Study on the Technical Evaluation of Acceptance of Water and Soil Conservation Facilities in Hydropower Projects——
Taking Yinpan Hydropower Station as an Example

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Abstract. Since soil and water conservation facilities through the purchase of services by the government, the working procedures had changed. This paper studied the evaluation work program, combination with Yinpan hydropower station, which divided into personnel composition, site survey, data verification, communication and reporting. The legal procedures for the implementation of soil and water conservation were checked to confirm the scope of responsibility for the prevention and control of soil erosion. Spoil yard and stone pit were surveyed and analysed one by one to confirm the soil and water conservation measures, the amount of soil and water conservation measures, the quality evaluation and the effect of soil erosion control. The construction and operation management of soil and water conservation were evaluated in the end. Through soil and water conservation facilities acceptance evaluation of Yinpan Hydropower Station, experience was summarized, which could be used as reference for the acceptance of soil and water conservation facilities in hydropower project in the future.

Keywords: Government purchase service Acceptance of soil and water conservation facilities; Technical evaluation Soil erosion control; Hydropower Station.

1. Introduction

The technical service unit of soil and water conservation was entrusted to carry out the Acceptance of water and soil conservation facilities in production and construction projects according to Technical specification for acceptance of water and soil conservation facilities in production and construction projects by the construction unit. After the technical assessment report of soil and water conservation was completed, the construction unit should apply to the water administrative department for acceptance, The water administrative department shall preside over the acceptance meeting of water and soil conservation facilities, and be responsible for the acceptance conclusion. In 2015, the Ministry of water resources entrusted relevant qualified organizations to carry out the technical evaluation of water and soil conservation facilities acceptance of production and construction projects through the government procurement service, and then Chongqing Water Conservancy Bureau entrusted our institute to carry out the technical evaluation of water and soil conservation facilities acceptance of Yinpan hydropower station through the government procurement service in 2016. The technical evaluation of acceptance of water and soil conservation facilities was the technical support and basic basis for the water administrative department to make the decision of acceptance and approval of water and soil conservation facilities. Through the mode of purchasing technical services from the third party, the government could further improve the acceptance quality of water and soil conservation facilities with.
the help of technical strength of professional institutions. The change of the entrusting body had changed the procedures and key points of the technical evaluation. The Ministry of water resources issued the notice ‘printing and distributing the key points of the technical evaluation of the acceptance of water and soil conservation facilities by the Ministry of water resources’ in March 2016, stipulating the key points of the technical evaluation of water and soil conservation after the transformation. This paper studied the steps, emphases and directions of the technical evaluation of soil and water conservation facilities under the mode of government purchase service.

2. Project Overview
Yinpan Hydropower Station of Wujiang River in Chongqing was located in Wulong County, Chongqing. It was located in the lower reaches of the main stream of Wujiang River. It was the 11th cascade hydropower station developed in the main stream of Wujiang River. Yinpan hydropower station was a second-class large (2) hydropower project with an installed capacity of 600 MW and an average annual power generation of 2.713 billion kwh. The normal water level of the power station was 215.00m, and the dead water level was 211.50m; the corresponding storage capacity below the normal water level was 183 million cubic meters, and the regulating storage capacity was 37.1 million cubic meters. The project has daily regulation performance.

The construction content mainly included three parts: main works, auxiliary construction works, resettlement and special facilities reconstruction works. The main works included dam works, power station construction works and navigation construction works. Auxiliary construction works mainly included construction diversion, traffic facilities inside and outside the site, construction attached enterprises and office and living areas, waste disposal area and earth rock yard area; resettlement and special facilities reconstruction works mainly included rural resettlement, market town relocation and professional project restoration.

3. Assessment Procedure
After undertaking the assessment task, the expert group and assessment group for acceptance of water and soil conservation facilities of Yinpan Hydropower Station Project in Wujiang, Chongqing were established. The expert group was composed of professor level senior engineers and senior engineers, and the assessment group was composed of relevant professionals such as hydraulic structure, water and soil conservation, hydrogeology, soil science, farmland water conservancy, etc.

3.1. Site Survey
By consulting the data, the assessment team carried out a comprehensive inspection of key areas (especially waste disposal areas and stone yards) and important unit works, and carried out on-site investigation on the principle of general areas and part of general unit works. According to the implementation of water and soil conservation facilities, the water and soil conservation facilities of the project mainly included 6 types of unit works, including slag retaining works, slope protection works, flood control and drainage works, land treatment works, vegetation construction works and temporary protection works. Among them: the important unit works were slag retaining works, slope protection works, flood control and drainage works, vegetation construction works, etc. There were 4 on-site survey and evaluation personnel and 17 survey points. The survey methods include on-site survey, manual sampling measurement, UAV aerial survey, camera photographing, on-site inquiry, data access, etc[1].

3.2. Data Verification
The assessment team consulted the self-inspection report on water and soil conservation facilities of Yinpan Hydropower Station Project on Wujiang River in Chongqing, water and soil conservation design, official reply and relevant contracts on water and soil conservation; quarterly report, annual report and work summary report on water and soil conservation monitoring; monthly report, project division, quality evaluation, acceptance data and summary report on water and soil conservation supervision; change of water and soil conservation scheme and subsequent design data, water and soil conservation
evaluation process data and technical evaluation report, as built drawing of main works, acceptance appraisal certificate, temporary land transfer procedures and other relevant data. The assessment team mainly checked the relevant data of the design, construction, supervision and acceptance of 5 spoil areas and 1 quarry, especially the stability assessment report of the spoil area of Wujiang Yinpan hydropower station. The self-inspection data of the project was completed, and the preparation of acceptance application materials met the requirements of relevant regulations; the follow-up design data, monitoring data, supervision data, waste dump and quarry data were relatively complete, basically meeting the requirements of relevant specifications[2].

3.3. Communication Report
During the evaluation, the Institute organized an expert group and an evaluation group to discuss the difficulties in the project. After the site investigation, the assessment team reported the project site situation to Chongqing Water Conservancy Bureau.

4. Implementation of Legal Procedures for Water and Soil Conservation
The construction unit had carried out the management procedures specified in the relevant laws and regulations on water and soil conservation, compiled and reported the water and soil conservation plan according to law, carried out the procedures for the change of water and soil conservation plan, implemented the follow-up design of water and soil conservation, paid the compensation fee for water and soil conservation in time according to the relevant regulations, and completed the legal procedures for water and soil conservation[3].

The monitoring unit should timely submit the annual report on water and soil conservation monitoring, 32 monitoring briefs, original monitoring records and other monitoring data, and put forward suggestions on improving various water and soil conservation measures to the construction unit according to the site conditions.

The construction unit had lagged behind in commissioning the water and soil conservation supervision work. The scope and content of the water and soil conservation supervision work of the project were clearly divided. The supervision unit had implemented the specific responsibilities of each supervision staff, and the responsibilities were clearly divided. The quality, progress, investment and other control methods and measures were basically true and effective, ensuring that the relevant control can be implemented in place. Overall, the supervision work basically met the requirements of regulations and specifications[4].

5. Control Range of Water and Soil Loss

5.1. Scope of Responsibility for Prevention and Control of Water and Soil Loss
According to the self inspection report of water and soil conservation facilities and the monitoring report of water and soil conservation, combined with the state-owned land use certificate, land acquisition agreement and handover procedure data, through on-site verification, the actual control responsibility scope of the project was 266.12 hectares, which was 366.74 hectares less than the control responsibility scope of the scheme design, including 82.15 hectares less area of the project construction area and 21.67 hectares less area of the directly affected area.

5.2. Waste Disposal Area
Five waste disposal areas were set up in the project. The actual slag stacking in each waste disposal area was in Table 1.
Table 1. Slag stacking in the waste disposal area.

| Name               | Position                                      | Area\(^2\) | Designed slag (10000 m\(^3\)) | Actual slag stacking (10000 m\(^3\)) | Maximum slag height (m) | Gradient Slag Stacking | Slag Slope Ratio |
|--------------------|-----------------------------------------------|------------|---------------------------------|---------------------------------------|-------------------------|------------------------|-------------------|
| Guantianba waste disposal site | Terrace 1.5km upstream of the right bank dam | 5.76       | 29.49                           | 13.5                                  | 10.08                   | 1                      | 1:2.0             |
| Ganxigou waste disposal site | In the gully 1 km upstream of the right bank dam | 23.36     | 300.85                          | 568.32                                | 65                      | 3                      | 1:2.0             |
| Diaozuixi waste disposal site | In the gully 1.8km upstream of the right bank dam | 22.11     | 1058.05                         | 431.0                                 | 48                      | 5                      | 1:2.0             |
| Shenxigou waste disposal site | 4.5km away from the dam site | 4.87       | 111.65                          | 47.5                                  | 19.8                    | 1                      | 1:1.5             |
| Dongjiagou waste disposal site | 1.2km downstream of the dam on the left bank | 7.34       | 61                              | 113                                   | 40.70                   | 1                      | 1:2.0             |

In May 2016, Yangtze River survey, planning, design and Research Co., Ltd. completed the stability assessment report of the waste disposal areas of Wujiang Yinpan hydropower station, which comprehensively analyzed and evaluated the five waste disposal areas of Yinpan hydropower station. The five waste disposal areas had been in operation for nearly ten years since the implementation of the design, and the monitoring data and observation data show that the five waste disposal areas were basically relative at present stable state.

The assessment team believed that the location of the waste disposal area of the project was reasonable, the water and soil conservation measures system basically conforms to the actual situation, and the waste disposal area occupied by temporary land acquisition has signed a transfer agreement with the local government, which wa qualified for acceptance.

5.3. Quarry

One quarry was actually set up, which was Yujiaodianzi quarry. It was located on the left bank of Wujiang River, 1.2km downstream of the dam site. It covered an area of 10.34 hectares. The mining elevation was 510m-525m, and the mining volume was 366700m\(^3\). The mining slope ratio of the upper slope and the lower slope of the quarry was 1:0.2 and 1:2.5 respectively.

The lower slope toe of yujiaodianzi quarry was provided with masonry retaining wall, the top of the mining slope was provided with intercepting ditch, and the slope was protected with shotcrete anchor and masonry grid. After the mining, the quarry was backfilled with topsoil for land restoration. The reclaiming platform was planted with trees and grass seeds. Eucalyptus was selected for trees and bermudagrass was selected for grass seeds. Climbing plants were planted on the excavated slope and mountain tigers were selected for climbing plants[5].

5.4. Water and Soil Conservation Measure System and Project Quality Division

5.4.1. Prevention and Control Measures System. The arrangement of water and soil measure system in each prevention and control area was as follows: (1) In the main project area, the slope of dam and water release building, the slope of upstream and downstream approach channel of ship lock, and the slope of diversion open channel were supported by anchor bolt, plain shotcrete or shotcrete with net hanging, and the supporting interception and drainage measures and greening measures are built. (2) For the rock excavation slope, shotcrete, mortar anchor bolt and other slope protection measures should be taken in the construction attached enterprises and office and living areas, masonry retaining wall should be adopted for the filling plot, and the interception and drainage measures and greening measures should be built. (3) In the traffic area inside and outside the site, retaining wall masonry, slope shotcrete and anchor support, interception and drainage ditch and other measures had been implemented, and arbor, shrub and grass greening and climbing plants had been planted. (4) Surface soil stripping and backfilling, drainage box culvert, open drainage ditch, intercepting ditch and other drainage measures as well as side slope protection measures such as retaining dam, slag retaining dam, dry masonry slope protection and retaining wall were implemented in the waste disposal area, and grass seeds were planted for greening. (5) Masonry retaining wall was set at the foot of the lower slope of the earth rock quarry area, intercepting and drainage ditch was set at the slope, shotcrete anchor and masonry grid were used for slope protection, and topsoil backfilling and greening were carried out for the quarry after mining. (6) In the resettlement area, the soil and water conservation measures such as masonry retaining wall, masonry revetment and dry masonry revetment had been implemented.

5.4.2. Completed Water and Soil Conservation Measures. According to the self inspection report, supervision report and project settlement data, the total quantities of completed engineering measures were: 168225.12 cubic meters of concrete, 141278.73 cubic meters of mortar masonry, 33518.35 cubic meters of dry masonry, 545031 cubic meters of stone slag filling, 5900 cubic meters of slope anti slide key, 46574 meters of drain hole, 961.57t of reinforcement, 947 bundles of anchor cables, 87279 anchor bolts, 159 soil rivets, anchor spray support 5990 square meters, drainage pipe 1600 meters, earth rock excavation 11813 cubic meters, block stone cushion 290 cubic meters, road engineering 387.5 cubic meters, topsoil backfilling 19.58 cubic meters.

The Plant measures were completed, including 1492 hole shaped land preparation, 1.05 hectares of land preparation, 20350 arbors, 29320 shrubs, 1.434 hectares of turf planting, 68.51 hectares of grass seeds and 9015 climbers.

The total quantities of temporary measures were completed, including 4400 meters of temporary drainage ditch and 1500 square meters of brick wall had been completed.

5.4.3. Quality Assessment. According to the supervision data of water and soil conservation, 48 unit projects and 83 divisional projects of water and soil conservation engineering measures were all qualified in quality assessment, with a qualified rate of 100%. The geometric dimension and appearance quality of key parts of the water and soil conservation project met the design requirements. According to the supervision data of water and soil conservation, the quality assessment of 36 unit projects and 58 divisional projects of water and soil conservation plant measures were all qualified, and the qualified rate was 100%. The quality of seedlings, land preparation specifications and planting methods all met the design requirements, and the plants grown well. After self-inspection and self-inspection by the construction unit, confirmation by the construction unit and the supervision unit, and verification by the quality supervision unit, the quality of plant measures was generally qualified.

After consulting the archives, the assessment team thought that the data of water and soil conservation facilities design, construction, supervision and acceptance were complete, the division of water and soil conservation projects was accurate, the quality assessment data was basically complete, and the content was basically accurate. Therefore, the overall quality of the water and soil conservation project of the project was qualified.
5.4.4. **Control Effect of Water and Soil Loss.** According to the soil and water conservation monitoring report, the control target value of the project was: the control rate of disturbed land was 99.37%, the total control degree of soil and water loss was 98.45%, the control ratio of soil loss was 1.25, the rate of slag blocking was 99.50%, the recovery rate of forest and grass vegetation was 98.05%, and the rate of forest and grass coverage was 31.54%. The project had basically completed the water and soil loss prevention and control task approved by the Ministry of water resources, and the water and soil conservation facilities were well preserved. According to the review of the project site and the analysis of monitoring data, the calculation of six prevention and control indexes of soil erosion was basically correct. The six indexes met the requirements of the approved water and soil conservation plan, and the water and soil conservation facilities had normal operation conditions[6-8].

6. **Construction and Operation Management**

The water and soil conservation management organization and personnel of the construction unit were complete, the rules and regulations were relatively sound, the water and soil loss has been controlled in the whole process, the supervision opinions of the water administrative department could be actively implemented, the engineering protection measures were in place, the vegetation had been restored, there was no major potential safety hazard of water and soil loss, and the water and soil conservation project was basically in normal operation. From the current operation situation, the project had clear management and protection responsibility of water and soil conservation facilities, and the implementation of funds could ensure the normal operation of water and soil conservation facilities.

7. **Summary**

In the process of technical evaluation of water and soil conservation facilities of Yinpan hydropower station, the differences from the previous acceptance projects were as follows: (1) According to the characteristics of large area of waste disposal area and large amount of slag, the evaluation team adopted the combination of UAV aerial photography technology and field measurement in the field inspection, at the same time, the owner was required to carry out the stability evaluation of waste disposal area, and issued the stability evaluation report of waste disposal area as follows Supporting materials for technical assessment and acceptance of soil and water conservation; (2) After receiving the acceptance task transferred by Chongqing Water Conservancy Bureau, the assessment team established a corresponding professional expert group and assessment team, organized the self-inspection unit to hold a symposium on site problems after the initial mobilization survey and reference of materials, and reported the work to the Water Conservancy Bureau Development; (3) In the process of organizing and reporting the acceptance meeting, the self inspection report was reported by the employer, which made the employer pay more attention to the acceptance of water and soil conservation facilities.

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**Reference**

[1] Li Huabin, Liu Tao, Wei quanen, et al. Practice of acceptance and evaluation of water and soil conservation facilities for resettlement project of Longtan Hydropower Station [J]. China water and soil conservation, 2014, (2): 22-25.

[2] Yang Fan. Preliminary study on technical evaluation of acceptance of water and soil conservation facilities - Taking Guangdong water conservancy project as an example [J]. Journal of Guangdong Institute of water conservancy and electric power, 2013, 11 (2): 9-13.

[3] Wang Huanhuan. Monitoring of water and soil conservation of hydropower projects in Sichuan Province - a case study of Jintan Hydropower Station in Yingjing County [D]. Chongqing: Southwest University, 2008.

[4] Yang ting. Practice of technical evaluation on acceptance of soil and water conservation facilities of Honghe Nansha hydropower station in Yunnan [J]. water conservancy planning and design, 2013, (5): 31-32.
[5] Ministry of water resources. Code for quality assessment of water and soil conservation engineering (water industry standard sl336-2006) [S]. 2006:4-6.

[6] Ministry of construction, General Administration of quality supervision, inspection and quarantine. Technical code for water and soil conservation of development and construction projects (gb50433-2018) [S]. 2018:20-21.

[7] Zhou Furen. A Research on The Idex-system and Model of Acceptance Technical Evaluation for Soil and Water Conservation Engineering of Production and Construction Projects[J]. Journal of EMCC, 2015, 25(6): 60-64.

[8] XIA Yuhui. Problems and Countermeasures of Soil and Water Conservation Facilities Technical Evaluation of Development and Construction Projects[J]. Bulletin of Soil and Water Conservation, 2015, 35(3): 149-151.