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Numerical Simulation of Turbulence and Flow Velocity Distribution Around the Spur Dike Using FLUENT

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ABSTRACT

Spur dikes are the intersecting or transverse structures, which are projected from the river bank toward the flow axis and cause diversion and direction of the flow from the banks towards central axis of the river. This structure affects the flow lines and causes change in the river flow pattern and protects the banks against erosion. Recognition of the flow pattern around a spur dike could help in a better understanding of the scour pattern and, as a result, achieving an accurate value of maximum scour depth. In this study, the k-ε turbulence models are investigated in determining the rotational flow and flow field around the spur-dike using FLUENT software. The results show that the software incorporating the k-ε model could appropriately model velocity distribution around the spur dike and the results exhibit a good compatibility with an average error of 9.24%.

Key words: Spur dike, Flow pattern, Velocity distribution, Turbulence model.

1. INTRODUCTION

One of the indirect and common methods in control of erosion and protection of river banks is the use of spur dike (1). Spur dikes are the intersecting or transverse structures which are projected from the river bank toward the flow axis and cause diversion and direction of the flow from the banks towards central axis of the river (2). This structure affects the flow lines, causes change in the river flow pattern and protects the banks against erosion. Recognition of the flow pattern around a spur dike could help in better understanding of the scour pattern and, as a result, achieving an accurate value of maximum scour depth (3). In this respect many research works have been conducted by various researchers. Ishi et al. (1983), performed studies on the effect of some non-dimensional parameters on the separation zone geometry at downstream of the spur dike and stated that the Froude number has impact on the geometry of the separation zone and for a spur dike with a length equal to 10% of the canal width, the length of this zone is 0-12 times the spur dike length and its width is maximum two times the spur dike length from the bank. By increase in the spur dike length from 10% of the canal width to 40% of it, the length of separation zone increases from 7 to 12 times the length (4). Chen and Ikeda (1997) performed relatively comprehensive research on the flow pattern around a single spur dike in the straight alignment. In this research the formation, development and transfer of horizontal eddies around the spur dike tip are experimentally studied. The abovementioned researchers found that transient eddies were separated from the spur dike tip and transferred downstream in an alternative way. Analyzing the obtained results, they found that the mean migration velocity of eddies was nearly constant and a bit higher than 1.5% of the mean velocity (5). Kadota et al. (2006) investigated flow structure around a single spur dike in two submerged and semi-submerged states and for the shallow depth flow condition. Kadota et al. used the surface particle tracking technique and measured the flow pattern in a wide area around the single spur-dike with sloped sides. The spur-dike was modeled after the constructed