

Practical No-4

Design of Grassed Waterways

Aim: Design of grassed waterway

Theory:

Grassed waterways are natural or manmade constructed channels established for the transport of concentrated flow at safe velocities from the catchment using adequate erosion resistant vegetation which cover the channels. These channels are used for the safe disposal of excess runoff from the crop lands to some safe outlet, namely rivers, reservoirs, streams etc. without causing soil erosion.

Procedure:

1. The design of the cross-section is done using formula ($a=Q/V$) for finding the area required and Manning's formula is used for cross checking the velocity.
2. A trial procedure is adopted. For required cross-sectional area, the dimensions of the channel section are assumed.
3. Using hydraulic property of the assumed section, the average velocity of flow through the channel cross-section is calculated using the Manning's formula.
4. If the velocity calculated by Manning's formula exceeds the permissible velocity, the cross-section is suitably altered and the velocity is calculated again.
5. The process is repeated till desired velocity is obtained with selected cross-section.

Design of Grassed Waterways:

The designs of the grassed waterways are similar to the design of the irrigation channels and are designed based on their functional requirements. The waterway is to be given greater cross-sectional area towards the outlet as the amount of water gradually increases towards the outlet. The cross-sectional area is calculated using the following formula:

$$a=Q/V$$

where,

a = cross-sectional area of the channel,

Q = expected maximum runoff, and

V = velocity of flow.

Shape of Water Way:

The shape of the waterway depends upon the field conditions and type of the construction equipment used. The three common shapes adopted are trapezoidal, triangular, and parabolic shapes.

The geometric characteristics of different waterways are shown below.

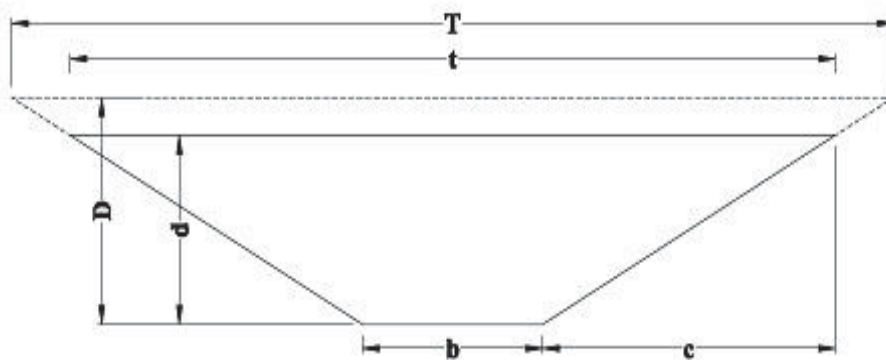


Fig. 4.1 Trapezoidal cross sectional

In the figure, d is the depth of water flow, b is bottom width, t is the top width of maximum water conveyance, T is top width after considering free board depth, $(D - d)$ is the free board and slope (z) is c/d .

The design dimensions for trapezoidal waterways are given in Table 1

Table 1. Design Dimensions for Trapezoidal Cross-section

Cross-sectional Area, a	Wetted perimeter, P	Hydraulic Radius, $R = \frac{a}{p}$	Top width
$bd + zd^2$ Where, $Z = c/d$	$b + 2d\sqrt{Z^2 + 1}$	$\frac{bd + zd^2}{b + 2d\sqrt{z^2 + 1}}$	$T = b + 2dz$ $T = b + 2Dz$

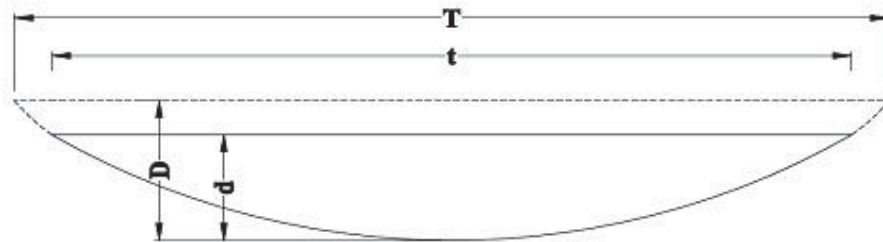


Fig 4.2 parabolic cross-section

Table 2. Design Dimensions for Parabolic Cross-Section

Cross-sectional Area, a	Wetted perimeter, P	Hydraulic Radius, $R = \frac{a}{p}$	Top width
$\frac{2}{3}td$	$t + \frac{8d^2}{3t}$	$\frac{t^2 \times d}{1.5t^2 + 4d^2}$ $\frac{2d}{3} \text{ approx}$	$t = \frac{a}{0.67d}$ $T = t \left(\frac{D}{d}\right)^{\frac{1}{2}}$

Channel Flow Velocity

The velocity of flow through the grassed waterway depends upon the ability of the vegetation in the channel to resist erosion. The average velocity of flow through the channel cross-section is calculated using the Manning's formula as below:

the average velocity of flow through the channel cross-section is calculated using the Manning's formula as below:

$$V = (S^{0.5} R^{(2/3)}) / n$$

where, V = velocity of flow in m/s; S = energy slope in m/m; R = hydraulic mean radius of the section in m and n = Manning's roughness coefficient.

NUMERICALS:

Question:

Design a grassed waterway of parabolic shape to carry the peak runoff rate as $2.6 \text{ m}^3/\text{s}$ down a slope of 3%. The waterways have a good grass cover, the allowable velocity may be assumed as 1.75 m/s . assume $n=0.3$.

Question:

Design a grassed waterway to convey a peak flow of $6\text{m}^3/\text{s}$ on 1 %slope with erodible sandy soil. The waterway has a good grass cover and a permissible velocity of 1.5m/s can be allowed. Assume the value of manning's coefficient as 0.034.

