GPS Real-Time Supervisory System and Application in the Construction of Face Rockfill Dam

HUANG Shengxiang  LIU Jingnan  ZENG Huai’en

ABSTRACT  According to the quality control needs of filling construction of the face rockfill dam, by means of the global satellite positioning technology, the wireless data communication technology, the computer technology and the data processing and analysis technology, and integrating with the roller compaction machine, the GPS real-time supervisory system is developed in this paper. It can be used to real-timely supervise the construction quality of the roller compaction for filling engineering. The composition and applied characteristics of GPS system, and the key technique problem and solution of the design are discussed. The height accuracy of GPS system is analyzed and the preliminary application is introduced.

KEY WORDS  GPS; filling construction; quality control; integrated system; face rockfill dam

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Introduction

At present, in the quality management of filling construction of the face rockfill dam the quality control method of “dual controls” is mainly adopted, of which one is manually controlling the parameters of roller compaction including thickness and roughness of filling layer and rolled times and rolled speed of compaction machines, the other is inspecting the test hole sampling manually in the area. The method play a positive role in promoting domestic development of concrete faced rockfill dam. However, the traditional manual management mechanism can’t meet the demands of modern mechanized construction and schedule any more, with increasing of scale of concrete face rockfill dam. Concrete faced rockfill dam of Shuibuya project in Qingjiang River of Hubei Province, China, ranking first in dam height of the same type in the world, is as high as 233 m. The project has a total filling volume of $1.6 \times 10^7$ m$^3$ and more than $6 \times 10^5$ m$^3$ for peak filling volume of a single month, so demands much more to control the quality of filling construction of the dam. For the sake of supervising the filling construction quality quickly in time, it is very important to develop a supervisory system of the construction quality of the roller compaction for filling engineering, which has characteristics of real-time, continuity, automation and high precision. The supervisory system has a great meaning for improving the construction quality of Shuibuya project.

As a brand-new technology of modern spatial satellites navigation and positioning system, GPS has gradually replaced the normal optical and electrical surveying equipment in more and more fields. Since 1980s, especially after 1990s, GPS technology has lead the spatial positioning technology, combining with modern communication technology to a revolutionary change. The method for simultaneously determining three dimensional coordinates by GPS has changed the traditional positioning technology from land with inshore to entire ocean and outer space, from statics to kinematics, from afterwards processing to network difference, from afterwards processing
to real-time positioning and navigation, and absolute and relative positioning precision coming to meter-level, centimeter-level, even submillimeter-level, therefore, expands the fields of application and effect in every walk of life. The fast development and improvement of modern data communication technology, computer technology, electrical technology and the spatial positioning technology on behalf of GPS make supervision of high precision real-time continuity and automation feasible.

According to the requirements of construction quality management for roller compaction in filling engineering, by means of the global satellite positioning technology, the wireless data communication technology, the computer technology and the data processing and analysis technology, and integrating with the roller compaction machine, in 2004 Wuhan University and Qingjiang Hydroelectric Development Corp. Ltd. jointly developed a real-time supervisory system suitable for the quality management needs of roller compaction in filling engineering, i.e. real-time supervisory system of filling construction quality (GPS system for short afterwards). The system has comprehensive functions of real-time, high precision, continuity, automation etc., so can be applied to real-time supervising construction quality of filling compaction for dam, road, protection dike, airport etc. and becomes an effective assistant of ensuring the construction quality for project. Combining with engineering needs and system characteristics, the composition, key techniques and schemes of the system are discussed in this paper. The height accuracy of the system is analyzed and the preliminary application is introduced.

1 Composition and characteristics of GPS real-time supervisory system

1.1 Composition of the system

Hardware unit of the system mainly includes 3 parts as follows;
1) Receiving system of GPS satellite signals;
2) Wireless network data communication system;
3) Computer system.

According to the requirements of compaction for filling and ramming engineering and construction quality management to system, the system is composed of supervisory center, network relay station, locale sub-control station, GPS reference station and mobile terminals (including roller compaction machines and quality supervisor working vehicle), regarding the effect of wireless communication from topographic environment. Fig. 1 is the illustration of construction quality supervisory system for filling compaction project. If the topographic environment is good and the distance between the filling construction on-the-spot and the system supervisory center is not long, the network relay station can be removed.