

## 22.5 Design of Unlined Channels

In 1895 Kennedy evolved an equation for  $V_0$ , nonsilting and non-scouring velocity and depth of flow after studying dimensions of stable alluvial canals ranging over 30 sites in a stretch of 144 km on upper Bari Doab Canal System in Punjab.

$$V_0 = 0.546y^{0.64} \quad (\text{in mks})$$

After a study of hydraulic dimensions of 4,345 km of channels in the Punjab, Lindley suggested, in 1919, the following relations connecting the velocity  $V$  ( $\text{m}^3\text{s}^{-1}$ ), the surface width  $B$  (m) and the depth of flow  $y$  (m):

$$V = 0.57 y^{0.57} \quad (\text{in mks})$$

$$V = 0.2646 B^{0.335} \quad (\text{in mks})$$

$$B = 7.86 y^{1.61} \quad (\text{in mks})$$

Lindley's theory was further advanced by Lacey in 1929, but he adopted  $P$ , the wetted perimeter and  $R$ , the hydraulic mean radius, as the flow parameters instead of the surface width  $B$ , and the depth of flow,  $y$ , and in addition introduced a 'silt factor',  $f$ . Lacey's formulae in their final form is as follows:

$$P = 4.825 Q^{1/2} \quad (\text{in mks})$$

$$R = 0.4725 Q^{1/3} / f^{1/3} \quad (\text{Same for both units})$$

$$S = 0.0003015 f^{5/3} / Q^{1/6} \quad (\text{in mks})$$

$$V = \frac{1}{N_a} R^{3/4} S_o^{1/2} \quad (\text{in mks})$$

$$N_a = 0.0225 f^{1/4} \quad (\text{Same for both units})$$

Lacey's general flow equation is similar to that of Manning; but  $N_a$  in Lacey's relation is an absolute rugosity coefficient which, in addition to boundary friction, allows for shock losses in the channel due to irregularities or bends. The silt factor  $f$  was correlated approximately to the silt grade  $m$  (in mm) by the relation  $f = 1.76\sqrt{m}$  on the implicit assumption of the 'regime charge' being carried by a channel in regime. Chitale analysed the data subsequently in 1966.

Though the Lacey equations have been in common use in India and also in other countries, it has been long realised that these equations were not perfect and suffer from certain shortcomings. Perhaps the major difficulty experienced in application of Lacey's equations is in the choice of appropriate value of the silt factor 'f' occurring in the Lacey formulae for depth and slope. It is also found that canals designed according to Lacey formulae give a somewhat wider and shallower section. Moreover divergence from dimensions given by Lacey equation in existing stable channels with those given by Lacey formulae errors resulting from adoption of Lacey equations for P, R, and S<sub>0</sub> were worked out which ranged from 11.27 to 83.47 percent.

