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AN OVERVIEW OF SLUICE GATE USED IN CANAL OR RIVER.

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ABSTRACT

A civil Hydraulic-Structure Engineer always think about to design a sluice gates which have better discharge, proper divert flow with related to water depth.

Sluice gates are typically installed in open channels such as streams to determine discharge (flow rate) and to divert flow; the basic principle is that discharge is directly related to the water depth**.** Sluice gates are extensively used in hydraulic structures to control the flow depth and discharge. In this paper we are studying about sluice gate and its application in canal or river.

Key words: Q, g, y, a, L, Cd, Cc, K_1***,***

I. INTRODUCTION

A sluice is a water channel that is controlled at its head by a gate (from the Dutch word 'sluis'). For example, a millrace is a sluice that channels water toward a water mill. The terms "sluice gate", "knife gate", and "slide gate" are used interchangeably in the water/wastewater control industry.

A sluice gate is traditionally a wooden or metal plate that slides in grooves in the sides of the channel. Sluice gates are commonly used to control water levels and flow rates in rivers and canals. They are also used in wastewater treatment plants and to recover minerals in mining operations, and in watermills.

Sluice gates are also used as flow diversion and flow measuring devices in irrigation. Among the various factors influencing the discharge characteristics of the sluice gates, alignment is an important one.

II. GATES USED IN CANAL OR RIVERS

Based on alignment, sluice gates are classified as:

(i) Normal sluice gates

(ii) Side sluice gates

(iii) Skew sluice gates

2.1 Normal Sluice Gate

The conventional sluice gate discharge equation is written as:

$$Q = C_d a L \sqrt{2gy} \qquad (2.1)$$

Where a = gate opening

Henry (1950) gave C_d versus y/a curves with y_t/a as third parameter, where y_t = tail water depth. Swamee (1992) gave the following equations for Henry's (1950) curves for free and submerged flow respectively:

$$C_d = 0.611\left(\frac{y-a}{y+15a}\right)^{0.072} \qquad (2.2)$$

$$C_d = 0.611\left(\frac{y-a}{y+15a}\right)^{0.072}\left\{1+0.32\left[\frac{0.81y_t\left(\frac{y_t}{a}\right)^{0.72}-y}{y-y_t}\right]^{0.7}\right\}^{-0.1} \qquad (2.3)$$

In theory, the sluice flow rate formula can be accurately obtained if the contraction coefficient is known (Henderson, 1966). The most common flow rate expression makes use of the conservation of energy, mass and momentum in the sluice gate - hydraulic jump flow. This procedure yields the following equation:

$$Q = C_d . a . L \sqrt{2gy_1}$$

a is the gate opening, L is the gate width and y_1 is the upstream water level. In this context, the discharge coefficient C_d is given by two equations (one for each flow condition), functions of the contraction coefficient Cc,L, y_1 and, for the submerged condition, the downstream
water level y_3:

Free flow:

$$C_d = \frac{C_c}{\sqrt{1+\eta}}$$

Submerged flow:

$$C_d = C_c \frac{\left[\xi - \sqrt{\xi^2 - \left(\frac{1}{\eta^2} - 1\right)^2 \left(1 - \frac{1}{\lambda^2}\right)}\right]^{\frac{1}{2}}}{\frac{1}{\eta} - \eta}$$

Where

$$\eta = \frac{C_c.L}{y_1}$$

$$\xi = \left(\frac{1}{\eta^2} - 1\right)^2 + 2(\lambda - 1)$$

and

$$\lambda = \frac{y_1}{y_3}$$

Unfortunately, the contraction coefficient varies with the amount of gate opening, shape of the gate lip, upstream water depth, gate type and so forth (Lin et al., 2002). Thus, it is very difficult to know its true value for all operating conditions in practice. That is why there are other approaches that combine some theoretical and some practical knowledge in order to simplify the task.

2.2 Side Sluice Gate

Panda (1984) studied velocity distribution and water surface profile in main and side channels under free and submerged flow conditions. The sluice gate discharge equation was given as:

$$Q = C_d a L \sqrt{2g\left(y_0 + y_a\right)} \qquad (2.4)$$

Tanwar (1984) obtained experimental curves for C_d which are similar to Henry's (1950) curves.

Hager and Volkart (1986) proposed the following equation for discharge variation along the rectangular side sluice gate in a prismatic rectangular channel of small slope:

$$\frac{dQ}{dX} = -aE\left(\frac{2g}{3(4E-3y)}\right)^{0.5} \qquad (2.5)$$

Using the concept of elementary discharge coefficient, C_e, Swamee et al (1993) gave the following equations for free and submerged flow respectively:

$$C_e = 0.611\left(\frac{y-a}{y+15a}\right)^{0.216} \qquad (2.6)$$

$$C_e = 0.611\left(\frac{y-a}{y+15a}\right)^{0.216}\left\{1+0.24\left[\frac{2.5y_t\left(\frac{y_t}{a}\right)^{0.2}-y}{y-y_t}\right]^{0.67}\right\}^{-0.1} \qquad (2.7)$$

2.3 Skew Sluice Gate

Mansoor (1999) conducted a vast number of tests in a concrete channel in Roorkee and proposed an equation for the elementary discharge coefficient for skew sluice gate, over a big range of h/w from zero to infinity. His equation is valid for angles 0° to 90° of skew sluice gates.

Using the sluice gate constants listed in table, the following equations were obtained involving ɵ (in radian)

$K_4 = 1 + .068\theta^{11.8}$

$K_5 = 0.216 - 0.0206\theta^{4.3}$

$K_6 = 0.24 + 0.051\theta$

$K_7 = 2.5 + 0.784\theta^{1.7}$

$K_8 = 0.2 + 0.03\theta^{6.3}$

$K_9 = 0.67 + 0.019\theta$

$$K_{10} = 1 - \frac{0.32\theta(\pi-2\theta)}{1-20\theta}$$

III. CONCLUSION

- Lot of works has been carried out by various investigators on normal and side sluice gates and suitable relationships for discharge coefficient C_d have been presented by them in literature for estimating flow rate in open channels.
- Other non conventional shapes of sluice gates were also tried by few investigators for special uses.
- It is found that scanty almost no work has been presented by any investigator on skew sluice gates. Thus need was felt to carry out detail study of skew sluice gates and to develop empirical relationship for discharge coefficient as well as flow rate in terms of flow and geometrical parameters of sluice gates.

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