Geophysical Research Abstracts
Vol. 19, EGU2017-10715, 2017
EGU General Assembly 2017

A research on unsteady period of debris flow surges

Muneyuki Arai
Meijo University, Faculty of Science and Technology, Civil Engineering, Nagoya, Japan (arai@ccmfs.meijo-u.ac.jp)

Debris flow is sometimes lots of intermittent surge flows. These many surges are generated in flow instability and it is a kind of roll wave. It is possible to generate the roll wave of shallow water on the experimental flume. In case of constant discharge and uniform flow at upstream, period of generated roll wave is not constant at downstream. A cause for unstable period of roll wave is discussed in this research. A wave equation for roll wave on inclined channel is obtained by the perturbation method considered shallow water momentum equation in case for rectangular cross section, wide width channel B compared with mean depth h_0 ($B >> h_0$), channel slope θ $\tan\theta < 1$ and Froude number $F_r \geq 1$. A obtained non-dimensional wave equation is

$$\frac{\partial \eta'}{\partial \tau'} + a_1 \eta' \frac{\partial \eta'}{\partial \xi'} + a_2 \frac{\partial^2 \eta'}{\partial \xi'^2} + a_3 \frac{\partial^3 \eta'}{\partial \xi'^3} = 0 \tag{1}$$

where,

$$\begin{aligned} a_1 &= (3/2){c_0'}^2, \\ a_2 &= -(1/2)\left(1/{c_0'}^2 - 1/2\right)\tan\theta\,(c_0'/u_0'), \\ a_3 &= (1/2)\left\{(2+{c_0'}^4)/(2{c_0'}^2) - 3/2\right\}, \end{aligned} \tag{2}$$

$\eta' = \eta/h_0$: fluctuation from mean depth h_0, $\eta' = \eta/h_0$, $\xi' = \xi/h_0 = \epsilon^{\frac{1}{2}}(x' - t')$, $\xi = \epsilon^{\frac{1}{2}}(x - v_{p0}t)$, x : axis of flow direction, t : time, v_{p0} : phase velocity, $\tau' = (v_{p0}/h_0)t = \epsilon^{\frac{3}{2}}$, $\tau = \epsilon^{\frac{3}{2}}t$, $t' = (v_{p0}/h_0)t$, $x' = x/h_0$, $c_0' = c_0/v_{p0}$, $c_0 = \sqrt{gh_0\cos\theta}$, $u_0' = u_0/c_0$, u_0 : mean velocity, ϵ : parameter of perturbative expansion.

Equation (1) is a kind of KdV - Burgers equation. For phase velocity v_{p0} is long wave velocity c_0, that is $v_{p0} = c_0$, equation (1) becomes Burgers equation. In this state, waves with different wave numbers deform to a wave of wave number one and phase velocity is added some. Then the equation of the phenomenon is shifted back to KdV - Burgers equation from Burgers equation. c_0' and u_0' are assumed as constant coefficient in equation (1), however u_0' is fluctuated by depth fluctuation in flow. Using a_2' by linear approximation as $a_2' = a_2(1 + b_1\eta')$, equation (1) is

$$\frac{\partial \eta'}{\partial \tau'} + a_1 \eta' \frac{\partial \eta'}{\partial \xi'} + a_2(1 + b_1\eta') \frac{\partial^2 \eta'}{\partial \xi'^2} + a_3 \frac{\partial^3 \eta'}{\partial \xi'^3} = 0. \tag{3}$$

Some numerical results of equation (3) using by experimental results and $b_1 = 0.01$ show shift or drift of peak of surges. Unsteady period of roll wave originates in the fluctuation in mean velocity influenced by deformed flow surface.