Application of GPS-based Dynamic Survey Technology in Civil Engineering

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Abstract: In recent years, advanced measuring technique have been introduced and widely used in the field of civil engineering, which has greatly improved the quality of engineering and has a positive impact on the improvement of construction efficiency. Civil engineering is an important part of China's infrastructure construction, which is closely related to people's lives. In order to improve the quality of civil engineering construction, the construction unit applies GPS survey technology to the field of civil engineering construction, in order to meet the requirements of civil engineering construction quality control and lay a solid foundation for China's socialist modernization. With the rapid development of economy and the continuous progress of science and technology, more and more science and technology are applied in the construction process of civil engineering, which greatly improves the construction quality and efficiency of civil engineering. Technology is an advanced measurement technology, which is widely used in urban survey, engineering survey, oceanography survey, geodesy and other aspects. This paper mainly introduces the measurement technology and its application in the field of civil engineering construction, so as to provide technical support for the development of civil engineering in China.

1. Introduction

In today's society, GPS survey is widely used in civil engineering construction. GPS is the abbreviation of Global Positioning System in English, while its Chinese abbreviation is "Spherical Position System" [1]. GPS is a new generation of space satellite navigation and positioning system jointly developed by the US Army, Navy and Air Force in 1970s. Its main purpose is to provide real-time, all-weather and global navigation services for land, sea and air, and it is used for some military purposes, such as intelligence gathering, nuclear explosion monitoring and emergency communication. It is an important component of the U.S. strategy of dominating the world. After more than 20 years of research and experiments, which cost 30 billion dollars, by March 1994, 24 GPS satellite constellations with a global coverage of 98% had been deployed. Because of its all-weather, high-precision and automatic measurement characteristics, GPS technology, as an advanced measurement means and new productivity, has been integrated into various application fields of national economic construction, national defense construction and social development [2]. With the development of the times, the progress of the society and the rapid development of urban construction, the civil engineering has correspondingly got a high development speed and a large development space. Moreover, the technical requirements of the actual construction projects in the construction process are becoming more and more strict. Some relatively traditional old-fashioned construction technologies can no longer support the high-level technical requirements of the civil construction projects in today's progressive society. Therefore, people have gradually transferred the sight to advanced science and technology and applied it to the actual construction of civil engineering. However, the emphasis on GPS measurement technology has played a vital role in promoting modernization and civil engineering. Compared with other similar technologies, GPS measurement technology is more advanced, and its characteristics are relatively prominent, such as all-weather detection, continuous coverage of the global area, extremely accurate positioning and relatively high efficiency of static positioning observation. GPS is a satellite-based radio satellite navigation and positioning system. GPS technology was first applied in surveying and mapping fields such as geodesy, engineering surveying, aerial photogrammetry, oceanography, urban

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surveying, etc., and then it was researched and widely applied in survey, design, construction, deformation monitoring and other aspects of bridge engineering [3].

2. Advantages of GPS in engineering survey

2.1. Application of GPS static measurement technology

The relative positioning principle of GPS is that several GPS receivers are used to track the GPS satellite signals, and the difference method is used for the observed carrier phase values, so that the baseline vector between the observation stations is the coordinate difference. Then calculate the coordinates of other observation points with the known baseline vector and coordinates[4]. GPS relative positioning can be divided into dynamic relative positioning and static relative positioning, and static relative positioning has been widely used in actual control survey. The static measurement technology of GPS has played an active role in many fields, and has shown great value in measurement, military affairs, transportation and other aspects[6]. Chinese name GPS Static Measurement mbth GPS static measurement defines a measurement method that uses a measuring GPS receiver and a positioning satellite for positioning measurement.Background With the in-depth development of information technology and digital technology, it has been widely used in practice, and the measurement technology and space science have made unprecedented progress and development. Among them, GPS technology has the remarkable characteristics of accuracy, rapidness, high efficiency and all-weather. It has been applied in many fields of modern social economy, especially in military affairs, transportation, surveying and other fields, and has achieved remarkable results, highlighting its important application value. In engineering survey and cities, static GPS survey technology has been widely welcomed and trusted by the vast number of surveying and mapping workers, and has increasingly become an important technology in urban work. Using this relatively static positioning method of GPS can not only eliminate the errors, but also greatly weaken the errors, such as the current delay, ionospheric delay and satellite seed difference, so the obtained position has high relative accuracy[5]. Principle GPS static measurement is a kind of positioning measurement using a measuring GPS receiver. It is mainly used to establish a global or national geodetic control network, a crustal movement monitoring network, a long-distance calibration baseline, joint survey between islands and continents, drilling positioning and the establishment of precision engineering control network. When GPS static measurement is carried out, it is considered that the position of the antenna of the GPS receiver is stationary during the whole observation process. When data processing, the position of the antenna of the receiver is regarded as a quantity that does not change with time, and the coordinates of the fixed point are obtained through the changes of the received satellite data. In the survey, the specific observation mode of GPS static measurement is to adopt two (or more than two) receiving devices, which are respectively placed at two endpoints of one or more baselines, and simultaneously observe more than four satellites, with each time period of 45 minutes to 2 hours or more. The positioning accuracy of the baseline can reach 5mm+1×10-6.D, and d is the baseline length (km). When surveying, all the observed baselinesshould form a series of closed graphs, which will help to further improve the positioning accuracy.Figure 1.

GPS dynamic measurements use satellite signals to measure objects moving relative to the Earth. Compared with static positioning, it can receive more data, including THREE-DIMENSIONAL coordinates, three-dimensional velocity and seven time parameters. GPS dynamic measurement can be used for civil engineering monitoring, can use this technology for bridge, dam, building deformation monitoring[11].

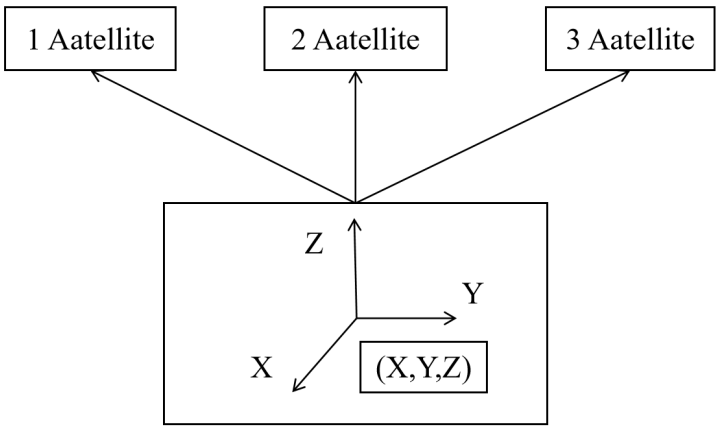

Figure 1 Schematic diagram of GPS measurement

2.2. Composition of GPS(RTK) system

GPS(RTK) system is mainly composed of three parts, including radio communication system, mobile station and reference station. Among them, the rover includes rover controller, power supply, radio communication answering system, GPS antenna and GPS receiver. The reference station covers the reference station controller, the power supply for the radio station and the GPS receiver, the radio communication transmission system, the GPS antenna and the GPS receiver, etc. The user receiving part, the space satellite part and the ground monitoring part together form a complete GPS system, and the functions are different and interrelated, thus forming a unified whole.

In order to ensure the satellite signal, in the selection of reference station stations to choose the field of vision is relatively open, it is best to have a height Angle of more than 15 degrees, do not have a piece of occlusion and obstacles in the area, such as high-rise buildings. In the selection of the monitoring station in a large area, it is best to stay away from the calm water, some high-power radio signal transmitting source, hillside and high voltage transmission line and other signal reflectors, so as to eliminate and weaken the error of the multipath. In addition, in order to facilitate observation, some favorable geological conditions and convenient transportation should be considered, which are important considerations[7]. Finally, the results can't be obtained immediately on the spot. Figure 2 is a simple demonstration of RTK real-time relative positioning principle

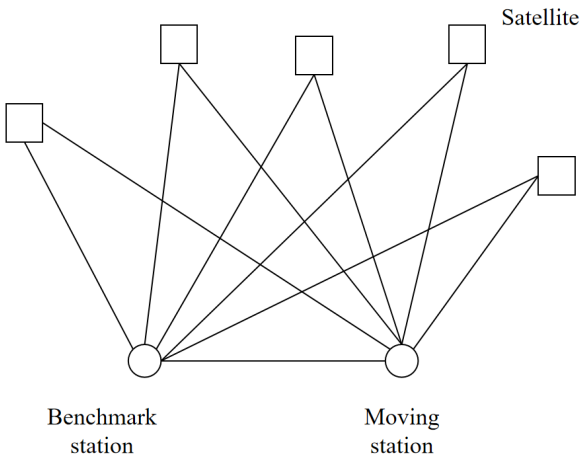

Figure 2 RTK real-time relative positioning principle

If the satellite signal received by the reference station is to be transmitted to the rover station in time and accurately, it depends on the radio communication system. The rover station can receive the satellite data in time, and it can also receive the satellite data transmitted by the reference station. After the initial work is completed, the rover station can transmit the information of the reference station to the controller in time, so as to carry out differential processing on these carriers, and

finally calculate the specific three-dimensional coordinates of unknown points. Using GPS technology in line survey can ensure that the point errors of each survey are independent and do not affect each other, and the errors that have already occurred will not be accumulated and superimposed. At the same time, when using GPS measurement technology, the measurement accuracy can reach centimeter level [8]. Therefore, GPS has the advantage of positioning accuracy. When GPS technology is applied between stations, there is no need for intervisibility, but only electromagnetic wave and other equipment can be used for measurement. At the same time, because GPS measurement is generally less affected by the natural environment, it makes the station selection more flexible and convenient, thus improving the work efficiency. Figure 3 is the operation flow chart of the survey area.

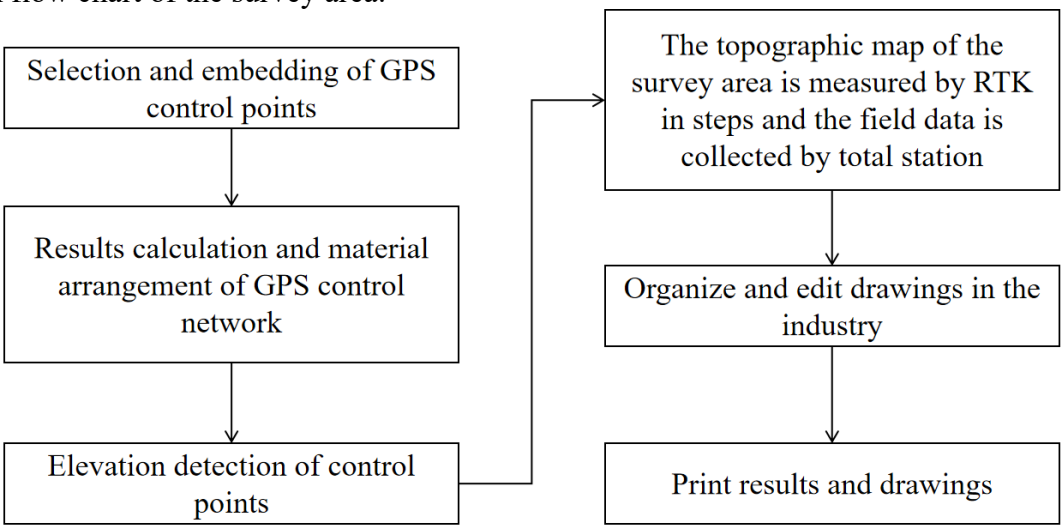

Figure 3 Flow chart of RTK combined with total station survey

3. Application of GPS Technology in Civil Engineering

3.1. Application of GPS in civil engineering

Because of its own characteristics, GPS measurement technology is gradually favored by civil engineering builders and widely used in the field of civil engineering construction. As far as the characteristics of GPS measurement technology are concerned, it can accurately measure the engineering projects, thus improving the construction quality and efficiency of the engineering projects, effectively reducing the construction cost and realizing the sustainable development of civil engineering. In bridge construction, GPS measurement technology is mainly used to effectively construct the control network and deal with the construction lofting. The application of GPS measurement technology can accurately measure various construction data on the construction site, such as elevation measurement and river-crossing leveling, which can obtain accurate data, thus being beneficial to control all links of bridge construction. Construction personnel can carry out the overall planning of the bridge project through the three-dimensional positioning information provided by GPS measurement technology, which makes the bridge construction more reliable and effectively guarantees the quality of the bridge construction [9]. In bridge elevation survey, GPS positioning system can provide measurement accuracy. Traditional surveying and mapping tools need to set up reference points, but it is difficult to obtain and unstable reference points at high points, so the measurement accuracy is relatively low. However, GPS positioning system can assume relative distance points according to ground base station, so its measurement accuracy is higher.GPS measurement technology can also be used in building construction, mainly used for accurate positioning of the construction coordinate system and geodetic coordinate system, so as to obtain the conversion relationship between the two. In the process of building construction, GPS measurement technology is used to continuously detect the vibration and deformation of the building, so as to obtain more accurate construction data. In the process of surveying buildings with

GPS survey technology, the starting point and direction are mainly taken as the observation base points. The reason why the starting point and direction are used as the reference points for observation is mainly to prevent the change of observation points from affecting the accuracy of the test results, so as to provide accurate measurement data for engineering construction and ensure the smooth implementation of construction projects. As far as the property is concerned, the dam is a kind of water conservancy project, which is easily influenced by various external factors during construction, which makes the construction more difficult, especially in the construction of inter-basin dams. Because the dam will be affected by various unfavorable factors in the construction process, it is difficult to control the quality of the dam. Therefore, scientific and technological means should be adopted to effectively monitor the dam construction and reasonably detect the possible deformation problems in the dam construction, so as to ensure the quality of the dam construction. In recent years, GPS survey technology has been gradually applied to dam construction, which makes the problem of dam deformation reasonably controlled. The GPS measurement technology has the characteristics of accurate detection and strong anti-interference characteristics, which have effectively improved the quality and progress of dam measurement and made the dam construction more accurate. As far as the water-resisting rock reservoir in a county is concerned, its dam belongs to gravity arch dam, and it has been put into use since its completion. It is mainly used for data acquisition, transmission and processing. According to the monitoring results, the GPS system has a high monitoring accuracy, and the time for data processing and analysis is less than 15 minutes. It can give feedback in the first time of the dam's ultra-high water storage deformation, and take timely flood control and disaster reduction measures to reduce the occurrence of disasters. It can be seen that the application of GPS technology in dam deformation monitoring is effective, but the application of this technology still needs to be studied to provide more effective dynamic support for modern dam construction [10].

3.2. Application characteristics of GPS in civil engineering

GPS receiver is a highly automated device. Generally, in field observation, it only needs to measure the height of the leveling, centering and measuring antennas, and set the parameters after starting up. As for the others, it only needs to be done by the working instrument itself. This is a device and machine with high working efficiency, which shows that automation technology and digital technology have been well applied in practice: GPS measurement can also provide the measured three-dimensional coordinates of the measured station with high accuracy. With the development and perfection of GPS measurement technology, the static GPS relative measurement only takes about 30min, while the dynamic GPS positioning technology is even shorter, and it only takes a few minutes or even seconds to achieve the accuracy of centimeter level or even millimeter level, which has extremely high efficiency.GPS system is very simple to operate, the mapping of GPS system is mainly completed by the satellite system, the main work of ground operators is to receive signals and complete auxiliary work, so the system is convenient to operate. GPS measurements do not require observation stations to be visible to each other, just to keep the sky open. GPS systems are widely used, covering 98% of the world's regions[11]. At the same time, the GPS system can resist the influence of a variety of bad weather, GPS observation can be carried out continuously at any time anywhere. GPS system can not only be used for ranging and navigation, but also for speed and time measurement. Its rich functions promote its application in the field of civil engineering[12].

4. Conclusions

Nowadays, with the rapid development of science, technology, economy and culture, of course, indispensable civil engineering and civil engineering construction technology will continue to develop, and GPS measurement technology should have its own unique advantages, which will make its application range constantly extensive, and then play a significant role in promoting the construction of civil engineering, making the civil construction industry develop continuously with a healthy and vigorous trend. With the maturity of GPS technology, it has been widely used in the

field of civil engineering construction. The application of GPS technology in bridge construction, tunnel survey, high-rise building and other projects has the characteristics of high precision, high degree of automation, strong anti-interference and no limitation of external working environment and distance, which greatly reduces the labor intensity, reduces the field workload and greatly improves the work efficiency and the quality of results.

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