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IRRIGATION ENGINEERING

[BTAI 2201]

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Kennedy's Theory:

R.G. Kennedy Carried out a number of study in Upper Bari Doab Canal System in Punjab

He selected some straight reaches of canal section, which had not posed any silting & scouring problems during the previous 30 years or so.



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He concluded that silt supporting power in a channel cross-section is mainly dependent on generation of eddies, rising to the surface.

These eddies are generated due to friction of flowing water with channel surface.

Vertical component of these eddies try to move sediment up, while weight of sediment tries to bring it down, thus keeping in suspension.

So if velocity is sufficient to generate these eddies, so as to keep sediment just in suspension, silting will be avoided.



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Based upon this concept, he defined the critical velocity (V_0) in a channel as the mean velocity which will just keep the channel free from silting or scouring and related it to the depth of flow by the equation.

$$V_0 = c D^n \quad (\text{Eq. 9.28})$$

where c and n are constants depending upon silt charge.

Values of c and n were found to be 0.55 and 0.64, respectively.

Therefore, Eq. (9.28) can be written as

$$V_0 = 0.55 D^{0.64} \quad (\text{Eq.9.29})$$



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Above Eq. (Eq.9.29) is true for Upper Doab Section. For general sections carrying silt laden water, he introduced critical velocity ratio (C.V.R.) (denoted by symbol m) which depends upon the silt grade.

The modified Kennedy's formula is given as:

$$V_0 = 0.55 m D^{0.64} \quad (\text{Eq. 9.30})$$

where, V_0 = Critical velocity in the channel in m/sec and D = Depth of flow in the channel, m.



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Recommended values of critical velocity ratio, m for different silt carried channel

Sl. No.	Type of silt	Value of m
Sl. No.1	Silt of river Indus (Pakistan)	0.70
Sl. No.2	Light sandy silt in North Indian River	1.0
Sl. No.3	Light sandy silt, a little coarser	1.1
Sl. No.4	Sandy, loamy silt	1.2
Sl. No.5	Debris of hard soil	1.3



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The values of constant c in Eq. (9.28) for various grades of materials are:

Types of materials	Values of c
Light sandy silt	0.53
Coarser light silt	0.59
Sandy loam	0.65
Coarse silt	0.70



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Design Procedure: Kennedy's design procedure is based on following steps.

Assume a trial depth, D & then compute critical velocity V_0 by Eq (9.29).

Determine area by dividing discharge by velocity (velocity calculated as in step above.)

Then determine channel dimensions.

Finally, compute actual mean velocity (V) by Chezy's equation with Chezy's constant C calculated either by Bazins formula or by Kutter's formula.

- i. If two velocities V_0 and V are same, then assumed depth is **ok**, otherwise change it and repeat the procedure. Thus several iterations are required to get dimensions of channel.



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Kutter's formula to Calculate Chezy's Constant, C

$$C = \frac{23 + \frac{0.00155}{S} + \frac{1}{N}}{1 + \left(23 + \frac{0.00155}{S} \right) x \frac{N}{\sqrt{R}}}$$



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An irrigation channel has side slope 1:1 & base width 3 m. It has flow depth of 1 m. Bed slope is 0.04%. Assume Manning's rugosity coefficient $N = 0.028$. Determine if channel will be regime channel. Assume critical velocity ratio as 1.0.

Given $N = 0.028$ and $S = 0.04$ percent = $1/2500$

Base width = 3 m & slope is 1:1. Depth of flow = 1m.

Hence top width of the channel = 5 m.

Area of the trapezoidal section = $(5 + 3)/2 = 4$ sq. m.

Wetted perimeter = $3 + 2\sqrt{2} = 5.83$ m.

Mean hydraulic radius, $R = A/P = 0.69$ m.



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Using above values of n , R and S , velocity by Manning's formula,
 $V = 0.56 \text{ m/s}$.

Using Kennedy's formula,
velocity $V_0 = 0.55 m D^{0.64}$
 $= 0.55 \times 1.0 \times (1.0)^{0.64} = 0.55 \text{ m/s}$.

Since the two velocities are
nearly same,
the channel is stable i.e. **regime**.



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Drawbacks in Kennedy's Theory

- (i) The theory is limited to average regime channel only.
- (ii) The design of channel is based on trial & error method.
- (iii) The value of critical velocity ratio was fixed arbitrarily.
- (iv) Silt charge & silt grade were ignored.
- (v) Kennedy did not notice importance of B/D ratio.
- (vi) No account was taken of silt concentration and bed load.
- (vii) No slope equation was given except depending on Kutter's equation



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