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Study of Width Reduced Transition Effects on Ripple Bed Form Height in Various Hydraulic Conditions

E. Roshani[1*]- A. Hussienzade Dalir[2] – D. Farsadizade[3]–F. Salmasi[4]

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Introduction: In alluvial streams, water flow affects the sediment and transports them to the downstream constantly. In the meantime, bed forms will be created on stream bed with various dimensions and in different conditions. In this paper experiments have been done to study the influences of width reduced transitions on the height of ripple forms. These transitions are made with different angel 5, 10 and 15 degrees. Based on Van Rijn (7), when the sediment particles are smaller than 500 μm, if the flow velocity exceeds about 10 to 20 percent of critical velocity for starting the particle movement, small ripples grow on the bed surface. Ripple profiles have an asymmetric shape which has steep slope at the upstream and mild slope at the downstream. If the particles are bigger, flow velocity should be higher too in order to create taller ripples and in this situation a variety of bed form height and length will occur. There is a lot of research associated to bed form formation in alluvial beds like Van Rijn (4 and 7), Karim (2009), Omid and et al (2010), Chegini and Pender (2012) and Esmaili and et al (2009). But in none of them a width reduced transition has applied. The mail part of this research is specified to the effects of width reduced transitions on the dimension of ripple bed form.

Methods and Materials: Experiments were done in the hydraulic laboratory of water engineering faculty of Tabriz University. The flume had a 6 m long, 50 cm height and 50 cm wide flume. The α (angle of transition at the beginning) was different. The sediment particles had $D_{50} = 0.86\, mm$ and $\rho_s = 2300 gr.cm^{-3}$. The sediment flow was directly injected to the main flow from the upstream carefully. Water level was measured with scales installed on the glass wall of the flume and sediments were collected with the help of a sand trap located at the end of the flume. Experiments were classified in three discharges of 10, 12 and 14 $L.S^{-1}$and in 0, 0.006, 0.009, 0.012 and 0.015 slopes of the channel. π Buckingham method was used to obtain a dimensionless relationship such as $\frac{\Delta}{y} = f(F_r, \alpha)$. In which the Δ is the bed form height, y is the flow depth, Fr is the Froud number and the α is the transition angle at the beginning part of it. To compare the situation of having transitions with the absence of any transition, was studied as a witness type. Totally, 136 experiments were done.

Results and Discussion: The changes in the bed form height based on different Froud Numbers, are exhibited in a series of curves. Basically, transitions which shortened the flow width, in low discharges, the initial walls of these transitions act like a barrier and absorb a significant amount of flow intensity. Therefore, when there is no such a transition, it is accepted that the flow has more freedom and as a result bed form height will grow bigger. Naturally, if the reduction of the channel width was milder, the barrier effect on the flow would be smaller slight. In study of bed form shaping and its height, in low discharges (e. 10 $L.S^{-1}$) the flow intensity is not strong enough to conquer the barrier role of the transitions and however with increasing angle of the transition, the bed forms height in the transition area decreased. For the 12 $L.S^{-1}$discharge the flow intensity is more and the power of entering flow to the transition is higher and ripples with taller height exist. But the point is that the 12 $lit.s^{-1}$ is still a transition stage, it means that when the discharge reaches to 14 $L.S^{-1}$, the bed form height has increased about 10 to 12 percent, comparing with no transitions. Another important issue is that, in any situation, transitions with $\alpha = 15°$ have a strong barrier role against the flow and they always reduce the bed form height.

Conclusions: It can conclude that width reduced transitions can decrease scours slightly and therefore sediment transitions was reduced about 15 to 20 percent, compared with no transitions installed on the flume. The results show that if the discharge exceeds 14 $L.S^{-1}$ or if steeper angles for the initial part of the transitions are used, the transition loses the barrier role and even they increases turbulences at the beginning and much more sediment would pass through the transition area due to higher velocities.

Keywords: Alluvial Beds, Entrannce Transition Angle, Sediment Movements, Ripple

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1, 2, 3 and 4- Ph.D. Graduate, Professor and Associated Professors Department of Water Engineering, Tabriz University
(*- Corresponding Author Email: Elhm.roshani@gmail.com)