Design Stable Channels in India

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Abstract— A landform consisting of flow of water is known as water channel. Canal is an example of artificial channel. Almost all the north Indian rivers flow through alluvial soil and therefore do carry certain amount of sediments. Silting and scouring is that processes in which sediments of water gets deposited in the bed and banks of channel. Silting and scouring is not desirable in water and must be avoided by proper design. Scouring lowers the full supply level and causes water loss and it may also cause of failure of foundation of irrigation structures. Therefore it is necessary to design such channel which does not carry silting or scouring. A stable channel is that which is free from silting and scouring. Kennedy's silt theory gave a formula of such a critical velocity at which silting and scoring may be avoided.
Key words: Channel Silting, Scouring, Etc

I. INTRODUCTION

Almost all the north Indian rivers flow through alluvial soil and they carry certain amount of sediments. Artificial channels like canal have to carry their water supply from such rivers, and thus carrying sediments. Water moving with a certain velocity and depth can carry in suspension, only a certain amount of silt of a certain nature. If water of a given velocity and depth is not fully charged with silt it will scour the bed and sides of channel, till it is fully charged with silt. Hence, if the speed of flow in channel is high, the bed and beds are likely to be eroded, and similarly if the velocity is low, the silt which was formerly carried in suspension is likely to be dropped. Silting and scouring is not desirable in water and must be avoided by proper design. Scouring lowers the full supply level and causes water loss. It may also cause of failure of foundation of irrigation structures. R. G. Kennedy an executive Engineer of Punjab public works department gave a formula to calculate critical velocity or mean velocity of water which is able to just keep the channel free from silting and scouring.

II. KENNEDY'S THEORY

He concluded that the silt supporting power in a channel cross section was mainly dependent upon the production of eddies, rising to the surface. These eddies are generated due to the friction of the flowing water with the channel surface. The vertical component of these eddies try to move the sediments up, while the weight of the sediments tries to bring it down, thus keeping the sediment in suspension. So if the velocity is sufficient to generate these eddies, so as to keep the sediment just in suspension, silting will be avoided. Based upon this concept he defined the critical velocity (V_0) in a channel which will just keep the channel free from silting or scouring. Formula for V_0 is given below.

$$V_0 = 0.55my^{0.64}$$

Where: V_0 = Critical velocity in the channel in meter/second
y = water depth in channel in meter
m = Critical velocity ratio (Which will depend upon type of silt)

S.No.	Type of Silt	Value of m
	Light sandy silt in north Indian rivers	1.0
	Light sandy silt, a little coarser	1.1
	Sandy, loamy silt	1.2
	Hard soil	1.3

Table 1: Recommended values of critical velocity ratio (m)

Determine the critical velocity Vo by the above equation, by assuming a trial depth, and then calculate area by dividing discharge by velocity. Then determine channel dimensions. Finally compute the actual mean velocity (V) that will prevail in the channel of this cross section, by using Kutter formula. If the two velocities Vo and V work out to be the equal, then the assumed depth is all right otherwise change it and repeat the procedure till V and Vo become equal.
Following is the formulas' to calculate actual mean velocity(V):

III. KUTTER'S FORMULA

$$V = \frac{\frac{1}{N}+(23+\frac{0.00155}{s})}{1+(23+\frac{0.00155}{s})\frac{N}{\sqrt{R}}} \cdot \sqrt{RS}$$

Where:
V= velocity of flow in meters/seconds
R= Hydraulic mean depth in meters
S= Bed slope of the channel
N = Rugosity constant

Value of N depends upon condition of channel and also upon discharge. The recommended values of N for lined channels are given below:

S.No.	Condition of channel	Values of N for Lined channel
	Very Good	0.0225
	Good	0.025
	Average	0.0275
	Poor	0.030

Table 2:

The recommended values of N for different discharges for unlined channel are given below:

S.No.	Discharge in meter^3/seconds	Value of N for Unlined Channel
	14 to 140	0.025
	140 to 280	0.0225
	280 and above	0.020

Table 3:

After trial and error a position may come where critical velocity and actual mean velocity will be equal, this velocity is considered to final design velocity of the channel.

IV. CONCLUSIONS

Almost all the north Indian rivers contain silt and causes increase of friction force between canal bed and banks. And it leads to lower the speed of flow and results into water losses, this process is known as scouring and silting. Stable channel is that which is free from silting and scouring. Silt is type of soil which has size lower than sand and greater than clay. To design a stable channel it is must required to design a velocity to keep these silt particles in suspension, and not allow it to deposited in bed of channel, this velocity is known as critical velocity. Kennedy's silt theory gave formula for design this critical velocity (Vo). Actual mean velocity is also calculated by Kutter formula and compared it with critical velocity. Trial and error method is carried out until the V and Vo will not be equal. By trial and error method final velocity of channel is carried out. This velocity is able to keep channel just free from scouring and silting.

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