RESEARCH ON INCIPIENT MOTION OF ROCK BLOCKS UNDER THE ACTION OF TIDAL BORES

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As far as tidal bore is concerned, the stability of blocks under the action of bore in beach protection is attentioned. The existing formulas for calculating blocks' stability under the action of bore are usually expressed with critical tractive velocity of flow (YANG et al. 2002, ZHANG 2003, XIAO 2000, ZHU et al. 2003), which results in the inconvenient use in praticce. A new formula deduced from height or propagation velocity of bore may improve this situation. To begin with our research, a dynamic coordinates (shown in Fig. 1) was built to treat tidal bore as constant flow so that the momentum equation and continuity equation of constant flow in open channel can be applied (ZHANG et al. 1999, SHENG 2002). Through theoretic analysis, the expression of propagation velocity of tidal bore C was obtained below, with base flow velocity $V_0 \approx 0$.

$$C = \sqrt{\frac{g}{2h_0}(h_b + h_0)(h_b + 2h_0)} \tag{1}$$

where h_0 = base water depth before tidal bore arriving; h_b = height of tidal bore. Moreover, a relationship between mean velocity in section of tidal bore back V_1 and propagation velocity of tidal bore C was got

$$V_1 = C(\frac{h_b}{h_b + h_0}) \tag{2}$$

with the conclusion that mean velocity in section of tidal bore back V_1 runs to propagation velocity C in the case of base water depth h_0 inclining to 0.

Under the action of tidal bore, block is acted by those forces such as effective gravitation, tractive force, lift force and sliding frictional force between blocks etc. So the block may loose its stability by sliding. From the analysis on block's stressed state, a formula for relative stable grain size of block (d/h_0) calculation expressed with relative wave height of tidal bore (h_b/h_0) was given as

$$\frac{d}{h_0} = A \cdot \frac{\gamma}{\gamma_b - \gamma} \cdot \left(\frac{h_b}{h_0}\right)^2 \cdot \left(1 + \frac{1}{1 + \frac{h_b}{h_0}}\right) \tag{3}$$

where $A=\dfrac{1}{4A_1^2}$. Through an experiment about bore conducted in laboratory, the value of coefficient A was determined at 0.10. Then the new fomula for calculating stable grain size of block under the action of tidal bore has the form

$$\frac{d}{h_0}=0.10\cdot\frac{\gamma}{\gamma_b-\gamma}\cdot\left(\frac{h_b}{h_0}\right)^2\cdot\left(1+\frac{1}{1+\dfrac{h_b}{h_0}}\right) \tag{4}$$

Fig. 2 and the calculated results from Eq. (4) illustrate that relative stable grain size of block (d/h_0) is in direct ratio with square of relative wave height of tidal bore (h_b/h_0). Fig. 3 shows the comparition between computed and experimental results of relative stable grain size of block (d/h_0). It can be seen that the calculated results from the new formula mentioned above were in accordance with the experimental results very well.

From what has been discussed above, it can be concluded that this new formula has the advantage of simple structure and clear physical significance over other existing formulas, so that it is more convenient to be used in practice.

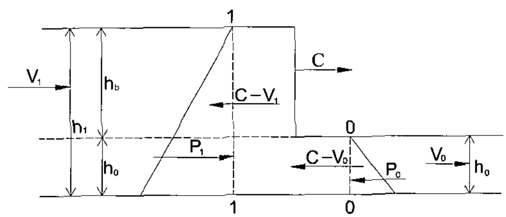

Fig. 1 Schematic illustration of tidal bore under dynamic coordinate

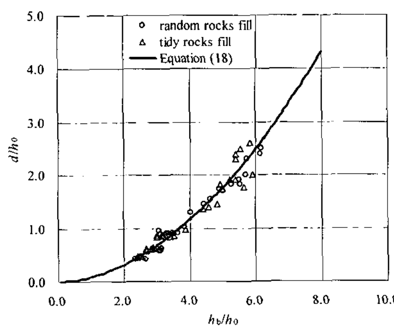

Fig. 2 Experimental results of rock blocks starting by tidal bore

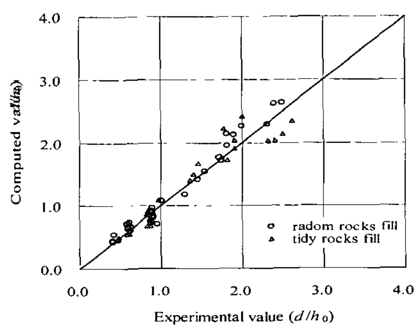

Fig. 3 Comparition between computed and experimental results of relative stable grain size of block (d/h_0)

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