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Safety assessment of caisson transport on a floating dock by frequency- and time-domain calculations

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Abstract. When caissons are mounted on a floating transportation barge and towed by a tug boat in waves, motion of the floating dock creates inertia and gravity-induced slip forces on the caisson. If its magnitude exceeds the corresponding friction force between the two surfaces, a slip may occur, which can lead to an unwanted accident. In oblique waves, both pitch and roll motions occur simultaneously and their coupling effects for slip and friction forces become more complicated. With the presence of strong winds, the slip force can appreciably be increased to make the situation worse. In this regard, the safety of the transportation process of a caisson mounted on a floating dock for various wind-wave conditions is investigated. The analysis is done by both frequency-domain approach and time-domain approach, and their differences as well as pros and cons are discussed. It is seen that the time-domain approach is more direct and accurate and can include nonlinear contributions as well as viscous effects, which are typically neglected in the linear frequency-domain approach.

Keywords: caisson transport; floating barge; safety; slip force; friction force; inertia/gravity effects; nonlinear terms; roll-pitch coupling; frequency-domain and time-domain analysis; irregular waves/winds. initial inclination; deck flooding

1. Introduction

Caissons are used for various offshore and coastal structures. In particular, box-type caissons are popular as base unit for harbor walls and breakwaters. They can be built on land, inside dry-docks, or on floating barges and are typically transported to the installation site by floating transportation barges and tug boats.

When caissons are mounted on a floating transportation barge and towed by a tug boat in waves, motion of the floating dock creates inertia loading on the caisson. In addition, the inclination of the floating dock generates gravity-induced slip forces. The inertia and gravity-slip forces are resisted by the friction force at interface between the surfaces of floating-dock and caisson in the absence of any blockage or supporting lines. As sea environments get severer, the motions are increased, and the resulting slip force may exceed the resisting friction force. In this case, the slip and collision may occur between the caisson and blocking side walls of the floating dock. In oblique

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