CALCULATION OF HYDRAULIC CHARACTERISTICS OF CHUTE SPILLWAY AND ENERGY DISSIPATION

Le Xuan Long*
College of Technology - TNU

SUMMARY

Hydraulic calculations on spillway now remained largely stable flow properties. In this report the author presents hydraulic calculation of spillway by instability characterized methods and calculation of water energy dissipation after spillway by means of digging pools.

Keywords: *spillway, instability characterized methods, stable flow, unstable flow, energy dissipation*

INTRODUCTION

Spillway is now being widely used in hydropower plants and hydraulic contructions. Spillway flow is not steady flow under the influence of waves rolling over spillway phenomenon. Regulatory process makes flow reservoir water level continuously change, especially in the rainy season. The current calculation considers the uphill flow is steady flow of water, waterline usually pour water line b2, without regard to the change of flow and water levels over time. In this report the author presents how to calculate the flow unstable by characterized methods.

CHARACTERIZED METHODS

Unstable flow slowly changing one way is represented by Saint Venant equations [4]:

$$\begin{cases} \dfrac{\partial Q}{\partial S} + \dfrac{\partial w}{\partial t} = 0 \\ \dfrac{\alpha_o}{g}\dfrac{\partial v}{\partial t} + \dfrac{\partial}{\partial s}\left(z + \dfrac{p}{\gamma} + \dfrac{\alpha v^2}{2g} \right) + J = 0 \end{cases} \quad (1)$$

In which:

Q: flow rate;

S: Coordinates section should be calculated;

ω: wet section;

α_0: coefficient momentum repair;

v: average velocity;

z: Distance from surface to point calculation standard on sectional survey;

p: Pressure

α: coefficient of kinetic energy repair;

J: Slope hydraulic

Equations (1) is explained by many different methods, mainly used to represent smooth flow in the channel system, river. In hydraulic contruction, flow on the spillway overflow flood discharge was flowing stream. To set the algorithm can be used in the hydraulic calculation of spillway, this report presents algorithms equations (1) characterized by the method used for the coordinates system fixed in the sectional and know before class time to experience the flow and depth. Modified Saint Venant equations we get:

Conveniently system characteristic equation [2]:

$$\begin{cases} \dfrac{ds}{dt} = v + c \\ \dfrac{dQ}{dt} - B(v - c)\dfrac{dh}{dt} = gw(i - J) \end{cases} \quad (2)$$

Characterized inverse quations:

$$\begin{cases} \dfrac{ds}{dt} = v - c \\ \dfrac{dQ}{dt} - B(v + c)\dfrac{dh}{dt} = gw(i - J) \end{cases} \quad (3)$$

In which:

$\dfrac{ds}{dt} = \lambda$: the speed of spread effects of waves

$c = \sqrt{\dfrac{gw}{B}}$: transmission speed

+ Conveniently wave: $\lambda = v + c = \dfrac{ds}{dt}$

* *Tel: 0989 740037, Email: xuanlong_0307@yahoo.co.uk*

+ inverse wave: $\lambda = v - c = \dfrac{ds}{dt}$

CALCULATION PROGRAM

The problem arises we know that water flow on sloping jet and we know the geometric parameters of steep spillway:

spillway length: L

Spillway trapezoidal cross-section with bottom width is B and the slope of the roof coefficient is m spillway of the water is: i Roughness of bed: n

The amount and depth of water in steep first section (the first section slope depth water depth of demarcation degree)

After steep downstream channel with trapezoidal cross country with a width Bk and comfort factor mk.

Computational requirements

Calculator features on spillway (flow, depth and velocity in the section at various times)

We determine the characteristics of the flow in the specified sections and predetermined time shown is the difference grid nodes. The horizontal axis represents the cross section, the distance between the sections is Δl. The vertical axis represents the class period, the gap between the time the class is Δt. Step time calculations must satisfy the condition Curant [2]:

$$\Delta t <= \frac{\Delta s}{\lambda_{max}}$$

Step computation time should be less than the lower limit of the transmission interval influences cross section to the other. To calculate the flow depth at fixed mesh nodeswe use iterative method until [2]:

$$|Q_M(k) - Q_M(k-1)| < \varepsilon_Q$$

We in turn passed to the class properties from the class time (j-1) to the jth class with initial conditions that we know the flow and flow depth in the section on water ramps at the initial moment (t = 0).

This calculation method always exist errors due to the accuracy of data input and so we replace the differential difference. If the diagram for error calculation to be accrued and amplified during the calculation, the scheme is not sustainable. In contrast, in the process of calculating error is reduced, errors are not cumulative, the scheme is sustainable. In this approach to ensure the scheme is sustainable time step to satisfy the Curant condition.

Calculate the height of the wall of the spillway (ht)

Based on the depth of the flow calculated above us determine the

the largest deep water level at a given moment is hmax. From which we determine the height of the wall of the spillway using the formula:

$$h_t = h_{max} + h_{hk}$$

Where h_{hk} is the depth increases due to gas; usually h_{hk} = 0.4 m [3]

RESULTS

Figure 1

The program is application hydraulic calculations for spillway overflow of Dam Bai reservoir (Hoa Binh). Works draining of Dam Bai spillway threads a broad peak was followed with steep downstream water characteristics are as follows:

The length of the spillway: L = 270m

Width: B = 21m; Slope: i = 0.06

Overflow concrete coefficient of roughness: n = 0.017

Steep sections of rectangular (m = 0) Time calculated at 44 hours

The distance between the sections is 54m cut calculation (section 6), the calculation time step is 1s. We conduct calculations by entering the data file and the characteristics of the water to calculate slope obtained calculation results on the flow characteristics in the section on spillway at different times

Characteristics spillway and steps of computing time are shown in Figure

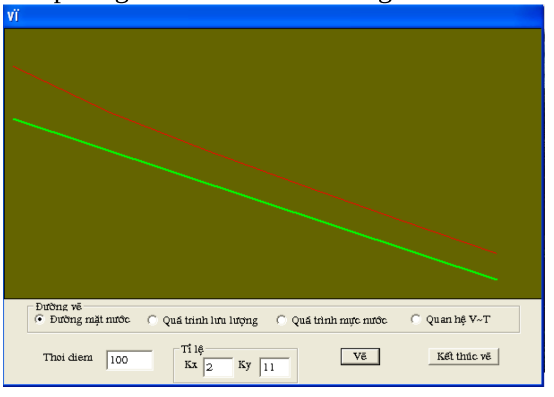

Figure 2

Process flow in the last process of the flood discharge of reservoir water through the spillway is shown in Figure 1

High water levels on the spillway at t = 25 hours is shown on Figure 2 At this point the flow in the section on Q = 789,657m3 / s; depth of flow in the first section hd = 5,243m; depth at the end of the spillway section is hc = 2,570m. Due rolling wave phenomenon should flow in the spillway section on changes. At this point in the flow in the first section is 789.657 m3 / s, the flow at the end of steep sections is 849.362 m^3/s.

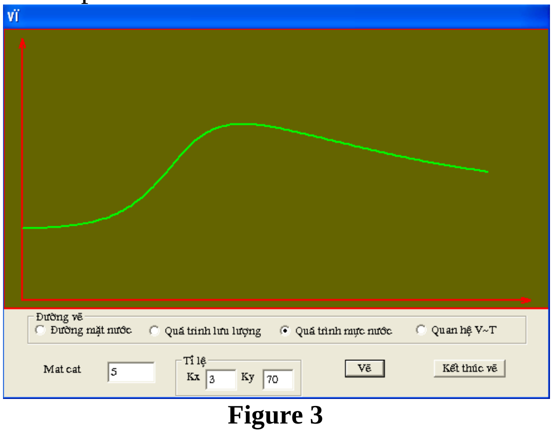

Figure 3

The process of changing the water depth at the end of the spillway section over time is displayed in Figure 3. The final section of the spillway has the smallest depth at time t = 0 to depth hmin = 1,095m, a time when end of spillway section reaches a maximum depth t = 16h with depth is hmax=2,685m

The velocity at the end of the spillway achieve maximum value vmax = 15,904 m / s

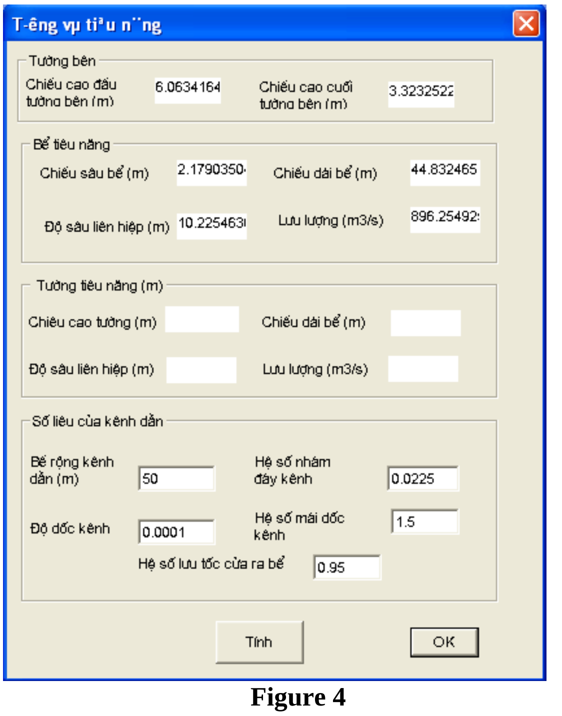

Figure 4

The result of the spillway sidewall height and size absorption basin is shown in Figure 4

+ Based on the water surface was determined to be in the program calculates the height of side wall:

Height side wall of the spillway h_{td} = 6,063m

Last height of the spillway sidewall h_{tc} = 3,323m

+ Featuring downstream channels:

Trapezoidal channel with a width of B = 50m; slope coefficient m = 1.5; the slope of the channel i = 0.0001

Of channel roughness coefficient n = 0.0225

Coefficient of velocity at the outlet of the tank: φ=0,95

Since then the program identified absorption basin size:

The depth of the tank d = 2,179 m

The length of the tank L = 44.832 m

Compared with the method of calculating the flow stability

Hydraulic calculation method of spillway under steady flow are widely applied in the calculation of hydraulic and hydroelectric contructions. This is the simplest method, but calculated for calculation results fast. However the calculation method has been found that this calculation ignores many hydrodynamic phenomena on spillway make calculation results are not close to reality. Due to flow over spillway usually unstable flow, flow in the first section of the spillway change over time as the flood season when flood discharge through spillway flow changes rapidly. So this time we see the flow on the spillway is stable line is consistent with reality.

Characterized method is one of the difference method, this method was calculated the rolling wave phenomenon on spillway, a phenomenon which in fact occurred when the flow through the spillway change over time. If calculated under steady flow considered to flow rate on all sections of the spillway equal, the method characterized consider flow rate on the section of the spillway is different due to the phenomenon of rolling way on spillway. In this section to compare calculation results between hydraulic calculation method in line spillway on stability and our unique approach to conduct hydraulic calculations on the spillway at a fixed time.

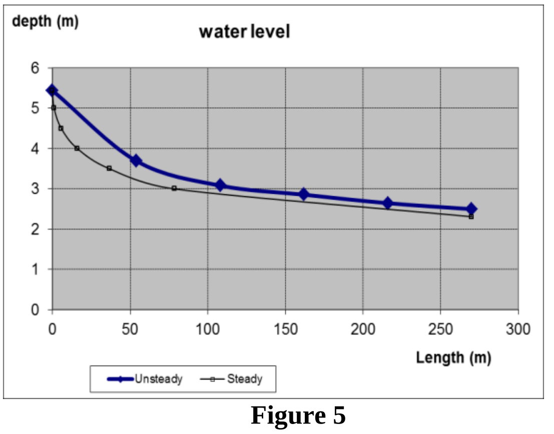

Figure 5

We calculate at t = 16h, the flow in the first section of the spillway is Q = 835,006m3 / s.

The results show that the two cases are different. Water elevation at the end of the spillway section calculated by the method of calculating higher characteristic steady stream method (Figure5)

In the characterized method calculated the rolling wave, water level of characterized method was higher than steady flow method, flow over spillway change in each section. The result of this calculation directly influences the size of the spillway and the size of the contruction of absorption. It was found that the results calculated by the characterized method, the side wall of the spillway height and size of the contruction of absorption is greater than the method of calculating steady flow.

CONCLUSION

In characterized method was to mention the complex hydrodynamic phenomena of jet phenomena like waves rolling on steep flow especially when the flow changes over time. The calculation may include rolling wave phenomena are consistent with spillways when operating especially in the flood season when the reservoir water discharge.

In our calculation results show that the flow of the flow in the spillway on different sections at the same time due to changes in surface flow and thus cut into the steep slopes. With calculation method steady stream must accept flow rate Q = const along the length of the flow, this does not fit with reality.

Based on the results of our calculations show that side of the spillway wall height and size will be larger contruction absorption compared with the method of calculation under steady flow.

Calculation results can be applied to study the hydraulic calculations for projects.

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TÓM TẮT

TÍNH TOÁN THỦY LỰC DỐC NƯỚC BẰNG PHƯƠNG PHÁP ĐẶC TRƯNG VÀ GIẢI PHÁP TIÊU NĂNG Ở HẠ LƯU

Lê Xuân Long*
Trường Đại học Kỹ thuật Công nghiệp - ĐH Thái Nguyên

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Từ khóa: *dốc nước, phương pháp đặc trưng, dòng chảy ổn định, dòng chảy không ổn định, tiêu năng*

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* *Tel: 0989 740037, Email: xuanlong_0307@yahoo.com*