives:

1. Generate a sinusoidal bed profile using the given information.
2. Create a new project.
3. Draw a schematic of a straight river.
4. Assign cross section data.
5. Assign boundary condition data.
6. Perform the analysis
7. View and present the results.

Following information are needed for this lab:

- The channel is rectangular.
- The channel width is 100 m.
- The channel length is 3750 m.
- Use 50 m interval
- Manning's n can be assumed as 0.025 $s/m^{1/3}$.
- The discharge in the channel is 20 m^3/s.
- Bed profile = Amplitude*Cos(PI*distance/625)
- Amplitude is = (Last two digits of your student number + 50)/100.
- Downstream boundary condition is = (Amplitude+0.3) m

Submissions:

1. Calculation of your longitudinal bed profile.
2. Calculation of your downstream boundary condition.
3. Printing of longitudinal profile of water surface elevation.
4. Printing of longitudinal profile of Froude number.
5. Does your water surface elevation is out of phase with bed elevation profile? Justify your answer.
6. What is a bar/island? How does a bar/island different than other bed forms?
7. Discussions.