Effect of Angular Variation in Detached Breakwater Structure on the Coastal Morphology

Maharatanawong, Subsirirach (School: Kamnoetvidya Science Academy)
Lucklertkul, Anon (School: Kamnoetvidya Science Academy)

Coastal erosion is a growing global crisis, threatening economies, ecosystems, and communities. Around the world, beaches are disappearing due to shifting wave patterns, rising sea levels, and human interventions such as coastal construction. A widely used mitigation strategy is detached breakwater—offshore structures designed to dissipate wave energy and slow erosion rate. However, their impact on coastal morphology depends heavily on their configuration, a factor that remains insufficiently studied. This research investigates how detached breakwater horizontal angle, i.e., the angle between the incoming wave direction and the breakwater axis, and slope angle influence erosion rate and wave energy transmission through numerical simulation and physical experiment. Our findings reveal that increasing the horizontal angle significantly reduces erosion rate and wave energy transmission, confirming our hypothesis. Strikingly, increasing the slope angle leads to a more significant decline in the trend across the horizontal angles. This reveals the optimal design for minimizing erosion rate and wave energy transmission is a horizontal angle of 90 degrees and a slope of 75 degrees. These insights are crucial for coastal engineers, policymakers, and environmental planners seeking to develop more effective and sustainable coastal protection strategies. By refining detached breakwater designs, we can enhance global coastal resilience, safeguard critical tourism and economic hubs, protect vulnerable coastal communities, and minimize long-term infrastructure costs. As climate change accelerates coastal degradation, this research provides essential knowledge to help preserve shorelines worldwide, ensuring a more sustainable future for coastal economies and ecosystems.

Awards Won: