Application Analysis of Information Technology in the Yellow River Flood Control Project Management

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Abstract: The central task of the Yellow River flood control works management is to maintain the integrity of the project and ensure the flood control ability of the project does not decrease. In order to achieve this goal, the Yellow River management departments at all levels need to use modern technology to supervise a set of modern project management system, so as to understand and grasp the project operation status in real time, so as to timely find and eliminate the project hidden dangers, and ensure the safety of the downstream embankment and flood control operation.

1. Introduction
The key to the modernization of the Yellow River Channel Project management lies in the information construction and application of new technologies[1]. An important research topic regarding the Yellow River flood control management at present is to establish and perfect the informatization and intelligent management system of the Yellow River channel project[2]-[3]. The primary problem to be solved in the Yellow River flood control project management is to analyze the technology contents and implementation difficulties, and moreover, the traditional management mode has not been completely broken through, yet. Therefore, it is urgent to accelerate the information construction and promote the R & D and application of new technologies. The construction and application of “database of root stone detection in dangerous buttress dam” and “engineering safety evaluation model”, which were completed and put into use, were taken as examples in the discussion and analysis.

2. Database Establishment of Root Stone Detection in Dangerous Buttress Dam and Its Safety Evaluation

2.1. Construction of “root stone detection management system of the Yellow River regulation project”[4]
The root stone detection in river channel regulation project is an important foundation work for understanding the basic distribution status of root stones in time, conducting the danger removal and dam reinforcement work well and ensuring the regulation engineering safety. In order to timely master the root stone status in the Yellow River regulation project, the Yellow River Conservancy Commission (YRCC) stipulates that the root stone detection should be carried out for three times, namely, before, in and after the flood season.

There are about 12,000 buttress dams in the Yellow River regulation project, especially most of the buttress dams constructed in recent years for the river regulation project have not accepted the ordeal of big floods. None of the dams, buttresses and revetments newly constructed according to the traditional
Dam construction technology are built to the design depth. Affected by the current scour, a pit is formed before the dam, the root stone protective covers then collapse, needing to the timely reinforced, each dam section must experience the repeated process of scouring danger—emergency rescue and reinforcement—in danger again—reinforcement again, and the foundation can be firm only when the root stones rescued and protected in front of the dam reach a certain depth (generally needing to exceed 12 m) with a certain stable slope gradient (generally needing to exceed 1:1.3). Meanwhile, due to the wandering characteristics of upstream and downstream channels of the Yellow River, the root stone loss will usually appear in the dangerous buttress dam project even just under medium and small floods. If this phenomenon is not timely discovered and rescued and protected by taking effective measures, the instability failure may occur to the dangerous buttress dam, and moreover, the buttress dam may collapse and break, thus endangering the embankment safety. Such case was once repeated throughout the history. Therefore, it is very necessary to strengthen the detection and real-time monitoring of root stones in the river regulation project.

According to the management requirements of root stone detection in the Yellow River regulation project, Research Institute of Engineering Geophysical Prospecting of Yellow River Engineering Consulting Co., Ltd has developed 3200-XS sub-bottom profiler based on the X-star underwater profiler imported from America, thus realizing the “root stone detection management system of the Yellow River regulation project” [5], with the main contents of detection operation, data storage and computer information management. On basis of basic information database, root stone section layout database, root stone detection database, image database and document database, etc. with respect to dangerous buttress dam works of different water conservancy management units, this system establishes the corresponding functional modules to manage the root stone detection data in the Yellow River regulation project, so as to realize various functions such as data maintenance, integrated query, statistical analysis, file management and system maintenance as shown in the following chart 1.

![chart 1: General System Structure Chart](image)

The databases established regarding the data of buttress dam, image, multimedia and root stone detection section (including crest elevation, elevation of root stone platform, water level elevation, root stone depth at monitoring point, detection time, detection unit, underwater slope of root stone, stone loss, etc.) in the Yellow River regulation project drew the cross-section diagram of root stone detection, calculated the sectional stone loss area and stone loss of buttress dam, and supported the import & export functions of images and data in various formats, along with universal data functions, interactive graph...
In principle, the basic databases are established, updated and maintained by the counties (cities and districts), the detection unit submits the achievement reports (detection data included) to the county-level bureaus, which then timely import the root stone detection data in and after the flood season into the databases. Yellow River Conservancy Commission of the Ministry of Water Resources, municipal bureau and county-level bureaus all can inquire all kinds of statistical statements, sectional diagrams and stone loss, etc. they need, provide the printed and export data, thus realizing the dynamic management and monitoring of root stone detection. After completing the detection each time, while submitting the detection achievements to the county-level bureaus, the detection unit can timely upload the root stone detection data to the root stone detection database of Yellow River Conservancy Commission so that the administrative departments at all levels can inquire whenever possible and master the root stone distribution in different projects as soon as possible.

2.2. Conception of Dynamic Management and Monitoring of Root Stone Detection
Dangerous buttress dam in the river channel regulation project is an outpost of embankment. When encountering current scour, the buttress dam is prone to root stone loss, foundation depression, collapse, landslide, etc., among which the root stone loss is the primary dangerous factor. As the dangerous case caused by the root stone loss is of suddenness, the reaction time of emergency rescue is short, the key to the operations management lies in monitoring and timely alarming the root stone loss of dangerous buttress dam, so the safety monitoring and warning and forecasting researches on the root stones in the dangerous buttress dam should be carried out to facilitate the early reinforcement and save the rescue work. Meanwhile, the basic engineering databases and computer network should be integrated to establish the corresponding relation between basic information of dangerous buttress dam and root stone detection data, in order to explore the change laws of root stone loss, river channel boundary conditions, water inflow volume and flow direction. This can not only facilitate the water conservancy units to save the detection data, master the root stone distribution status of dangerous buttress dam under their jurisdiction, and effectively monitor the distribution dynamics (root stone depth on the detected cross section, underwater slope of root stones, stone loss, etc.) of root stones in the dangerous buttress dams, but also provide a basis for reinforcing the root stones of dangerous buttress dams and realizing the emergency rescue under dangerous cases.

3. Model Investigation on Engineering Safety Evaluation
The data should be acquired through the monitoring process, and moreover, the engineering safety evaluation model should be established, in order to timely, accurately and effectively evaluate the internal quality and safety status according to the safety monitoring data of flood control project. Whether the safety evaluation model is objective and reasonable is related to the efficiency of safety evaluation; safety monitoring indexes constitute the basis for realizing the online monitoring system warning and forecasting of engineering safety, formulating the accurate safety limits is the key to the engineering safety monitoring and evaluation model, and the safety limits should be determined in consideration of the interdependence between engineering parameters and other influencing factors. In a future time period, the development and research work of safety evaluation model for the flood control project is a long way to go. The safety evaluation system mainly includes two contents: intelligent and comprehensive analytical calculation of basic data acquired by the monitoring system using the established safety evaluation model; comprehensive evaluation by importing the model’s analytical calculation results into the engineering safety evaluation system consisting of knowledge base, expertise database, etc. In the end, the indexes reflecting the engineering safety operation status are proposed, and the system flow chart 2 is as follows:
As for the engineering safety evaluation, the acquired effective monitoring data and basic information should be comprehensively analyzed and processed, the internal quality of the project should be correctly evaluated, and the project operation status should be understood and mastered, to provide a support for the flood prevention scheduling, water resources scheduling, danger removal and dam reinforcement and maintenance decision-making.

According to the functions and tasks of water conservancy units, the conventional engineering safety evaluation and real-time evaluation work should be carried out in the flood control project safety evaluation.

3.1. Conventional evaluation
General safety evaluation of flood control project. The daily monitoring, inspection and observational data should be organized and analyzed after the flood season every year. The general safety quality of flood control projects like embankment project, river channel regulation, reservoir dam and sluice project should be evaluated using the safety evaluation models, with the emphasis laid on evaluating the embankment quality and flood control ability of embankments and dangerous points and sections.

3.2. Real-time evaluation
The real-time evaluation of emergencies endangering the safety of flood control project should be conducted, including the evaluation of flood control project quality and flood control ability under heavy rainfall. The evaluation model should be timely started under relatively heavy rainfall (the rainfall intensity is greater than 50 mm within 12 h), the monitoring data should be collected, and the evaluation report and emergency treatment plan should be timely submitted; when large-area and large-scope
floating objects are found in the river channel during big flood, the monitoring and evaluation model
should be emergently launched to realize the locating and tracking of the floating objects, evaluate the
possible building blocking and clash and put forward the treatment opinions in a timely manner; when
any abnormal deformation (dangerous case) occurs to the flood control project according to the
monitoring data information, the safety quality evaluation model should be immediately started, the data
information should be analyzed and processed, and the danger removal and reinforcement emergency
measures should be taken, and the treatment process should be tracked, and after being organized and
analyzed, the relevant information should be imported into the experts’ neuronal analysis database.

4. Conclusions
The basic route to realizing the modernization of Yellow River governance system and control ability is
informatization, and facilitating the development of water conservancy project management. The
standardization and modernization of management can be forced by the informatization. The
information construction of water conservancy project management means developing and utilizing
water conservancy information resources by taking full advantages of modern information technology,
including the acquisition, transmission, storage, processing and utilization of water conservancy
information, improving the application level and sharing degree of water conservancy information
resources, and thus comprehensively improving the efficiency and effectiveness of water conservancy
project management.

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