Open Channel Flow

I. Introduction

Determination of the flow rate of water in open channels is significant in many aspects of society. For example, urban and industrial water supplies must be measured so that demands are satisfied; the amount of water required for the dilution of pollutants being wasted into a river can be calculated mathematically, but metering devices are required to measure the supplied flow; and flood damage can be determined by correlating the depth of water passing over a dam spillway (a special type of weir) to the volume of water flowing downstream.

A weir is a vertical obstruction placed in an open channel, normal to the mean flow, thus forcing the flow over a crest designed to measure the flow rate. A well designed weir will exhibit subcritical flow upstream, accelerating to critical flow at the crest. For more information on subcritical and supercritical flow, this experiment will consider one class of weirs, known as sharp-crested weirs, which are smooth, vertical, flat plates with a sharpened upper edge. In particular, rectangular and triangular weirs will be studied.

Consider a schematic diagram of flow over a weir (Figure 12). Among the complicated features of the flow are:

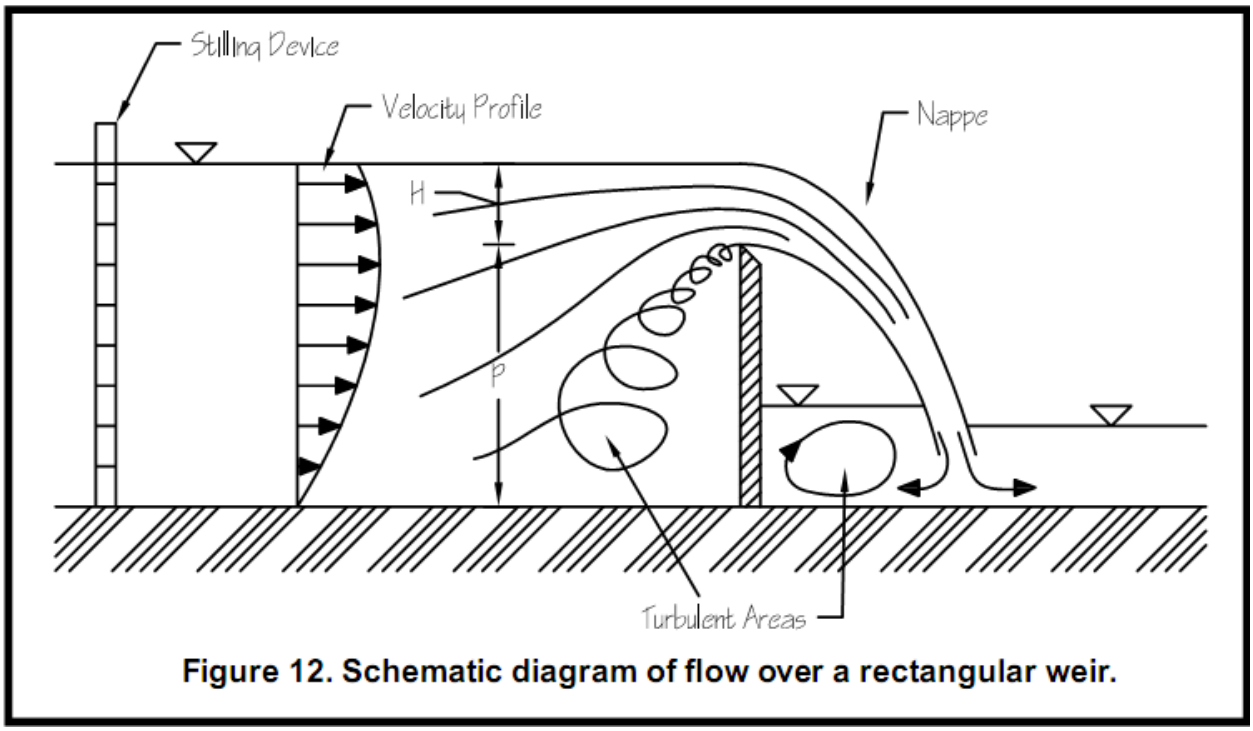

Figure 12. Schematic diagram of flow over a rectangular weir.

(1) upstream velocity profile which varies over the vertical;

(2) curved streamlines over the crest;

(3) potentially inadequate ventilation under the nappe, which may result in

subatmospheric pressure there;

(4) secondary flows and other turbulent processes;

(5) surface tension

For a first analysis, the problem is greatly simplified by neglecting these complicating features. A diagram of the simplified flow is shown in Fig.

Specifically, simplifications include:

(1) Uniform upstream velocity profile (generally valid for H/P <0.4);

(2) Straight, horizontal streamlines over the crest;

(3) Good ventilation, and therefore atmospheric pressure, under the nappe;

(4) neglect of secondary flows and other turbulent processes;

(5) Neglect of surface tension (generally valid for H>3cm).

Simplifications (2) and (3) indicate that the flow over the weir may be treated as a jet. Note that the velocity profile over the crest is still not uniform.

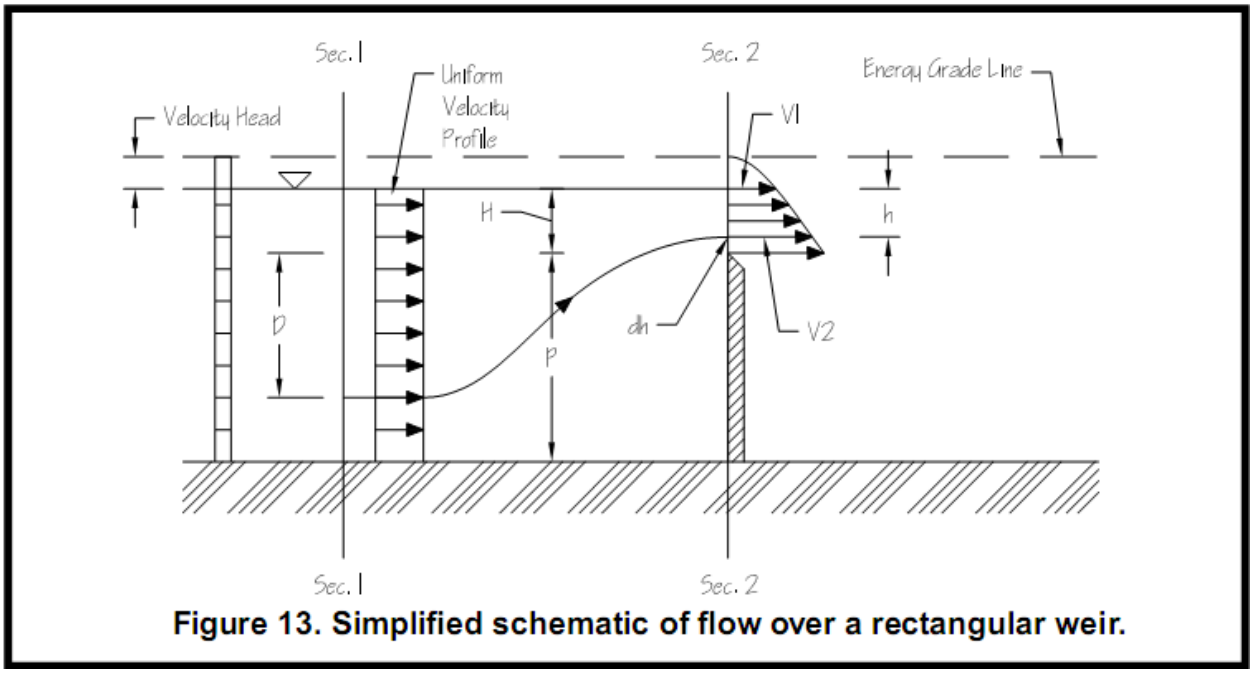

Figure 13. Simplified schematic of flow over a rectangular weir.