The Effect of Different Curvatures on Flow Structure inside the River Meander

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Abstract
In this study an effort was made to compare flow structure inside two river meander models with different curvatures (relative curvature of model 1=2.6, model 2=4.43), experimentally. Flow velocity was measured in a fine grid from the bed to the water surface in 360 different points in each model using ADV. As a result, situation of maximum tangential velocity moves from near bed to near the water surface in depth by decreasing the curvature. Also it was found that the effect of centripetal force of previous and next bend on bed topography and flow structure of second bend in model 1 is stronger than model 2.

Keywords: Flow structure, River meander, Different curvature, ADV.

1. INTRODUCTION
The flow structure inside the river meanders is complicated and it is influenced by various properties and conditions for example the curvature and properties of bends (multi bend or single bend). The ratio of curvature radius to river width (relative curvature) is very important factor which has main role in morphological changes of river meander. In this basis, river bends can be classified to 2 classes; strongly curved bends which their relative curvature is smaller than 3 and mild bends which have relative curvature larger than 3 [1, 2].

A number of studies for example by Blue [3], Mockmore [4], Braden and Minnesota [5], Ikeda et al. [6], Parker et al. [7] and Da Silva [8] have attempted to investigate the cause of meandering in rivers and streams. Many experimental and numerical studies have been carried out different type of bends (mild, strongly curved, sharp). Odgaard and Berge [9] performed some experiments inside a mild (Rc/B=5.4) 180-Degree alluvial curved bend. They reported that velocity components, bed topography and flow structure are affected by changing in the curvature. Ikeda et.al [10] developed a three dimensional mathematical model to simulate fully developed flow in mildly curved open channels. Jung and Yoon [11] conducted laboratory experiments in a mild 180-degree curved bend with different bed materials and found that in the upper part of the bend, situation of maximum streamwise velocity does not change by the effect of bed materials and is skewed inwards. Blankaert [12] presented a model for vertical profiles of downstream velocity and secondary circulation in open channel bends which accounts the interaction between them. This model, in addition to chezy coefficient, is affected by curvature ratio, Froude number and normalized transversal velocity gradient. The results of this model showed good agreement with experimental data of a strongly curved flow. Blankaert and Graf [13] performed some experiments inside a strongly curved open channel and found that Rozovski model overpredicts the strength of secondary circulation and velocity distribution for this kind of bend. Giri et al. [14] performed some experiments inside a mild meandering flume which consists of a three sequential bends with and without river training structures to investigate influence of these structures on flow pattern. They found that in model without structure, graduate acceleration or deceleration occur near the both banks and water flow almost uniform along the center. Also, their results showed that in the models with structure, a dead region generated all over the outer bank of second bend which is probably because of presence of training structures inside the previous bend. Blankaert and De Vriend [15] and Blankaert and De Vriend [16] investigated turbulent structure in sharp open channel. Esfahani [17] and Esfahani and Keshavarzi [18] designed three physical models of multi-bend meandering river to investigate flow structure.