17.4 The Section Factor for Uniform-Flow Computation

The term AR $^{2/3}$ is known as the section factor for uniform - flow computation; in case of Manning formula. This would be AR $^{1/2}$ for Chezy formula. It is an important parameter in the computation of uniform flow. From the equations given above, this factor may be written as

For Manning formula	For Chezy formula
$AR^{\frac{2}{3}} = \frac{n\,Q}{\sqrt{S_0}}$	$AR^{\frac{1}{2}} = \frac{Q}{C\sqrt{S_0}}$
$AR^{\frac{2}{3}} = n\,K$	$AR^{\frac{1}{2}} = \frac{K}{C}$

Primarily, above equation applies to a channel section when the flow is uniform. The right side of the equation contains the values of n or C, Q and S; but the left side depends only on the geometry of the water area. Therefore, for a given condition of n or C, Q, and S_0, there is only one possible depth for maintaining a uniform flow, provided that the value of A R $^{2/3}$ (or AR $^{1/2}$) always increases with the increase in depth, which is true in most cases. This depth is the normal depth y_n. When (n or C) and S0are known at a channel section, it may be seen from above equation that there can be only one discharge for maintaining a uniform flow through the section, provided that A R $^{2/3}$ (or A R $^{1/2}$) always increases with increase of depth. This discharge is the normal discharge.

An exponential Channel is defined to be that channel for which the relationship between depth y and area of cross section A may be expressed in the form

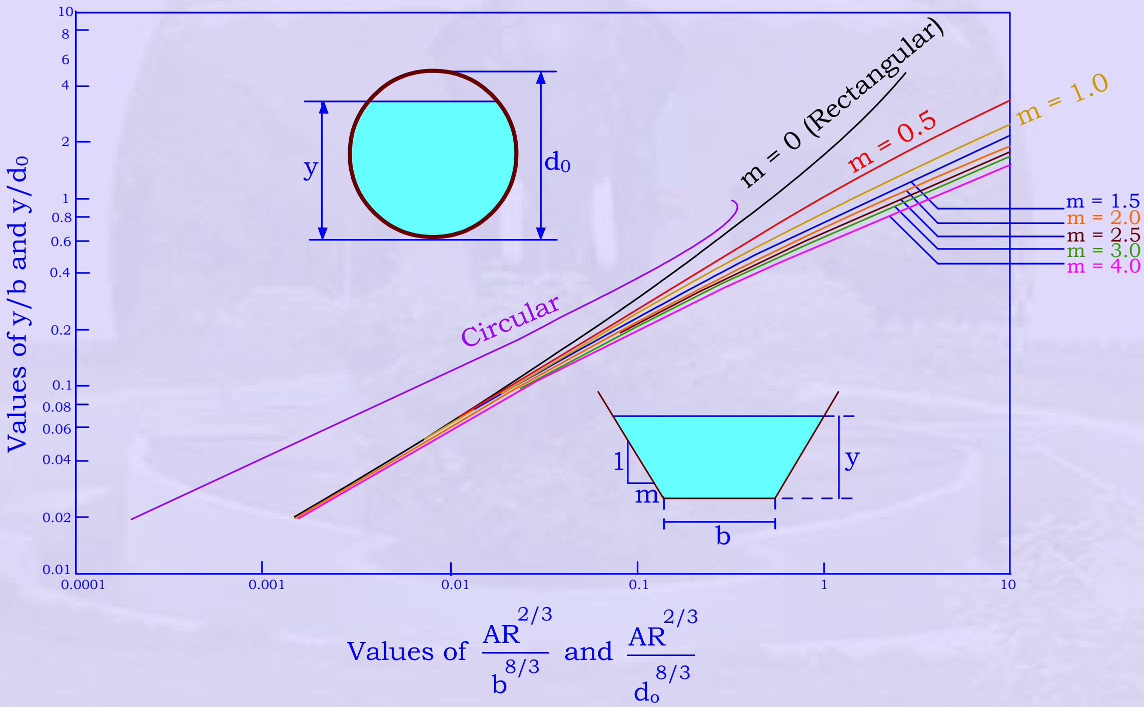
A = k y i

in which k is a coefficient, different values for the exponent viz.; i =1, 1.5, 2.0, represent rectangular, parabolic and triangular channels.

The above equation is a very useful tool for the computation and analysis of uniform flow. When the discharge, slope, and roughness are known, this equation gives the section factor and hence the normal depth y_n can be computed. On the other hand, when n or C, S_0, and the depth (hence the section factor), are given, the normal discharge Q_n can be computed from this equation in the following form:

This is essentially the product of the water area and the velocity defined by the Manning or Chezy formula. Sometimes the subscript n is used to indicate the condition of uniform flow.

In order to simplify the computation, dimensionless curves showing the relation between depth and section factor have been prepared for rectangular, trapezoidal, and circular channel sections for Manning formula. These curves aid in determining the depth for a given section factor, and vice versa. The $A R^{2/3}$ values for a circular section are given in the table in Appendix. With the advent of numerical methods the usage of the dimensionless graph is limited.



Curves for determining the normal depth

Problem: Calculate conveyance factor K using Manning equation for a trapezoidal channel.

Solution:

$$\therefore\ K = \frac{AR^{2/3}}{n}$$

$$= \frac{(b+my)\,y\,(b+my)^{2/3}\,y^{2/3}}{n\left(b+2\sqrt{1+m^2}\,y\right)^{2/3}}$$

$$= \frac{b\left[1+\frac{my}{b}\right]y\left[1+\frac{my}{b}\right]^{2/3} b^{2/3}y^{2/3}}{n\left[1+2\sqrt{1+m^2}\,\frac{y}{b}\right]^{2/3} b^{2/3}}$$

$$= \frac{\left[1+\frac{my}{b}\right]^{5/3}\left[y^{5/3}\right]b^{5/3}}{n\left[1+2\sqrt{1+m^2}\,\frac{y}{b}\right]^{2/3} b^{2/3}}$$

$$K = \frac{1}{n}\frac{\left[1+\frac{my}{b}\right]^{5/3}[by]^{5/3}}{\left[1+2\sqrt{1+m^2}\,\frac{y}{b}\right]^{2/3} b^{2/3}}$$

$$K = \frac{1}{n}\frac{\left[1+\frac{my}{b}\right]^{5/3}}{\left[1+2\sqrt{1+m^2}\,\frac{y}{b}\right]^{2/3}}\left[\frac{y^5b^5b^3}{b^2b^3}\right]^{1/3}$$

$$K = \frac{b^{8/3}\left[1+\frac{my}{b}\right]^{5/3}}{n\left[1+2\sqrt{1+m^2}\,\frac{y}{b}\right]^{2/3}}\left[\frac{y}{b}\right]^{5/3}$$