淤泥特性對防淤隧道進水口阻塞影響之研究

Study on the Characteristics of Sediment and Its Impact on Blockage at the Inlet of Desilting Tunnel

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摘要

一般而言，泥砂淤積會導致防淤隧道內部空間減少，進而增加水流速度和壓力，對隧道的結構安全性產生潛在威脅，增加設施的風險；泥砂淤積導致水道的有效截面積減小，可能導致附近地區水位上升，增加洪水的發生風險，且隨著泥砂淤積的增加，防淤隧道的有效截面積減小，導致水流通過的截面積減小，進而影響水道的暢通性，增加水流受阻和淤塞的可能性。本試驗利用兩種不同濃度的泥砂來進行試驗，在水庫水位高程EL.1005m、防淤隧道閘門全開情況下，於防淤隧道進水口前鋪設不同壓密條件淤泥，探討泥砂覆蓋超越進水口頂部高程時，是否影響防淤隧道啟閉及含砂水流排放。試驗淤泥特性採用低壓密 30 萬 ppm，相當於現場$1.01g/cm^3$，模型動床粒徑$d_{50}=0.015mm$；另一種淤泥特性則採用高壓密 100 萬 ppm，相當於現場$3.37g/cm^3$，淤泥動床鋪設高程均約 EL.987m。兩種淤泥特性分別進行試驗後，在防淤隧道入口具備導槽試驗可知，低壓密 30 萬 ppm 組別，模型防淤隧道入水口處沉積物厚度約 1.4 公分至 2.7 公分(實際約 0.56 公尺至 1.08 公尺)、高壓密 100 萬 ppm 組別模型防淤隧道入水口處沉積物厚度約 1.5 公分至 3.4 公分(實際約 0.6 公尺至 1.36 公尺)。此外，經由不同時刻之出流水體採樣分析後，可看出防淤隧道出流泥砂濃度會隨時間越來越低，且兩種情境皆無阻塞狀況產生。

關鍵詞：泥砂濃度、淤泥壓密、阻塞

Abstract

Generally speaking, sedimentation reduces the internal space of desilting tunnel, which in turn increases the water flow velocity and pressure, posing potential threats to the structural safety of the tunnels and raising the risk of the facilities. Sediment accumulation reduces the effective cross-sectional area of the waterway, which may lead to a rise in water levels in nearby areas, increasing the risk of flooding, especially during heavy rains or flash floods. As sediment accumulation increases, the effective cross-sectional area of the desilting tunnel decreases, reducing the water flow area and affecting the waterway's smoothness, thereby increasing the possibility of water flow obstruction and blockage. This experiment uses two different concentrations of sediment to conduct tests. At a reservoir water level of EL.1005m, with the desilting tunnel gate fully open, different sediment compaction conditions are laid in front of the desilting tunnel inlet. The study explores whether the sediment cover exceeding the inlet top elevation affects the opening and closing of the desilting tunnel and the discharge of sediment-laden water. The sediment characteristics for the experiment are low compaction at

300,000 ppm, equivalent to 1.01 g/cm³ on-site, with a model movable bed particle size of d_{50}=0.015mm. The other sediment characteristic is high compaction at 1,000,000 ppm, equivalent to 3.37 g/cm³ on-site, with the movable bed sediment laid at an elevation of approximately EL.987m. After conducting experiments with both sediment characteristics, it was observed that in the tests with guide grooves at the desilting tunnel entrance, the low compaction 300,000 ppm group showed sediment thickness at the model tunnel inlet ranging from approximately 1.4 cm to 2.7 cm (actual 0.56 m to 1.08 m). In the high compaction 1,000,000 ppm group, sediment thickness at the model tunnel inlet ranged from approximately 1.5 cm to 3.4 cm (actual 0.6 m to 1.36 m). Furthermore, analysis of water samples taken at different times showed that the sediment concentration in the outflow from the desilting tunnel decreased over time, and no blockage occurred in either scenario.

Keywords: sedimentation, compaction condition, blockage