The calculation of flood peak discharge for the area lack of hydrological data

*Qingjie Zhang [1, a], Liren Tan [2,b] and Zhifeng Li [1,b]

[1] Henan Yellow River Reconnaissance, Design and Research Institute, Zhengzhou

[2] Yellow River Water and Hydropower Development Corporation, Zhengzhou

[a]zqj351@163.com, [b]154597905@qq.com

Keywords: storm flood; flood peak; comprehensive instantaneous unit line method

Abstract. The engineering area studied in this paper belongs to the areas without hydrological data.The actual measurement data and storm record are both lacked. In this paper, the different methods were performed for the analysis of design flood calculation, at the same time, the rationality of results was also studied. Finally, the design flood peak discharge was determined. In this paper, the analysis and calculation method of design flood peak discharge are equipped with important reference significance for the small watershed area which is lack of hydrological data.

Project summary

An engineering project is located in the Yellow River on a small branch channel. Due to the narrow channel topography and bending, more life rubbish, more abandon soil and slag, flood discharge ability is poor. The engineering design of profile control in the basin is a typical loess plateau landscape, beam and distribution, the overall topography of the east high and west l ow. There is no clear water flow all the year round, only a flash flood in the rainy season. Appears to be on the "V" shape on the whole gully form, on both sides of valleys have scattered exposed bedrock. The project area is in national key control, with serious soil erosion phenomenon.

The area of Engineering control section above management is 8.80 km^2, with gully length 5.80 km. The project area is a typical loess hilly topography. The main manifestation is gully density and narrow, the bottom bedrock exposed, sparse vegetation in this area, soil erosion is serious. Project area mainly grey brown promised in soil with homogeneous structure, loose structure, soil deep, complex features such as mineral composition.

Storm flood characteristics

Influenced by eastern monsoon climate, in the project areas heavy rain distributed unequally for time and space. Large area heavy rain occurred fewer, and often give priority to with local flooding. Heavy rain duration is generally less than 24 hours, rarely more than three days. According to the measured data, 24 hour rainfall generally accounted for about 80% of the rainfall in three days.

Channel flood are formed by heavy rains in a region .Owing to the big rain intensity, high and steep mountain terrain, the characteristics is easy to produce severe consequences.

Design flood

Combined with the feature of river basin and the materials status, design the section selection of the peak flow of *hydrological calculation manual*[1] method to calculate.

Production flow analysis

Except on both sides of the channel and part of the river bedrock outcrops, project area entry control section in the basin is basically for cutting broken covered with thick loess. In combination with the *hydrological calculation manual*[1]of hydrological underlying surface runoff to class partition graph analysis, the basin runoff yield is loess hilly-gully region.

© 2015. The authors - Published by Atlantis Press

Confluence analysis

Basin precipitation produced by the net the rain under the action of gravity and surface resistance along the slope and the river to the convergence of export section collection process is called watershed confluence. Basin confluence calculation task is net rain according to the design process, with some sort of calculus method or model , then transform it into a basin design flood process line of the export section.

According to the *hydrological calculation manual* [1], confluence calculation mainly includes comprehensive method, the inference of comprehensive instantaneous unit line method, rational formula method, regional experience formula method and hydrologic assimilation method. The following calculation and analysis is based on the above four methods.

Comprehensive instantaneous unit line method[2]

Instantaneous unit line is assumptions basin confluence process for n series equivalent linear reservoir body of water storage process. The unit net rain multiplied by the instantaneous flow curve is called instantaneous line.

Confluence land type

Basin confluence depends mainly on basin slope vegetation conditions and river network impedance. Serious incised channel, basin surface exposure, sparse vegetation, extensive cultivation, steep slope flow hurry, for severe soil and water loss region. According to the *hydrological calculation manual*[1], overall consideration, such as the convergence of the channel to appropriate chooses loess hilly-gully region.

Parameter calculation

Instantaneous unit line has two parameters, linear reservoir number n, and linear reservoir to regulate parameter k. Both the product of the m_1 ($m_1 = nk$) called the instantaneous flow curve hysteresis .Its physical meaning is the instantaneous flow curve heart time coordinates the first-order moments, also is a net rain's center of gravity to the curved shape heart during unit time interval of curvilinear. So of instantaneous unit line become replacement of two parameters n and m_1, and calculated k by $k = m_1 / n$.

Designed flood hydrograph

By solving the lasted an average rainfall intensity $\overline{i_t}$, calculated m_1 , calculated k by the $k = m_1 / n$. The convergence calculates curve, so as to calculate the design flood process line.

Rational formula method

a. Intersection method calculates confluence last τ and maximum flood peak flow Q_m.

b. List calculates reasoning flood process line.

The unit is formed by the net each time the rain flood process line superposition according to time design flood process line. Through calculation, frequency $P = 1\%$, the peak flow of 171 m³/s, less than the intersection method peak flow of 214 m³/s, so need to adjust small M value, $M = 4$, look-up table shape parameter $c = 0.552$, obtained $P = 1\%$, the peak flow of 222 m³/s.The results are inconsistent with the Q_m, which is the reasoning formula method to calculate the design flood peak discharge, the design flood process line.

Regional experience formula method

By the design storm the corresponding frequency design flood peak discharge area of the empirical formula method is a collection of runoff and confluence calculation method of the peak flow .The method is usually used to calculate the small area of wading engineering design flood peak discharge.

Hydrologic assimilation method

Hydrologic analogy method is based on the similarity. It is a simple way with hydrological information in the similar basin.

A station near the project area, it is proposed the site set up since 1956.Compared with the project area, the hydrological stations watershed hydrological underlying surface condition is relatively close, hydrologic meteorological conditions are consistent. Geographical location close to the hydrologic station and the design of linear distance control basin center about 30 km. Based on the above conditions, the site can be stand as a complement in the cross section of the design.

© 2015. The authors - Published by Atlantis Press

Results of the rationality analysis

According to the regulation of *hydrology calculation manual* [1], for general engineering of design flood peak discharge, reasoning formula method or regional empirical formula method can be used. To design the flood flow process line engineering, appropriate uses instantaneous unit line method, the comprehensive reasoning formula method may be adopted. Also could using hydrologic assimilation method with neighborhood or data from field investigation and rainstorm.

According to the use of the four methods and engineering design requirements, the design flood calculation using the comprehensive instantaneous first, at the same time verified by the result of rational formula method, regional experience formula method and hydrologic assimilation method. The calculation results are shown in table 1. Compared the results of the after three methods with the results of comprehensive instantaneous unit line method, maximum floating within 5%, which verifies that comprehensive instantaneous unit line method has higher reliability. Through comprehensive analysis, comprehensive instantaneous unit line method is recommended.

Table 1 The summary of the peak flow Unit: m^3/s

Frequency	Comprehensive instantaneous unit line method	Rational formula method	Regional experience formula method	Hydrologic assimilation method	Adopted value
P=1%	217	222	227	218	217

References

[1]*Shanxi Province hydrology calculation manual*, edited by Shanxi Provincial Water Resources Department, The Yellow River water conservancy publising , (March,2011), in press.

[2] Mingsheng Wang, The instantaneous unit line method in the application of hydrological data lack of regional flood peak flow calculation, Science and technology information, NO.28,2010, pp. 31&33.

© 2015. The authors - Published by Atlantis Press