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黑潮發電機組之繫纜動態模擬
Dynamic Simulation of a Kuroshio Turbine's Mooring Cable

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摘要

利用臺灣鄰近的黑潮來發電，除了流速與流量的良好條件外，地理位置也是主要的優勢。然而在颱風盛行的天氣條件下，海流對發電機組會產生很強的破壞力，尤其臺灣東部沿海的海底不僅相當深並以很大的坡度下降，所以如何將機組以經濟有效的方式固定於深海中是必須要面對的挑戰。本研究模擬浮游式黑潮發電機組(floating Kuroshio turbine, FKT)施放在海流作用下的移動情況，並同步計算繩纜受到的各種作用力歷程，分析其最大應力的可能位置，希望可以提供設計參考以避免發電機組失效的機會。繫纜主要是連繫海床的錨碇以及海流發電機的重要媒介，由於繩子與物體的連接處是最容易產生破壞的地方，所以繫纜與發電機跟錨碇處的受力情況是我們必須要探討的部分。期間繫纜本身也會受到張力、海流給予的側向力以及繫纜移動時遭受到的扭力，另外還要考慮到重力及浮力的影響。我們使用 MapleSim 這個軟體來建立模型並模擬繫纜在海流作用下的動態行為，模型分成了四個部分，其中包含水輪機模型、海床、支纜、主纜、力量感測器。模擬時使用從 OrcaFlex 的模擬結果中得到的位置數據當作水輪機組的輸入條件，用 MapleSim 來加入 OrcaFlex 所沒考慮進去之繩纜本質的條件，來深入模擬 FKT 機組在海中的情況，以期能達到更接近真實情況之模擬結果。結果顯示，未考慮海水阻尼的條件下，纜繩的自由度越大就越容易產生較高的擾動作用力，因此纜繩的模型除了自身的質量與機械性質外，亦須將海水的阻尼納入考慮，將來可以成為纜繩暨連接元件的整體設計工具。

關鍵詞：繫纜、黑潮、洋流發電。

Abstract

Kuroshio current nearby Taiwan is a very promising natural power source due to its steady and enormous flow. However, the extreme weather, like typhoon season, frequently causes destructive damage to the current turbine. The high descending and deep ocean bed is also the major challenge to the safety and cost of the system. In this study, we made use the simulation data of a floating Kuroshio turbine (FKT) system by OrcaFlex software in a preliminary study to investigate the dynamic response of the FKT's mooring system. The mooring system were combined with a turbine, an fixed anchor, a main cable, and two supporting cables. All these components were built by the physical-based modeling function of another MapleSim software. The weight and mechanical properties of the cable, the shear and buoyance forces from the fluid, and the model's degree of freedom (DOF) were all considered in this study. The results reveal that, without the actuation of flow's viscosity, the disturbance force significantly increases with the model's DOF, which suggests that the consideration of flow's viscosity as well as the mass and mechanical properties of the cable should be the essence of an engineering model as a practical and complex design tool in the future.

Keywords: Mooring cable, Kuroshio, Marine current power generation.