Design and Simulation of Hinge-type Ro-Ro (Roll-on/Roll-off) Ship Car Deck Structure

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ABSTRACT

Ro-Ro ships can roll-on or roll-off cargo with self-driving power such as passenger cars and trucks, and container cargo on transport devices such as trucks or trailers on a ramp. The representative types of Ro-Ro ships are PCC (Pure Car Carrier) and PTCT (Pure Car & Truck Carrier). Ro-Ro ship is configured to load as many cargoes as possible by dividing the cargo hold into multiple card decks up and down. It is necessary to adjust the height of the car deck according to the type of vehicle being loaded. For this purpose, a number of fillers are installed on the inner deck of the Ro-Ro ship. In other words, to load high cargo such as heavy equipment on the car deck, the height between the decks must be high. At this time, the liftable car deck is adjusted using the deck lifter installed on the pillar. Existing liftable car deck structures are made of a single large plate, so it takes a lot of time and money to install and dismantle them. In this study, a hinge-type liftable car deck was designed. In addition, the overall structural integrity including the hinge was evaluated through structural analysis in accordance with the classification regulations.

KEY WORDS: Ro-Ro ship, Hinge-type car deck, Topology optimization, DNV ship rule

INTRODUCTION

A Ro-Ro Ship is a cargo ship that transports general vehicles, heavy equipment, and trucks. It does not require a separate crane or equipment, and vehicles can directly load and unload regardless of poor port conditions. It helped a lot in overcoming the infrastructure that was devastated after the war. Container ships are the most common and widely used in marine transportation today, but Ro-Ro ships also have strengths in vehicle transportation. According to MDS Transmodal, it is showing a trend of 3-4% increase every year (Ovstebo and Fagerholt, 2011). As shown in Figure 1, since the cargo heights of Ro-Ro ships are different, it is necessary to flexibly adjust the height of the car deck to load various types of cargo on Ro-Ro ships.

Figure 1 shows the schematic view of a Ro-Ro ship structure and overall process (Source: https://www.carexshipping.com/rates/best-roro-shipping-companies-in-usa/).

The height of the car deck should be adjusted according to the height of the cargo to maximize the loading. To adjust the height of the car deck, a mobile deck lifter as shown in Figure 2 has traditionally been used. However, there are disadvantages in terms of the environment because a person must manually drive and operate the vehicle, and exhaust gas is emitted from the vehicle. To improve this, a hoistable car deck as shown in Figure 3 was developed and can be easily operated hydraulically or electrically. However, the downside is that it is expensive.

Romanoff (2008) used enumeration and vectorization-based Genetic Algorithm to optimize the structure of a hoistable car deck. Tuswan