

滲水對水庫安全與營運之影響評估

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摘 要

水庫的破壞肇因多與異常滲水有關。就土石壩而言，一般輕微的滲水只要不影響大壩安全與水庫營運則是可被接受的，但若滲水量過大或無法控制時，則有造成發生管湧破壞的高度風險。滲水路徑除透過壩體本身外，在壩體與基盤界面縫隙、基盤或壩座山脊岩層面等缺陷處皆有可能是潛在的滲水通路。早期針對大壩安全所進行之滲流分析，多僅針對代表性斷面進行二維分析，但傳統二維分析並無法有效考慮壩體、壩基及壩座三者接合處之滲漏，亦無法充分考量河谷形狀效應、壩基岩層之滲透異向性及岩層不連續面位態等條件，上述問題須透過三維分析方能解決。本文建立一套可完整評估水庫滲水之三維水文地質模式分析程序。模式可充分整合庫區之地形、地質、水文及地下水等調查資訊，並納入壩體、壩基及壩座山脊幾何條件建置水庫三維水文地質模型；透過求解模型內地下水之流況分布，藉以研判可能的滲水成因及路徑；另採用現地監測資料進行模式率定及驗證，以提昇模式分析之正確性及準確度；最終針對滲水量對水庫安全與營運之影響進行評估。相關成果提供各界參考運用。

關鍵字：水庫、土石壩、滲水、三維滲流分析、水庫安全評估。

Assessment of Effects of Groundwater Leakage on Dam Safety and Reservoir Operation

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Abstract

Unexpected leakage may be the precursor of dam failure. For earth dams, a slight leakage is acceptable if it does not significantly affect the dam safety and reservoir operation. However, it will have a high risk of piping failure if the leakage is excessive or uncontrolled. The leakage usually occurs through the earth dam or through the rocks surrounding the dam site. Unfortunately, the traditional 2-D seepage analysis, which based on the typical cross section of earth dam, could not effectively solve the problem for the leakages seeping from the dam, the foundation and the abutments cannot be predicted. Moreover, the 2-D model could not adequately consider the 3-D valley shape effects, the permeability anisotropy of the rocks surrounding the dam site, and the orientations of the discontinuities. The aforementioned problems can be solved via a 3-D model analysis. This paper proposes a systematic procedure to assess the leakage problem using a 3-D hydrogeological model. The data of topography, geology, hydrology and groundwater were integrated and incorporated into the 3-D model. The geometric conditions of dam, foundation and abutments were also considered. The 3-D seepage analysis yields the groundwater flow field. The sources and pathways of leakages can accordingly be estimated. Finally, the effects of the leakage on dam safety and reservoir operation can also be estimated. The results demonstrate that the 3-D hydro-geological model is powerful for safety assessment of reservoirs.

Key Words : reservoir, earth dam, leakage, 3-D seepage analysis, safety assessment.