ABSTRACT

East Kalimantan, as one of the most impactful provinces for coal export in the world's largest archipelagic country, Indonesia, relies heavily on the Mahakam River for logistical and industrial water transport. Consequently, the development of water-based infrastructure such as jetties becomes crucial to support port operations. However, a significant displacement was observed in a jetty dolphin structure located along one of its tributaries, predominantly affecting the berthing dolphin component with movements of up to 70 cm toward the river side. Therefore, a further investigation is needed to evaluate the cause of the observed displacement, considering both structural and geotechnical aspects.

This study aims to assess the cause through a comparative analysis involving both manual methods and numerical modeling focusing on soil-structure interaction using PLAXIS 2D, supported by structural response evaluation. The subsoil conditions consist predominantly of soft to stiff clay, with hard strata encountered at approximately 20 meters depth. Manual calculations based on N-SPT-derived parameters were conducted to estimate allowable pile capacities. The Mohr–Coulomb model was applied to simulate soil behavior, with back-analysis incorporated to refine parameter selection. Additionally, a macro structural modelling was conducted to check pile internal forces as comparation.

The results indicate that the observed field displacement corresponds to a lateral flow-type failure mechanism, strongly influenced by fill surcharge and tidal variation. Macro structural model tends to underestimate deformation due to simplification of subgrade behavior, while PLAXIS 2D captures a maximum horizontal displacement of 10.64 cm under berthing scenarios, which aligns closely with the measured field value of approximately 13.4 cm. It was found that the displacement was not caused by slope instability or structural failure, but by cyclic lateral loading acting on unconsolidated soft clay. Across all scenarios, safety factors remained above 1.25 and internal forces (axial, shear, bending) stayed within pile capacity, confirming structural adequacy. These findings highlight the value of realistic soil modelling and staged construction in simulating field behavior for riverine structures.

Keywords: jetty design; pile foundation; soil-structure interaction; soft clay soil; back-analysis