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Hydrodynamic Analysis of the Fishery-Photovoltaic Complementary Structure in Marine Conditions

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ABSTRACT

The fishery-photovoltaic complementary industry, an innovative model integrating aquaculture and photovoltaic power generation, offers several advantages, including mitigating the spatial conflict between aquaculture and renewable energy facilities and enhancing the economic viability of traditional floating photovoltaic projects. Additionally, the integration of power systems facilitates the implementation of unmanned and intelligent aquaculture, particularly in offshore regions. However, existing fishery-photovoltaic structures are predominantly deployed in freshwater and tidal zones, with insufficient research on their dynamic characteristics under wave and current conditions. This study, based on physical model experiments, investigates the dynamic characteristics and power generation performance of a fishery-photovoltaic complementary structure. The results reveal that, under equivalent environmental conditions, the mooring force on the fishery-photovoltaic structure exceeds that of traditional floating photovoltaic structures, particularly in high-velocity flow environments. Increased weight and reduced solidity help mitigate the mooring forces under wave action. The fishery-photovoltaic structure also demonstrates reduced pitch motion, leading to lower irradiance fluctuations on the surface and improved electrical performance. Moreover, the variation in irradiance on the structure's surface is more strongly correlated with wave parameters than with net cage characteristics. Although the fishery-photovoltaic structure can maintain a relatively large aquaculture volume under wave action, it experiences significant volume loss under current influences. This issue can be alleviated by employing heavier weights and net cages with lower solidity and reduced depth, although this increase in weight results in a higher mooring force. This study provides valuable insights for the design and optimization of fishery-photovoltaic complementary structures.