Extract – Agenda of 10 th Meeting of WRD 13 held on 07 March 2008

WRD 13(378) Draft IS for adopting coefficient of friction

ANNEX 10

(Item 4.4)

Draft Indian Standard

GUIDELINES FOR ADOPTING COEFFICIENT OF FRICTION (RUGOSITY COEFFICIENT) FOR DESIGN OF CANALS

FOREWORD

There is necessity of preparing this code for standardizing the value of coefficient of friction (Rugosity coefficient) for different type of strata in lined and unlined canals.

This standard has been prepared based on the practices prevalent in the field in India.

In the formulation of this standard due weightage has been given to international coordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country. This has been met by deriving assistance from the following publications:

- Design Standard No. 3: Water Conveyance Systems, Chapter 11, General Hydraulic Considerations, United States Department of the Interior, Bureau of Reclamation, Denver, Colorado.
- Chow, V.T., Open – Channel Hydraulics, McGraw-Hill International Book Company
- IS : 7112 – 1973 Criteria for design of cross section for unlined canals in alluvial soil.
- IS : 10430 – 2000 Criteria for design of lined canals and guidance for selection of type of lining.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated expressing the result of a test or analysis, should be rounded off in accordance with IS 2:1960 ‘Rules for rounding of numeric values’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard

Draft Indian Standard

GUIDELINES FOR ADOPTING COEFFICIENT OF FRICTION (RUGOSITY COEFFICIENT) FOR DESIGN OF CANALS

1. SCOPE

This standard lays down the guidelines for adopting Coefficient of Roughness (Rugosity coefficient) for design of canals.

2. DEFINITION

The Coefficient of Roughness (Rugosity coefficient) is a parameter representing the integrated effects of the channel cross-section resistance to the flow of water in the canal.

In order to give guidance in the proper determination of the coefficient of roughness (Rugosity coefficient), general approaches will be as follows:

(a) To understand the factors that affect the value of 'n' and thus to acquire a basic knowledge of the problem
(b) To consult a table of typical 'n' value for channels of various types
(c) To examine and become acquainted with the appearance of some typical channels whose roughness coefficient are known
(d) For uniform channel sections covered with sand and gravel, the equivalent Manning's 'n' may be determined by Strickler equation:

$$n = \frac{d_{50}^{1/6}}{21.1}$$

d_{50} is in meter and represent the particle size in which 50 percent of the bed material by weight is finer.

3.0 FACTORS AFFECTING MANNING'S ROUGHNESS COEFFICIENT

3.1 Surface roughness: The surface roughness is represented by the size and shape of the grains of the material forming the wetted perimeter and producing a retarding effect on the flow. Generally speaking fine grains result in a relatively low value of 'n'.

3.2 Vegetation : Vegetation may be regarded as a kind of surface roughness, but it also markedly reduces the capacity of the channel and retards the flow. This effect depends mainly on height, density, distribution and type of vegetation, and it is very important in designing small drainage channels. A flow of sufficient depth tends to bend over and submerge the vegetation and to produce low 'n' values. A steep slope causes greater velocity, greater flattening of the

vegetation, and low ‘n’ values. The capacity test conducted by USBR indicated that ‘n’ values increase seasonally as much as 30% in canals heavily infested with green algae.

3.3 Channel Irregularity: Channel irregularity comprises irregularities in wetted perimeter and variation in cross section, size, and shape along the channel length. A gradual and uniform change in cross section, size, and shape will not appreciably affect the value of 'n', but abrupt changes or alteration of small & large sections necessitates the use of a large value of 'n'. In this case the increase in 'n' may be 0.005 or more.

3.4 Channel Alignment: Smooth curvature with large radius will give a relatively low value of 'n', whereas sharp curvature with severe meandering will increase 'n'. Value of 'n' be increased 0.001 for each 20 degree of curvature in 100 feet of canal. An increase of 0.002 in 'n' value would constitute an adequate allowance for curve losses in most flumes containing pronounced curvature.

3.5 Silting and Scouring: Silting may change a very irregular channel into a comparatively uniform one and decrease 'n', whereas scouring may do the reverse and increase 'n'. However the dominant effect of silting will depend upon the nature of the material deposited. Uneven deposits such as sand bars and sand waves are channel irregularities and will increase the roughness.

3.6 Obstructions: The presence of log jams, bridge piers, and the like tend to increase 'n'. The amount of increase depends on the nature of obstruction, their size, shape, number and distribution.

3.7 Size and shape of the canal: There is no definite evidence about the size and shape of a canal as an important factor affecting the value of 'n'. Comparing two channels, all other factors being equal, a triangular channel has a higher 'n' value than a trapezoidal channel, and a wide channel has a lower 'n' value than a narrow channel. An increase in hydraulic radius may either increase or decrease 'n', depending upon the condition of canal.

3.8 Seasonal change: Owing to the seasonal growth of aquatic plants, grass, weeds, willow and trees in the channel or on the banks, the value of 'n' may increase in the growing season and diminish in the dormant season.

3.9 Suspended material and bed load: The suspended material and the bed load, whether moving or not would consume energy causing head loss and increase in the apparent channel roughness.

Table 1 :Value of rugosity coefficient 'n' for unlined canals .
(As per IS 7112 : 1973)

S. No.	Type of canal	Value of 'n'		
		Minimum	Normal	Maximum
1	2	3	4	5
i).	Earth, straight and uniform:			
	a) Clean, recently completed	0.016	0.018	0.020
	b) Clean, after weathering	0.018	0.022	0.025
	c) Gravel, uniform section, clean	0.022	0.025	0.030
	d) With short grass, few weeds	0.022	0.027	0.033
ii).	Earth, winding and sluggish:			
	a) No vegetation	0.023	0.025	0.030
	b) Grass, some weeds	0.025	0.030	0.033
	c) Dense weeds or aquatic plants in deep channels.	0.030	0.035	0.035
	d) Earth bottom and rubble sides.	0.030	0.035	0.040
	e) Stony bottom and weedy banks.	0.025	0.035	0.040
	f) Cobble bottom and clean sides.	0.030	0.040	0.050
iii).	Dragline excavated or dredged:			
	a) No vegetation	0.025	0.028	0.033
	b) Light brush on banks.	0.035	0.050	0.060
iv).	Channels not maintained:			
	a) Dense weeds, high as flow depth	0.050	0.080	0.120
	b) Clean bottom, brush on sides	0.040	0.050	0.080
	c) Same, highest stage of flow	0.045	0.070	0.110
	d) Dense brush, high stage	0.080	0.100	0.140

Note 1 – For normal alluvial soils, it is usual in India to assume a value of n=0.02 for bigger canals (Q>15 cumecs) and n=0.0225 for smaller canals (Q<15 cumecs).

Note 2 – A suitable value of 'n' should be adopted keeping in view the local conditions and the above values as a guide.

Table 2 : Values of Rugosity coefficient 'n' for lined canals with straight alignment

(As per IS 10430 : 2000)

S. NO.	Surface Characteristics	Value of 'n'
1	2	3
i)	Concrete with surface as indicated below: a) Formed, no finish/PCC tiles or slabs b) Trowel float finish c) Gunited finish	 0.018 –0.020 0.015 – 0.018 0.018 – 0.022
ii)	Brick / tile lining	0.018 – 0.020
iii)	U.C.R. / Random rubble masonry with pointing	0.024 – 0.026
iv)	Asphalt a) Smooth b) Rough	 0.013 – 0.015 0.016 – 0.018
v)	Concrete bed trowel / float finish and slopes as indicated below: a) Hammer dressed stone masonry b) Coursed rubble masonry c) Random rubble masonry d) Masonry plastered e) Stone pitched lining	 0.019 – 0.021 0.018 – 0.020 0.020 – 0.025 0.015 – 0.017 0.020 – 0.030
vi)	Gravel bed with side slope characteristics as given below: a) Formed concrete b) Random rubble in mortar c) Dry rubble (rip-rap)	 0.02 – 0.022 0.017 – 0.023 0.023 – 0.033

Note - For canals with an alignment other than straight, a small increase in the value of 'n' may be made. An increase of 0.002 in 'n' value would constitute an adequate allowance for curve losses in most channels containing pronounced curvature. These values are for new/well maintained surfaces. For other surfaces with algae, grass, etc. 'n' values should be suitably increased.