◆Research Paper◆

Three Stages Collapse Connection of Riverbank

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Abstract: Three stages of the shore riverbank collapse are a result of macro performance confrontation between the riverbank and the water pressure and the water penetration. The shore dike is in a kind of equilibrium, which may lean to the active water pressure (permeate), or may also lean to the passive pressure (permeate). When the shore dike is in the condition which leans to the active water pressure (permeate), the rising water level will low the safety of the shore dike and the embankment easily collapse. In this paper, the three kinds of collapse are connected together. In this way, the natural laws can be obtained, and the engineers in the field can do better with this understanding.

Key words: Three stages collapse, Riverbank collapse, Formula connection

1. The definition of three stages collapse

Many riverbank collapse is connect with the rainfall[1], the river scouring and sediment transport[2], the cracks of the riverbank appear[3] with the water scouring. The lecture [4] gave a experiment and math mode to study this collapse. So water is polluted[5]. So it is very important to study the riverbank collapse. The paper studies the three stages of riverbank collapse.

According to current researches, the research idea is shown as figure1,

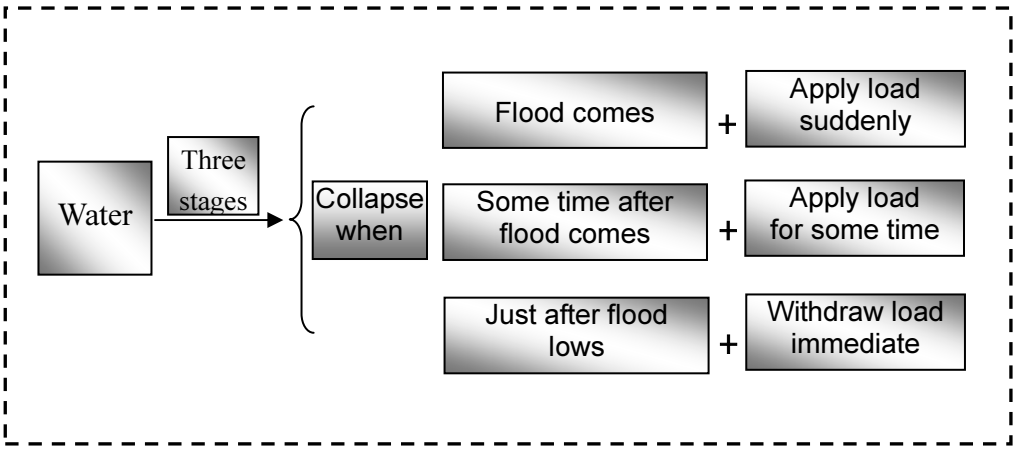

Figure 1 Three stages of embankments

Definitions of three stages collapse are that the collapse occurring when the flood comes is called the first stage collapse at which the embankment is suddenly applied force, the collapse occurring after some time immersed is called the second stage collapse at which the embankment is applied force for long time, and the collapse occurring just after the flood receding at which the applying force is quick released.

2 The continuous state model of three collapse stages

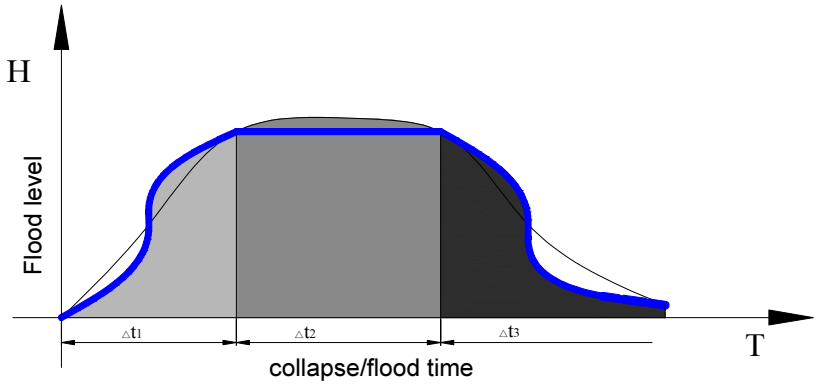

Figure 2 Different stages with the flood

$$F=\begin{cases}\text{Ⅱ} & \Delta t1<t<\Delta t1+\Delta t2\\ \text{Ⅲ} & \Delta t1+\Delta t2<t<\Delta t1+\Delta t2+\Delta t3\end{cases}$$

Figure 2 shows the concerted reaction of water rising and lowing and the embankment collapse in different stages. The water level starts to rise according to the index function, $H''=\frac{d^2H}{dt^2}>0$ and then the water level changes according to a curve with a little slope, $H''<0$. If the embankment collapses at this time, the collapse is called the first stage collapse.

After the water level reaches a higher value and keeps stable for a period of time $\triangle t_2$, in which the collapse occurs, the collapse is called the second stage collapse.

The high water level finally becomes lower and this process is $\triangle t_3$ and it also carries on along the process in the first stage. It first experiences a process of $H''<0$ and then experiences a process of $H''>0$. In the above process, the collapse is called the third stage collapse.

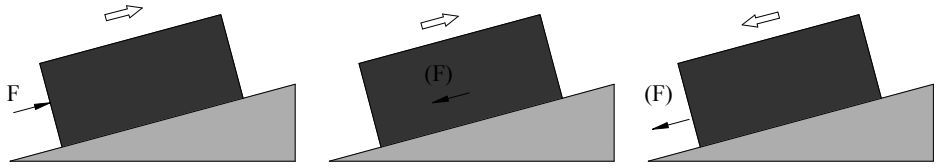

Figure 3 The collapse mechanism of embankments

Explanations of three kinds of collapse are as follow,

Ⅰ stage collapse: The river keeps a stable level for a long time, and the dike keeps in long time stability. The front part of the shore dike is subjected to a suddenly water pressure and collapse which is an additional load when the water suddenly comes and water level suddenly rises. Figure 3 (A) shows the destroy mechanism. F is the water pressure led by the rising water, which pushes the slider to move forward.

The Ⅱ stage collapses: The river water level continuously rises and finally attains an stable state, the shore dike is immersed in the river of the high water level, water continuously seeps into shore dike soil, mechanics parameters of soils continuously change, such as cohesion, internal friction angle gradually decreasing, the sliding resistance is smaller than the sliding force, and the embankment collapses. The

internal anti-slide force becomes less, so the sliding down appears, as shown in Figure 3(B). There is an additional force in Figure 3(B), which does not exist and is represented by F.

The Ⅲ stage collapse: The shore dike soil is immersed in water of the high level and gets into a stable state. The internal water pressure has no enough time in vanishing when the water lows and the external force disappears, so the embankment collapses. The embankment is formally applied a sliding down force, as shown F in Figure 3(C).

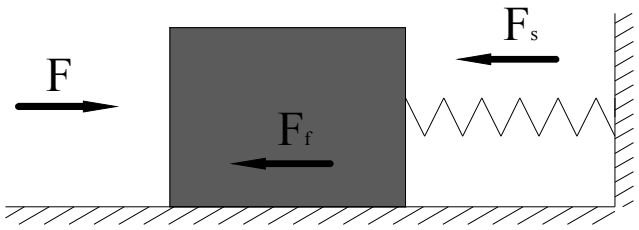

Figure 4 The continuous state model of three collapse stages

As Figure 4 shows the continuous state model of three collapse stages which is essentially understood. In Figure 4, F is the pressure of river water or the comprehensive effect of the water pressure and the permeation, the F_s is the shore dike resistance, F_f is an additional force under the combination of F and the F_s which is connected with the weight of the embankment, the size and direction of which can change with the stress condition, which decides the stability of the embankment, and which decides the ability to self control of the embankment, that is the resistance to the water rise and reduction.

The continuous state function of three collapse stages,

$$F = F_f + F_s$$

Where $F_f \in [-F_{fmax}, F_{fmax}]$.

The corresponding collapse to three stages separately is

$$\begin{cases} F > F_{f\max} + F_s \\ F > F_f(t_0) + F_s(t_0) \quad F_s(t) = K(t^{-1}), F_f(t) = K(t^{-1}) \\ F_{f\max} < F_s \end{cases}$$

$F_s(t)=K(t^{-1})$, $F_{fmax}(t)=K(t^{-1})$ mean the resistance and additional force reduce along with time.

This concept model naturally mixes three stages together and turns three separate processes into a continuous state function.

3.Conclsions

In this paper, the three kinds of collapse are connected together. In this way, the natural laws can be obtained, and the engineers in the field can do better with this understanding.

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References:

1. Sun Jichao, Gao Quanchen. Numerical Simulation of Coupled Rainfall and Temperature of Unsaturated Soils. Key Engineering Materials.2006,306
2. Sun Jichao, Wang Guangqian. Transport Model of Underground Sediment in Soils. The Scientific World Journal Volume 2013.
3. Sun Jichao, Wang Guangqian. Crack spacing of unsaturated soils in the critical state. Chinese Science Bulletin,2009,54: 2008-2012\
4. Sun Jichao, Wang Guangqian. Evolution of the riverbank damage under scouring, Journal of Tsinghua University, 2010,50(9):1346-1349
5. Sun Jichao, Wang Guangqian. Research on underground water pollution caused by geological fault through radioactive stratum. Journal of radioanalytical and nuclear chemistry, 2013: 1-6.