Turbulence Modelling of Three Dimensional Flow in Rectangular Harbours

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Abstract

Details of the numerical model results of the layer integrated model for rectangular harbours with large aspect ratios (i.e. L/B = 1/4 to 4/1), using the two equation and zero equation turbulence models are discussed. For the zero equation turbulence model, the simple mixing length model was deployed to calculate the horizontal eddy viscosity coefficient in the numerical tests whereas for the two equation turbulence model, the depth integrated k-ε turbulence model was used for this purpose. Likewise, the mixing length and the layer integrated k-ε model were used to determine the vertical eddy viscosity. The model was first applied for the channel flow and a reasonable agreement between the predicted values and experimental data was achieved. The model was then applied for the model harbours. The numerical results of the k-ε and mixing length turbulence models compared graphically with the experimental results to indicate the best model for these model harbour configurations. The no-slip and partial-slip closed boundary representation were considered to evaluate the second derivative for the horizontal turbulence diffusion terms adjacent to walls. The numerical model results have been shown that, firstly the predicted flow patterns of the k-ε model were almost similar to those of the mixing length turbulence model. Secondly, the flow patterns in different layers were similar and the horizontal velocity distribution showed very small variations through the water column. Finally, it has generally been found that the numerical model results of the k-ε turbulence model were in very good agreement with the experimental results. Some of the typical results are shown.

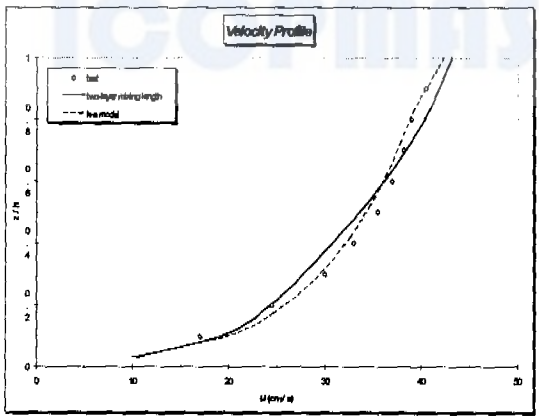


Figure 1. Velocity distribution for open channel flow

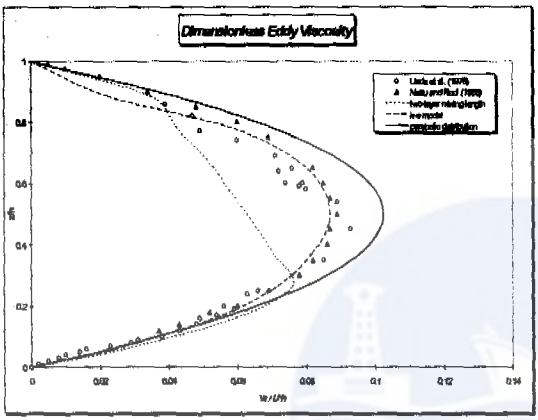
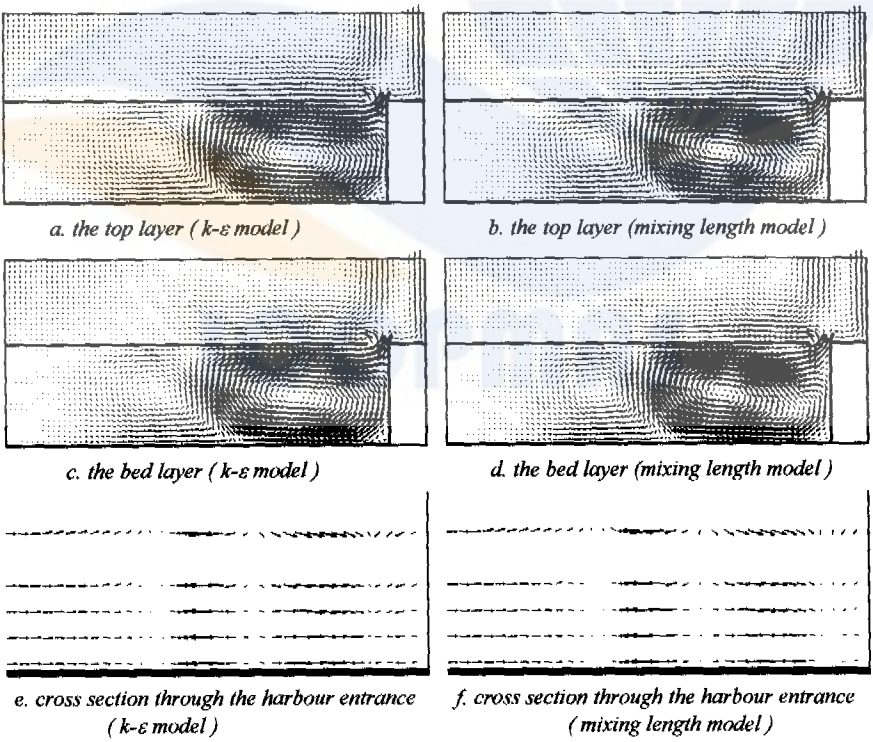


Figure 2. Eddy viscosity distribution for open channel flow



a. the top layer (k-ε model)

b. the top layer (mixing length model)

c. the bed layer (k-ε model)

d. the bed layer (mixing length model)

e. cross section through the harbour entrance (k-ε model)

f. cross section through the harbour entrance (mixing length model)

Figure 3. Flow pattern using the k-ε and mixing length turbulence models at high tide for L/B = 4 at two main layers