Design of stilling Basins

***1- Introduction***

Stilling basins are external energy dissipaters placed at the outlet of a spillway, culvert, chute, or rundown. These basins are characterized by some combination of chute blocks, baffle blocks, and sills designed to trigger a hydraulic jump in combination with a required tailwater condition. With the required tailwater, velocity leaving a properly designed stilling basin is equal to the velocity in the receiving channel. Depending on the specific design, that operated over a range of approach flow Froude numbers, the United States Bureau of Reclamation (USBR) developed several designs of stilling basins based on model studies and evaluation of existing basins.

***2- Type of USBR Stilling Basin***

**A- Type IV Stilling Basin**

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**Fig.1: USBR Type IV Stilling Basin ( Fr = 2.5 to 4.5 ).**

**B- Type III Stilling Basin**



 **Fig.2: USBR Type III Stilling Basin ( Fr = 4.5 to 17 ).**

 **C- Type II Stilling Basin**



 **Fig.3: USBR Type II Stilling Basin.**

***Design Example***

 **Proportion a USBR stilling basin Type II for the overflow spillway designed in previous example. The tailwater elevation is at El = 920.**

**Solution**

 **Start the design from the Fig.13 with:**

 **a head of Hd = 17.7 ft & a total fall Z = 120 ft**

**So, the actual velocity will be V = 79 *ft l s* ( from the Fig.13)**

**So A = Q / V = 75000 / 79 = 949.37 ft2**

**But A = b . y1 or y1 = A / b = 949.37 / 250 = 3.797 ≈ 3.8 ft**

 **So, Fr = V / (g y1) 0.5 = 79 / (32.2 x 3.8) 0.5 = 7.13**

**Now, from the (Fig.3 of USBR Type II Stilling Basin) with Fr=7.13 yields:**

1. **Tw/ D1 = 9.7 from the solid curve**

 **So Tw = 9.7 x D1 = 9.7 x 3.8 = 36.9 ft = D2 = y2**

1. **From the line of minimum Tw the figure gives:**

 **Tw/ D1 = 9.2 , So**

 **Tw = 9.2 x D1 = 9.2 x 3.8 = 35 ft**

***Note that this Tw = 35 ft now ≠ (D2 = y2), which is a very important note.***

***Now, for purposes design adding 8 % to this value the Tw will be:***

 **Tw = 35x 1.08 = 37.8 ft *( > D2 or 1.024 D2)***

***So, the EL. of the basin floor of the tailwater = 920 – 37.8 = 882.2***

 ***Now, the length of the basin can be obtained by entering the curve in Fig. 3c with Fr=7.13. Thus,***

***L/D2= 4.16 So, L = D2\*4.16 = 4.16 \* 36.9 = 154 ft***

 ***Also, the height, width and spacing of the chute blocks as recommended by the design of type II, will be such that:***

 ***h1 = W1 = S1 = D1 = 3.8 ft (say 3 ft and 10 inches)***

***The height of the dentate sill is 0.2 D2= 0.2 \* 36.9 = 7.38 ft***

***The width and spacing of the dentate is:***

 ***0.15 D2= 0.15\*36.9= 5.54 ft***