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Design of Hoisting System for Six Vertical Sliding Gates in Oliyamulla Stormwater Pumping Station

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Urban flooding in low-lying areas of Colombo has intensified due to increased monsoonal rainfall and inadequate gravity drainage capacity, necessitating reliable stormwater control infrastructure. The Oliyamulla Stormwater Pumping Station was developed as a flood mitigation measure within the Peliyagoda-Kelaniya drainage basin and incorporates six vertical sliding gates to regulate pumped and gravity-driven discharges to the Kelani River. Accordingly, an electrically hoisted sluice gates or vertical gates were designed that overcame significant engineering challenges to ensure safe and reliable gate operation. This paper presents the design and implementation of a mechanically robust and cost-effective hoisting system for vertical sliding gates with significantly different sizes, weights, and operating heads. The design methodology involved analytical evaluation of hydrostatic thrust, buoyancy, friction at guides and seals, and dynamic lifting forces. Maximum operating loads of approximately 76 kN per spindle for pump outlet gates and 178 kN per spindle for gravity-flow gates were derived using standard hydraulic load formulations with appropriate safety factors. The spindles are 90 mm in diameter and manufactured from stainless steel Grade 304. Power requirements were calculated from the lifting forces and target spindle speed, resulting in the selection of 7.5 kW and 11 kW geared motor systems operating at lifting speeds of approximately 0.34 m/min. Structural integrity of the screw spindles was verified against Euler buckling, thread wear, and combined stress criteria, while the hoisting platform was validated using SAP2000 finite element analysis. The finalized systems achieved reliable dual-mode operation with overload protection and adequate safety margins. The novelty of this work lies in the unified design approach that standardizes spindle size and transmission components across heterogeneous gate configurations while complying with American Water Works Association (AWWA) and Indian Standards (IS), thereby providing a practical solution for urban flood control infrastructure.

Keywords: flood control, gate hoisting mechanism, screw jack design, stormwater pumping station, mechanical design, sluice gates