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Evaluation of the Performance of the Floating Fiber Embankment Model in Addressing Rising Tides in Coastal Areas

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ABSTRACT

Objective: *This study aims to evaluate the development of floating fiber embankment technology as an innovative solution for mitigating tidal flooding in coastal areas of Indonesia, particularly along the northern coast of the Java Sea. The proposed system is designed to automatically adapt to tidal level fluctuations, addressing challenges related to land subsidence and sea level rise.* ***Method***: *The study employed a combined simulation and laboratory experimental approach to analyze the performance of the floating fiber embankment. Numerical simulations were conducted to evaluate the structural behavior under hydrostatic pressure, while laboratory testing was performed using a scaled physical model to validate the simulation results.* ***Results***: *The findings indicate that the floating fiber embankment demonstrates stable structural performance under tidal loading conditions. The maximum deformation recorded was 0.0043 meters, with a maximum stress of 8.231 × 10⁶ Pa and a strain value of 0.00045. These results confirm that the structure is capable of maintaining elasticity and structural integrity under hydrostatic pressure.* ***Novelty***: *The novelty of this study lies in the application of adaptive floating fiber embankment technology that can automatically adjust to tidal fluctuations as a sustainable alternative to conventional static embankments. This system offers an effective and efficient solution for reducing the impact of tidal flooding in coastal regions.*

INTRODUCTION

Tidal flooding, or what is known as flooding due to high tide, is one of the natural phenomena that often occurs in coastal areas of Indonesia. This coastal area, especially on the north coast of the Java Sea, has a relatively flat topography, making it more vulnerable to the impacts of rising sea levels. According to Marfai (2004), tidal flooding occurs due to rising sea water to land, which is triggered by the gravitational pull between the Earth, Moon, and Sun, as well as atmospheric conditions that also worsen the situation. This phenomenon causes sea water that should be held in the sea, to flow into land areas, resulting in waterlogging that damages settlements, agricultural land, infrastructure, and disrupts people's economic activities.

Tidal flooding is not a rare event in Indonesia. This phenomenon even tends to be a routine problem experienced by coastal communities every year. This is exacerbated by the increasing frequency and scale of tidal flooding caused by a combination of factors, including land subsidence, coastal development, global climate change, and sea level rise (Sunarto, 2003; Suryanti & Marfai, 2008). The cumulative effect of all these factors worsens the tidal flooding conditions, which are increasingly widespread every year and result in significant economic losses.

Losses due to tidal flooding in coastal areas are not only limited to physical damage, but also involve the social and economic life of the community. According to Efendi (2016), losses caused by tidal flooding in various regions in Indonesia can be in the form of infrastructure damage, disruption of transportation and distribution of goods, to decreased agricultural and fishery yields. Tidal flooding also contributes to the decline in the quality of public