Discussion on the Application of the New Hydrological Instrument in the Flow Test

Yaping Du

Yuncheng Hydrology and Water Resources Survey Station, Yuncheng, 044000 Shanxi, China

Keywords: New instrument for hydrology, Flow monitoring, Adcp

Abstract: In the flow monitoring, the application of new hydrological instruments can make the flow monitoring results more accurate, and it is also a necessary tool for the modernization of our hydrological work. At present, there are some problems in using new instruments, such as non-standard, so we should take some useful measures to improve the quality of using new instruments and the precision of flow monitoring results. This paper mainly discusses the application effect of acoustic Dopler velocity profiler (ADCP) in hydrologic monitoring, and discusses the quality control of hydrologic flow monitoring.

1. Introduction

In the work of hydrological flow monitoring, the use of traditional monitoring equipment is limited and the operation is relatively cumbersome, which shows that it is difficult to improve the quality and efficiency of hydrological flow monitoring itself, it is also difficult to adapt to the needs of social development. The navigation-type ADCP is a new type of measuring instrument with high technical level, and the efficiency of data acquisition is obviously higher, the operation is simpler, and the working efficiency is higher, therefore, it has been applied in the existing flow monitoring work.

2. The Difference between Walking Adcp and Traditional Monitoring Instrument

In the previous work of hydrological flow monitoring, most of the traditional flow meters used, whether in efficiency or quality, ADCP is obviously superior in all aspects.[1] Specifically, the ADCP approach has the following differences:

(1) the traditional rotor-type flowmeter method is static in nature, because the flowmeter itself needs to be fixed at the monitoring point, but ADCP is different, the ADCP is dynamic, and can be repositioned and measured according to the change of the position of the measuring ship, not confined by space.[2]

(2) in the process of sampling with the traditional rotor-type velocity meter, the subsection division is usually not very fine, and the measuring points of the vertical velocity are very limited, so the accuracy of the data obtained is relatively low; However, the ADCP itself has a high sampling rate, which allows subsections to be subdivided into smaller sections, and the measuring points of the vertical velocity are more dense, so it is equivalent to having multiple velocimeters to measure it together, the accuracy of the results obtained has also been significantly improved.[3]

(3) when using the traditional rotor-type current meter to monitor the hydrological flow, it is usually required that the cross-section of the measured flow should be perpendicular to the riverbank, but the ADCP method does not need to follow this standard, moreover may carry on the measurement according to the survey ship route, the survey track may be the diagonal line, may be the straight line, may also be the curve, the overall application is more convenient.[4]

(4) under normal circumstances, the traditional flow meter needs to record and calculate manually in the field, and then plot the measurement results based on the calculated data, but the ADCP test is more convenient, and the monitoring data can be stored in the on-line system directly, and the results can be calculated directly in the system, the results obtained are more accurate and can greatly improve the level of modernization of hydrological testing.[5]

3. The Application of Navigation Adcp in Flow Measurement

3.1 Case Profile

In this paper, taking a hydrologic station in North China as a case, the necessary research is carried out by comparing ADCP with traditional anemometer. The data were collected in may-july 2019 and June-september 2020, during which the station experienced several distinct flood events under the influence of upstream water and the opening of the reservoir gates. Of these, the highest level was 61.35 m in September 2020 and the lowest level was 50.33 m on 31 July 2020. In the course of the discharge test, the hydrologic station adopts the navigation ADCP and the cable current meter, because at the highest water level, the river sediment content will increase obviously, the floating matter will increase obviously and so on. So these factors need to be considered fully in the course of measurement. In the process of actual comparison, it is difficult to start and end the same flow synchronously, and it is also difficult to start and end in the same vertical line. Therefore, in order to ensure the integrity and accuracy of data collection, the following two necessary conditions need to be satisfied: (1) cable velocimeter and navigation ADCP two different sets of monitoring instruments to ensure the start time synchronization as far as possible; (2) to keep the vertical distribution and the cross-section of flow measurement in line as far as possible, and to eliminate the interference of external factors to the greatest extent, so as to ensure the accuracy of flow monitoring. Then do a good job of data collection and analysis, a total of 58 samples collected data, collated out of the measured data.

3.2 The Results of the Test

After collecting, sorting and analyzing the data, we can know that there are 58 groups of data participating in the actual analysis, among which, the amplitude of the measured flow rate by the cable channel anemometer method and the navigational ADCP is between 2020-19200m3/s, and the amplitude of the measured flow rate is between 2020-19200m3/s, the amplitude of the measured flow rate is between 2020-19200m3/s, the amplitude of the measured flow rate is between 2020-19200 The variation range of average flow velocity and water level is 1.32-3.20 m/s and 54.33-61.28 m respectively. According to the hydrologic classification standard of the hydrologic station, if it exceeds 56.30 m, it will be high water level, if it is above 51.39 m, below 56.30 m, it will be medium water level, and in the actual comparison data, the intermediate and high water levels will be covered.The results were as follows: the sample size was N = 58, the number of positive signs was 27, and the number of symbol exchanges was 26. In the symbol test, U = 0.39, allowed: 1.15(significance level a = 0.25) , the test was qualified, allowed: 1.28(significance level A = 0.10) , test pass; test for deviation, | T | = 0.81, allowed: 1.30(significance level A = 0.20) , test and pass; standard deviation Se (%) = 2.4, random uncertainty (%) : 4.8, test for deviation, | T | = 0.82, test for deviation, test for deviation, test for deviation, test for deviation, test for deviation, test for deviation, test for deviation, test for deviation, test for deviation, test for deviation, test for deviation, test for deviation, test for deviation, test for deviation, test for deviation, test for deviation, test for deviation, test for System error (%) : 0.2. According to the error of each group of data, systematic error, random uncertainty, the system error of flow measurement should not be more than 2.5% , and the random uncertainty should not be more than 5% ~ 12% . It is in accordance with the requirements of GB50179 and TCHES61. The system error of flow measurement should be less than 2.5% , and the random uncertainty should not be more than 5% ~ 12% .The navigation-type ADCP is a high-tech flow-measuring instrument with a series of advantages, such as lower running cost, simple operation, less maintenance, higher efficiency and accurate results, etc. , and it can be installed on trimaran, unmanned ship and other carriers flexibly. In the process of actual comparison and analysis, the equipment is more stable, the data is more normal, and has obvious anti-interference ability. In addition, in the process of practical application, it can also solve the hidden trouble of safety existing in cable flow measurement. The original intention of the hydrological station is to provide more accurate and timely information of high flood discharge for flood control in the downstream region. Through the actual comparison and analysis, we can know that the

navigation ADCP flow measurement system can effectively meet the basic requirements of various hydrological norms, and in this system, in the middle and high water levels, can also be put into use.

4. Main Error Control in Hydrologic Flow Measurement

4.1 Quality Control of System Error

First of all, in the actual monitoring process, the sediment concentration in the flow is easy to affect the actual use of ADCP effect. For the rivers with relatively high sediment concentration, the ADCP with high frequency is not completely applicable, mainly because of the relatively high sediment concentration of the flow itself, the probability of bathymetry and riverbed disappearance failure will obviously increase, however, in the process of using low frequency ADCP equipment to measure the relatively high sediment concentration, the river itself can not be too shallow, too shallow is not applicable, mainly can not use the narrow-band ADCP. If the river itself is relatively high in sediment, but the river itself is too shallow to apply a walking ADCP, then in this case the measurement of the ship's available speed difference can be made with the help of a GPS system, bathymetry can be used for bathymetry[6].Secondly, the bed load movement will directly affect the accuracy of river bottom tracking measurement. If the current speed is too fast, the sediment on the bottom of the river can easily form bed load, so if the GPS system is used to measure the speed of a ship, the effects on the movement of the bed load must be minimized.[7] Finally, for the shore shape, flow coefficient and so on, can be measured through the on-site cross-section, shore velocity distribution tests, and with the relevant provisions, to obtain its corresponding parameters. After actual comparison, the equipment can be calibrated and measured, the flow velocity in the blind zone can be analyzed, and relatively accurate interpolation can be carried out.

4.2 Quality Control of Random Error

First, we need to choose a scientific and reasonable working model. Generally speaking, there are many working modes of the navigation ADCP, and the launching mode and processing mode of different models will also affect its accuracy.[8] For example: the wide-band velocity measurement itself high precision, wide measurement range, measurement depth, in most cases, can be applied. Secondly, the walking ADCP usually combines the magnetic azimuth provided by the compass with the actual track calculated by the various sound beam Doppler effect. The magnetic azimuth provided by the compass is subject to errors, need to do a good job of error calibration.

5. Measures for Quality Control of Hydrologic Flow Measurement

5.1 Be Fully Prepared Before Going out of Storage

In order to ensure the normal operation of the navigation ADCP, the necessary pre-inspection should be done. When actually going out of storage, it is necessary to check the equipment list carefully, and at the same time, check carefully whether there are any omissions in the carrying equipment and devices, connect the power supply, connect the ADCP to the computer, and debug the radio signal carefully, at the same time, the software system should also be a comprehensive check to ensure that the software system can run more stable.

5.2 Do the Installation of Field Instruments

In hydrologic work, it is necessary to use new instruments such as ADCP to measure flow, especially the installation work, which has certain requirements for the staff, staff must be fully aware of the new instrument installation method, the ratio of the method, and the new instrument to analyze the actual quality of work. Among them, the hydrological station can arrange professional personnel to supervise the installation of new hydrological equipment, and do the corresponding monitoring, so as to ensure the installation of new instruments correct and scientific. One can develop clear installation rules, and require staff to strictly comply with the installation rules for

installation work. It is clearly stated in the installation rules that prior to the installation of the new hydrological instrument, the staff shall conduct a ratio determination and then study the original installation instructions, the overall structure and the operating principle of the new instrument, after installation, the scale measurement shall be remeasured. Typically, the walking ADCP must be mounted on a non-ferromagnetic trimaran bracket, where the transducer is immersed to a depth of about 10 meters, surface and internal cavitation should be avoided; in the case of sand movement at the bottom of a stream-measuring section, the speed of a ship needs to be measured with the help of GPS equipment; and in the case of maximum depth, which is difficult to measure, it is necessary to measure the depth of water with the help of a depth sounder..

5.3 Pay Attention to the Details of the Flow Test

Before the flow measurement work starts, the basic information should be recorded strictly according to the position and date of the corresponding section on the operating system, and the distance between the starting point and the end point should be measured, the distance from the end point to the bank and so on, and enter these data information into the system. If the deviation between the average and the value of each half-measured return flow is more than 5%, the corresponding analysis needs to be combined with specific problems, and the relevant data need to be re-measured. The cross-section flow will involve the shore, the blind area and the direct measured part of the flow.

5.4 Need to Pay Attention to the Maintenance of Warehousing-Related Work

At the end of the hydrologic flow measurement work, it is necessary to combine with the maintenance-related requirements, and timely washing of the instrument's internal transducer. Among them, the power supply system needs to do the necessary maintenance work strictly according to the regulation, and the field work is usually exposed to the sun, the sensor is easy to be damaged, need to do a good job of sensor protection; In the probe surface, if there is an attachment, it is necessary to carefully carry out the corresponding maintenance work, if there are relatively deep cracks or scratches, to consider whether the test accuracy is affected; If the corrosion of anti-corrosion components themselves serious corrosion problems, the need for timely replacement of new components. For some long-used equipment, regular inspection and maintenance should be done, but also in accordance with the appropriate manner of equipment maintenance, so as to improve the use of equipment efficiency and use quality.

6. Conclusion

In the research of this paper, we mainly analyze the measurement of hydrologic flow by the new hydrologic instrument, the navigation ADCP, in which we can know, the navigation ADCP itself is suitable for the station which is affected by scouring and silting and has a large task of reporting information. In the actual survey, it is necessary to select different types of ADCP according to the characteristics of different rivers, its own advantages can meet the basic requirements of modern hydrology for high accuracy, the whole has a larger space for development. In practice, some problems may be found, therefore, it is necessary to carry out necessary analysis and combine theory with practice, so as to promote the development of ADCP in hydrological monitoring, and provides the solid foundation for the follow-up hydrological work.

References

[1] Jiang Dewu. Application of walking ADCP in flow measurement in Liesing hydrographic survey area [J]. Water Resources Development and management, 2022(003):008.

[2] Ji Haixiang, Chen Zhi, Yang Haimei, etc. . Develop new side-scan radar system to improve on-line flow monitoring capability [J]. Management and research of scientific and technological achievements, 2022(10):3.

[3] Guo Jianchang. Analysis of influence of Water Conservancy project on hydrologic and hydraulic characteristics [J]. Science, technology and economics of water resources, 2023,29(1):5.

[4] Liao Liguo. Application and analysis of the new technology of video water level and discharge measurement in Luolingqiao hydrological station [J]. Hunan Water Conservancy and Hydropower, 2022(4):3.

[5] lo po-man, Cheung kwok-tai. Discussion on the application of new hydrologic instruments in flow measurement [J]. Natural Science, 2021(1):2.

[6] Huanglong. A study on the application of new hydrologic instruments in the measurement of small and medium-sized rivers [J]. East China Science & Technology (integrated), 2021, (007):1-1.

[7] Hu Changhe. Application of domestic 600kHz ADCP in river flow measurement [J]. Acoustics and Electrical Engineering, 2022(4):4.

[8] Mao Zhenyu. Analysis of the application of navigation ADCP in hydrologic flow measurement [J]. Science, Technology and Innovation News, 2022(004):019.