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DEPENDENCE OF SALTATION PARAMETERS ON BED ROUGHNESS AND BED POROSITY

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Abstract: *In numerical models of bed load transport a bed structure of channel could be described by two parameters, a size of bed particles and a standard deviation of normal distribution of bed particles in the vertical direction. The present paper deals with the effect of bed parameters on average length and height of one jump of saltating particle. A new formula was proposed for bed roughness based on size and standard deviation of the normal distribution of the bed particles. The dependences of length and height of the jump on the diameter of the saltating and bed particles were determined for different variation of vertical distribution of the bed particles.*

Keywords: ***Saltation parameters, saltation length, saltation height, bed structure, normal distribution of bed particles, bed roughness.***

1. Introduction

Saltation is a type of bed-load transport of solid particles in natural channels. During saltation the conveyed particles move along rough bed periodically jumping and colliding with bed particles. Parameters of motion of solid particles and its behaviour depend significantly on bed structure, i.e. not only on size of bed particles but on their distribution on the bed, too.

The goal of the present paper is to find a dependence of average parameters of saltation motion, such as length and height of one jump, on size of bed particles and on their vertical distribution with respect to the bed plane.

Present research is conducted on the base of a saltation model (Lukerchenko et al., 2009) and a model of rough bed (Kharlamova et al., 2011). This bed model allows changing size of bed particles, d_b, and changing bed porosity by varying standard deviation σ of normal distribution of bed particles in vertical direction around mean bed level.

Twenty various bed geometries were analysed; these were formed by four different values of standard deviation of vertical distribution of bed particles, i.e. $\sigma = 0$, $0.08d_b$, $0.17d_b$ and $0.33d_b$; and by five different sizes of the bed particles, i.e. $d_b = 3$, 4, 5, 6 and 7 mm.

Two sets of numerical experiment were conducted. The first simulation provides a situation where the size of saltating particle is equal to size of the bed particles ($d = d_b$). In the second simulation the size of saltating particle is constant and equal to $d = 3$ mm.

For the dependence of bed roughness $k_s(d_b, \sigma)$ we propose a new formula:

$$k_s = 6\sigma + 0.5d_b \tag{1}$$

that measures the distance between the deepest depression and the highest protrusion of different bed formations.

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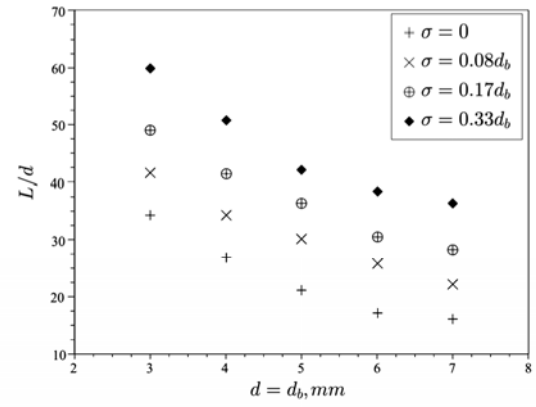
2. Conclusions

As a result of modelling different bed geometries saltation parameters (length, height of one jump) were obtained.

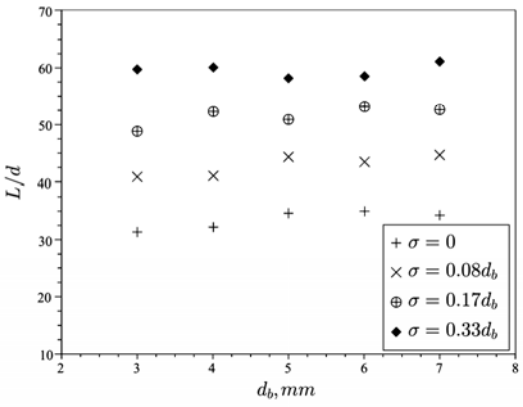
It was conducted that for the equal saltating and bed particles (less than $d \leq 5$ mm) the dependences of length and height on the diameter of particles ($d = d_b$) were nearly linear, see Fig. 1. The length and height of the jumps strongly depend on particle size d and on standard deviation σ - they increase with decreasing particle diameter d and with increasing standard deviation, σ (bed porosity).

For constant diameter of the saltating particle d and varying size of the bed particles d_b, other tendencies were observed, see Fig. 2. The length and height of the jumps with varying diameter of bed particles remain approximately constant with slight tendency to increase; they also increase with increasing bed porosity (σ). However, in the case of large bed porosity and small saltating particles, the saltating particles tend to stick into the bed among bed particles, and therefore they make only a limited numbers of jumps.



a)

Fig. 1. Dependences of average saltation length on diameter of saltating particle at various standard deviations, diameter of bed particles is the same as saltating particle.



b)

Fig. 2. Dependences of average saltation length of one jump on diameter of bed particle at various standard deviations, diameter of saltating particle is 3 mm.

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