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On the efficient time domain stress analysis for the rolling chock of an independent type LNG tank targeting fatigue damage evaluation

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A B S T R A C T

This paper targets to develop the procedure of stress analysis of the structural details near the rolling chock by using the time domain modal analysis technique where both the contact and friction behavior can be accurately simulated. In order to perform the time domain analysis focused on the contact and friction, the interaction between hull and tank was modeled via Coulomb friction which were combined with modal analysis technique. Modal analysis using the quasi-static deformation modes is chosen as a cost effective time domain simulation method and this is based on the fact that the structural response of the tank, together with hull, is quasi-static. Based on the developed cost effective time domain simulation method, the long-term fatigue analysis procedure for the structural details near the rolling chock and key of independent type tank is targeted to be established. The developed fatigue assessment procedure takes into account, wave induced stresses and both contact and friction induced stresses without loss of accuracy.

1. Introduction

International gas code (IGC) defines several different types of cargo containment system (CCS) which may be applied to the ships and offshore structures that transport and store liquefied natural gas (LNG) or liquefied petroleum gas (LPG). Membrane type cargo containment systems have been popularly used for LNG carriers for past decades, whereas independent type tank received less attentions due to relatively high capital expenditure. However, in line with the increasing demand for the offshore LNG facilities asking for the operation under partial filling condition, independent type tank starts to draw attention owing to its capability to reduce the violent internal liquid motion. As its name holds, the independent type tank has internal tank which is structurally independent of the hull structure, but connected to it via some support structures such as vertical supports, rolling and pitching keys and chocks. It is natural to expect the relative motion between the supporting structure of the hull, i.e. chock, and its counterpart on the tank, i.e., keys, which is induced by the acceleration of the ship under the seagoing condition. The structural details near the rolling chock located along the center line of the ship is considered to be prone to the fatigue damage owing to both the contact and friction force between the rolling key and chock induced by the relative motion of tank and hull. As shown in Fig. 1, many structural discontinuities are observed near the rolling key such as

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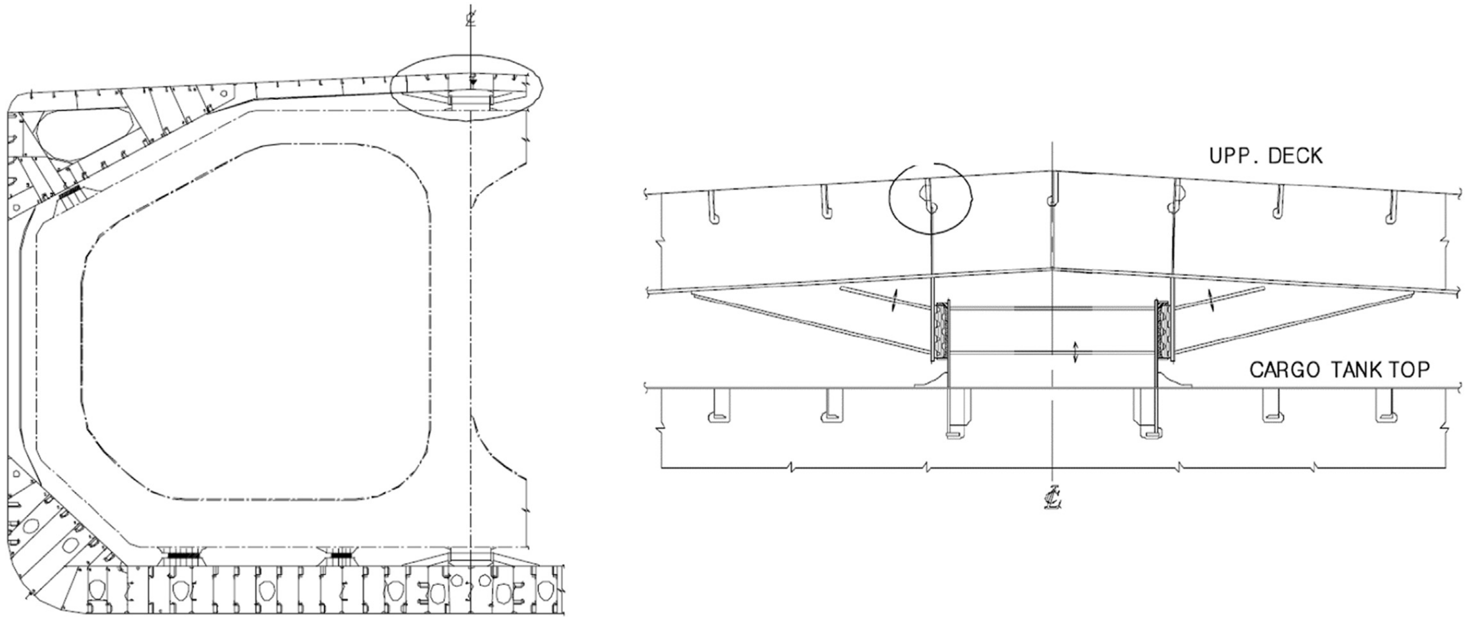

Fig. 1. Typical structural detail near the rolling key and chock.