

經濟部水利署南區水資源局

「109 年度阿公店水庫大壩安全檢查及監測分析」

成果報告書

主辦機關：經濟部水利署南區水資源局
執行單位：黎明工程顧問股份有限公司

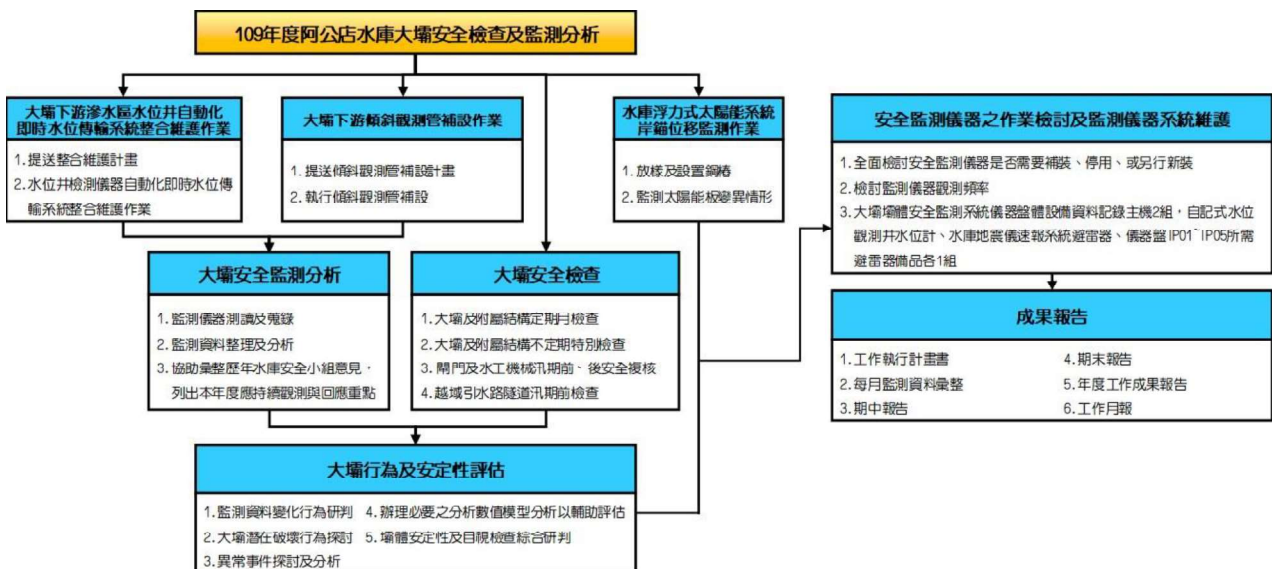
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摘要

本計畫為『109年度阿公店水庫大壩安全檢查及監測分析』，由經濟部水利署南區水資源局委託黎明工程顧問股份有限公司辦理。計畫目的係利用大壩埋設之監測儀器，於水庫營運期間持續辦理監測，並對大壩進行定期或不定期安全檢查，以維水庫營運期間之壩體安全性。相關工作內容及重點概述如下：

一、概述及工作內容

阿公店水庫為一防洪為主要目標之水庫，為解決日趨嚴重之淤積、供水及滯洪空間不足等問題，維持防洪、灌溉、公共給水等多目標功能，特於民國86年起進行更新改善計畫，至民國95年完工，為臺灣舊水庫再造之最佳案例。為確保水庫蓄水營運期間之壩體安全性，以提供水庫下游民眾生命財產之安全保證，計畫執行期間配合其相關設施進行安全監測分析及檢查，工作內容包括：1.大壩安全監測分析；2.大壩安全檢查；3.越域引水路隧道汛期前檢查；4.大壩行為及安定性評估；5.安全監測儀器作業檢討及監測儀器系統維護；6.大壩下游滲水區水位井自動化即時水位傳輸系統整合維護作業；7.辦理本水庫浮力式太陽能系統岸錨位移監測作業；8.辦理大壩下游傾斜觀測管(編號K4)補設作業；9.工作簡報及報告編撰印製等。



圖摘-1 本計畫工作計畫流程圖

二、設施基本資料及年度概況

阿公店水庫主要工程設施可分為：大壩、溢洪管、取出水工及越域排洪道等。阿公店水庫目前設置之監測系統儀器主要分布在五個里程斷面位置：0k+280m、0k+425m、0k+700m、1k+100m與1k+500m，藉由五個代表性斷面所布設的監測儀器量測值，可長期追蹤大壩整體之穩定性與安全性。監測項目包括壩體與壩基之內部水壓(孔隙水壓計)、壩體及下游區域之水位(水位計)、壩體滲流量(量水堰)、壩體側向變位(傾斜觀測管)、壩體沉陷(沉陷觀測點)及壩體地震反應強度(地震儀)等。

本年度水庫水位介於EL.28.03~EL.37.18m，累計雨量為1,477.90mm，本年度單日最大降雨量為5月22日之302.7mm；地震儀共蒐錄到11次地震，最大PGA值為21.282gal，最大PGV值為1.211cm/sec。109年度5月25日因溢洪管放流量達到72cms，故辦理1次特別檢查。

三、計畫工作成果

根據本年度阿公店水庫大壩及附屬設施各項監測儀器及現場檢查之結果概述如下：

1.大壩

壩體及壩基水壓計及水位計總水頭變化之規律與趨勢整體而言呈穩定狀態，各斷面監測儀器讀值皆小於警戒值，研判大壩滲流行為尚屬合理。109年度上游側大壩年垂直變位增量0.5cm/年，下游側大壩年垂直變位增量0.1cm/年，皆未超過國內外文獻建議之沉陷容許值(穩定期大壩年垂直變位增量為1.0cm/年以下)，顯示壩體垂直變位已趨於穩定。壩體結構、上游坡面、下游坡面，整體屬良好，並無大規模坍塌、滲水、沉陷、損壞等特殊狀況。

2.越域引水路

本年度檢查發現之襯砌剝落、鋼筋外露、裂縫、滲水及白華等異狀與108年度檢查成果比較顯示並無明顯劣化情形。里程7k+475m處發現之仰拱隆起現象，經查施工及地質資料初步判定應係受剪裂帶之地質因素影響，里程2k+467、6k+725、6k+890、8k+940為損壞狀況較為嚴重之既有鋼筋外露異狀，異狀位置之襯砌外觀並無受外力變形之跡象，故研判應為材料劣化所造成，管理單位已預定於110年度辦理工程發包。

3.安全監測儀器作業檢討及監測儀器系統維護

目前大壩可供判示儀器有孔隙水壓計4處、自記水位計7處、水位觀測井內水位計15處、地震儀3處、傾斜儀觀測管11處、沉陷觀測點26處、量水堰1處及儀器盤5組，尚足以研判大壩整體安全。

水壓計主要規劃於施工階段及水庫剛完成之蓄水期監測用，且阿公店水庫大壩竣工至本年度(109年)屆60餘年，壩體行為已進入穩定期，且依目前儀器數量仍足以判斷大壩斷面之行為，鑑於水壓計抽出更新、確認或鑽孔新設之風險過高，可能擾動壩體填方及造成水力破壞，在壩體擾動與監測需求兩相權衡下，建議保持現狀，採鄰近尚可發揮功能水壓計及水位計推估。

4.大壩下游滲水區水位井自動化即時水位傳輸系統整合維護

本年度3月已完成BH03~BH04兩孔水位井之自動化即時水位傳輸系統整合作業，現場水位資料回傳監控室既有之水文流量自動觀測系統後，並於現有網頁上即時呈現水位資料，相關監測分析成果詳第六章，未完成之水位井建議延續本計畫之成果持續辦理。

5.水庫浮力式太陽能系統岸錨位移監測作業

本年度2月已完成浮力式太陽能系統岸錨測量點裝設，並量測初始值，並於10月辦理位移測量，相關監測分析成果詳第三章。

6.大壩下游傾斜觀測管(編號K4)補設作業

本年度4月已完成K4傾斜觀測管作業，並於5月定期辦理監測作業，相關監測分析成果詳第三章。

Abstract

In 2020, safety inspection and monitoring of Agongdian reservoir was entrusted by Southern Region Water Resources Office, WRA, MOEA(WRASB), and it was executed by Liming Engineering Consultants. The purpose of this project is by using the monitoring instrument to continuous monitoring during the operation of the reservoir and carry out the regular or irregular inspections of reservoir to maintain the safety of reservoir during the operation. The work content and summary of key content are the following:

a. The overview and the work content

The Agongdian reservoir is the reservoir which is built for preventing flood and solve the issues of sediment accumulation, irrigation, domestic water supply, and inadequate freeboard. At the same time, it can achieve the target functions of Flood control, irrigation and public water supply. The updated improvement project started from 1997 and finished in 2006, which is the best case of old reservoirs re-building in Taiwan. In order to ensure the residents living downstream of the dam are safe and secure. During the project progress, doing safety inspection and monitoring analysis with the related equipment. This project include the following works: 1. Dam safety monitoring analysis. 2. Dam safety inspection. 3. Trans basin waterway safety inspection. 4. Dam behavior and safety evaluation. 5. Review of the operation and maintenance of safety monitoring devices. 6. Automatic water level real-time transport system at downstream seepage area of dam. 7. solar system shore anchor monitoring analysis. 8. Inclinator installation at downstream seepage area of dam. 9. Work Briefing, report writing and printing.

b. Facility basic information and annual overview

The main civil structures at Agongdian reservoir are include the main dam, spillway, intake works, and the interbasin transfer spillway. The monitors at Agongdian reservoir are spread across five sections: 0k+280m、0k+425m、0k+700m、1k+100m、1k+500m. The dam safety and stability can be long-time tracking by the five section's monitoring value. The monitoring content includes 1. The water pressure inside the dam (piezometers). 2. The

water level inside the dam and downstream (groundwater gauges). 3. The dam seepage (seepage weir). 4. The lateral displacement of dam (inclinometer). 5. The dam settlement (settlement observation point). 6. The dam seismic intensity (seismograph).

In 2019, the dam water level was between EL. 28.03m~ EL. 36.97m, the annual accumulated rainfall is 1,452.8mm. The maximum daily rainfall is 302.7mm on May-22rd. The seismograph recorded 11 earthquakes, the maximum PGA value is 21.282 gal, the maximum PGV value is 1.211 cm/sec.

c. Project result

According to the various monitoring instrument and inspection, the result is the following:

1. Dam

The change in the total head which in the dam body and dam foundation is regular and stable. All the monitors at the dam sections are both below the warning value. Therefore, the dam seepage is considered as reasonable. During previous year, the vertical settlement in dam stabilization period at upstream is 0.01cm/year, and the vertical settlement in dam stabilization period at downstream is 0.31cm/year. Neither of the settlement on upstream and downstream exceed the allowable value. (The vertical settlement in dam stabilization period should less than 1.0cm/year.) The vertical settlement demonstrates a stable tendency. The dam structure, upstream slope and downstream slope are overall good. There are no wide range sliding, leakage, settlement and damage.

2. Trans basin waterway

The abnormal conditions of spalling tunnel lining, exposed deformed bar, crack, seepage and efflorescence already exist from the past. There is no significant difference from last year's results. The heaving inverted lining at sta.7k+475m is affected by the shear zone. The exposed deformed bar at sta.2k+467, 6k+725, 6k+890, 8k+940 are the relatively severe area, but there are no signs of being affected by external forces on lining. It might be caused by the aging of the material (Neutralization of concrete).

3. Review of the operation and maintenance of safety monitoring devices

Currently, there are 8 sets of pore water pressure cell, 10 sets of self-recording groundwater gauges, 8 sets of groundwater gauges, 3 sets of seismograph, 11 sets of inclinometer, 26 sets of settlement observation point, 1 set of seepage weirs and 5 sets of data recording devices, and it is enough to judge the dam safety.

4. Automatic water level real-time transport system at downstream seepage area of dam.

The automatic water level real-time transport system at water well BH-03~BH-04 was finished in this year. The onsite water level data can be transport to the monitoring room in real-time and show up the water level data on the monitor screen. The related monitoring and analysis results are presented at Chapter 6. The other water wells which haven't been automated are recommend to continue the achievement of this project. Considering the result of this report, unautomated water level wells are proposed to be upgraded.

5. Safety monitoring devices of Solar system Shore anchor.

The Safety monitoring devices of Solar system Shore anchor was finished and Perform initial measurement operations in March this year. And perform measurement again in October. The analysis results are presented at Chapter 3.

6. Inclinometer(No.K4) at downstream area of dam.

The Inclinometer(No.K4) installation was finished in April this year. And Start monitoring in May this year. The analysis results are presented at Chapter 3.