THE EFFECT OF BED FRICTION ON THE PERFORMANCE OF FIXED BED TIDAL MODELS OF ESTUARIES A N D MODEL TESTING OF A STORM - WATER OVERFLOW CHANNEL

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PART ONE

THE EFFECT OF BED FRICTION ON THE PERFORMANCE OF FIXED BED TIDAL MODELS OF ESTUARIES

List Of Symbols.

The following symbols are used except where otherwise mentioned.

Suffixes m and p refer to model and prototype respectively.

A = Area of cross-section

b = Width of Section

C = Chezy coefficient

c = Wave celerity

d = Diameter of hemispherical cement blocks.

e = Vertical exaggeration = $\frac{Vs}{Hs}$; Also diameter of uniform hemispherical sand grain.

f = A friction coefficient

g = Acceleration due to gravity.

H = Elevation of water level measured with respect to the mean water level at section 1 .

Hs = Horizontal Scale = $\frac{Xm}{XP}$

Hf = Frictional head loss in a pipe of length L and diameter D in which the mean velocity of flow is V .

h = Depth of water in the model.

i = Bed Slope

L = Wave length

n = Manning Coefficient

P = Wetted perimeter

R = Hydraulic mean depth

r_o = pipe radius measured to crests of roughness elements.

S = Centre to Centre spacing of hemispherical cement blocks .

T = Tidal period

t = Time

U = Horizontal velocity

Vs= Vertical scale = $\frac{Ym}{Yp}$

X = Horizontal distance along the estuary

Y = Vertical distance

y = Depth of water in the flume measured up to the flat bed of the flume.

SUMMARY

This report describes an investigation that was conducted on a fixed bed hydraulic model of the Solway Firth. The aim of the investigation was to study the manner in which the roughness of the bed of model influences the performance of the model regarding tidal levels and tidal velocities.

Models of estuaries are usually constructed to a distorted scale and it is not possible to derive theoretically, the correct magnitude of bed roughness necessary in order to obtain dynamic similarity. In this investigation, it was intended to study the extent to which the tidal velocities and elevations depend on bed friction and also explore the possibility of ascertaining what magnitude of bed roughness of model would produce dynamic similarity between a given model and prototype.

The method adopted in this investigation was to produce roughnesses of known magnitude on the bed of the model and study the performance of the model under these roughnesses. Bed roughness was produced by fixing hemispherical cement blocks on the bed of the model according to predetermined patterns. By means of a series of tests in a rectangular flume under uniform flow conditions, the patterns required to produce the desired magnitudes of roughness were determined. Tidal velocities and Elevations were observed at seven points of the model for three different roughnesses of the bed.

A theoretical analysis of the flow in the model was also carried out taking into account, the bed roughness. As a result of this analysis it was found possible to represent the flow in the model by means of a mathematical equation adapted to a computer program. The results of this mathematical analysis showed agreement with the observations made. This agreement failed in certain parts of the model which remained dry during a certain period of the tidal cycle causing discontinuity of the water level as a function of time.

Although it is not possible to calculate the correct magnitude of bed roughness for the model, it has been found possible with the above theoretical analysis of flow in the model, to select a suitable magnitude of bed roughness which produces the desired behaviour of the model as regards tidal levels. However, it has not been possible in this investigation to verify the accuracy of the representation of tidal velocities in the mathematical treatment owing to the difficulty of measuring the mean tidal velocities, since in most regions of the model, the depths of flow were insufficient for accurate velocity measurement .

In the range of bed roughnesses employed in this investigation, it has been found that the effect of bed roughness on the tidal elevations is comparatively less significant than its effect on tidal velocities.