# Determination of flow resistance of vegetated floodplains


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Vegetation on river banks can reduce flow velocity during flood events and protect river from erosion flow. The external organs of the resisting plant species contribute to surface roughness, reduce flow velocity and consequently decrease the fluid shear stress. Due to vegetation flexibility, the water energy is dissipated and the resulting hydraulic resistance helps to sediment deposition in the river banks, contains the width of the flow and enhances the walls satiability with extending the banks.

Flow resistance due to vegetation may greatly affect the conveyance of river, and thus evaluating the resistance is a critical task in river engineering and restoration. Therefore, flow resistance of natural willows was studied in nonsubmerge and subcritical condition in a flume with the length of 12.6 m, width of 0.5 m and hight of 0.6 m in different velocity, discharge and depths.The hight of plants in this is 35 cm with a natural arrangement in a bench of 2.8 m in length put in the bed of a laboratory flume.

The aim was to investigate, hydraulic radius, type of vegetation, flow depth and velocity influence vegetal friction losses. Friction factors,f, was determined for a selection of 60 test runs. The results showed large variations with depth of flow, velocity, Reynolds number and vegetal characteristics. Vegetal drag coefficient for the leafy willows was three to four times that of the leafless willows.

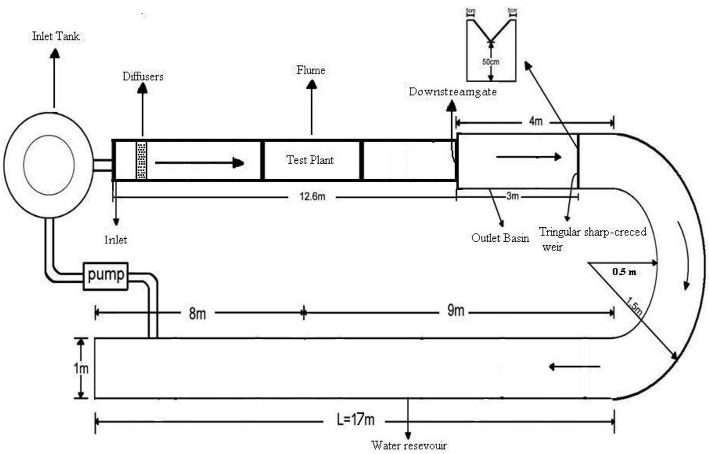


**Fig.1 :Layout of flume for vegetation roughness experiments**

$$n_{Vb} = \frac{1}{\bar{V}} R^{2/3} S_f^{1/2} \qquad (1)$$

$n$ = Manning roughness coefficient

$\overline{V}$ = measured mean flow velocity

$R$ = Hydraulic radius

$S_f$ = Energy loss slope in upstream and downstream vegetation

**Fig 2: River natural willows plants**

**Conclusions**

After the tests were conducted on the provided physical model, the results were reproduced in several plots. With due regard to the physical limitations in execution of the tests the total number of tests was reduced to twenty four tests. Considering the actual observations and the figures obtained the results can be summarized as follows:

**1. Flow Velocity**

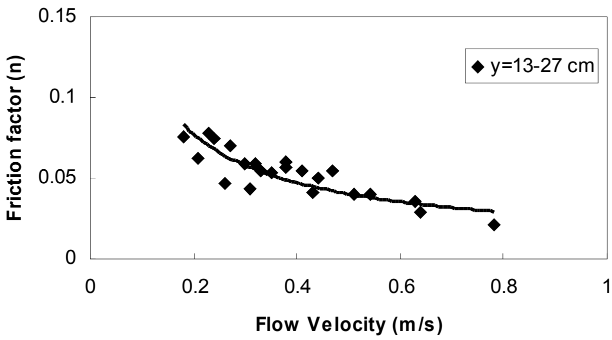


**Fig. 3: Variation of friction factor (n) with flow velocity and flow depth for non-submerged condition**

**2. Flow Depth**

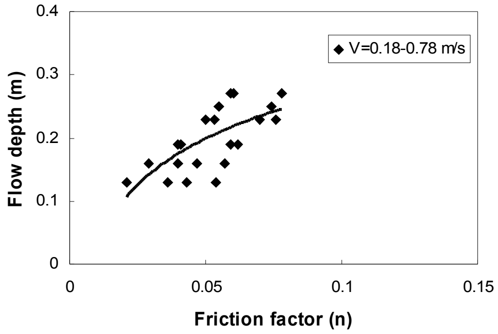


**Fig. 4: Variation of friction factor (n) with flow depth and flow velocity for non-submerged condition**

**3. Plant Submergence Depth**

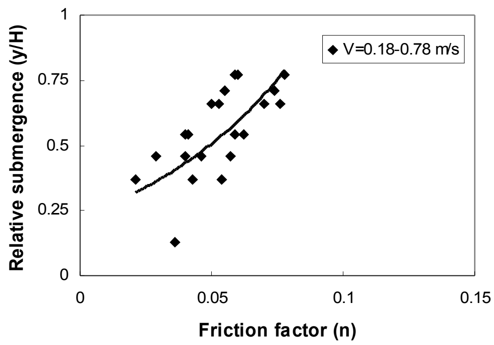


**Fig. 5: Variation of friction factor (n) with relative submergence and flow velocity for non-submerged condition**

**Conclusions**

The following points can be summarized as the conclusions of the present study:

- Plant roughness coefficients are functions of flow conditions such as velocity, depth and hydraulic radius along with the vegetation species;
- With an increase of flow velocity in non-submerged vegetation Manning $(n)$ coefficients decrease non-linearly;
- With an increase of both flow and submergence depths in non-submerged vegetation Manning $(n)$ coefficients increases non-linearly

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