

Automatic Mooring System for Ship

Masahiko Nakamura, Hiroyuki Kajiwara, Masaru Inada
Kyushu University, Fukuoka, Japan

Shoichi Hara, Kunihiro Hoshino, Takako Kuroda
National Maritime Research Institute, Tokyo, Japan

ABSTRACT

The paper is concerned with the automatic mooring for a ship to reduce the labor load of standby operations in domestic shipping. A simulator that calculates mooring tensions and ship motions was built, and calculation accuracy was checked by model experiments. A controller was then designed using the simulator and the performance was verified by tank tests. Successful results are shown.

KEY WORDS: Automatic mooring; winch; control; model experiment; domestic shipping

INTRODUCTION

In Japanese domestic shipping, a recent shortage of crew members resulting from the severe labor environment and the aging of members have been serious problems, causing concern about difficulty arising in stable transportation. The hiring of younger crew members by improving the labor environment and reducing the labor load is therefore an important target. Automatic mooring is one means of mitigating the labor load of standby operations (Hara et al. 2005). If a shift in the mooring tension induced by tide level change and a draft change while loading can be prevented, and moreover, if the hull position can automatically be held within the allowable limit, the labor load can be reduced. Such new technical developments are believed particularly effective to support standby operations, because the navigation distance of ships operating only in Japanese waters is shorter than that of foreign ships and berthings are frequent.

In this research, a simulator that calculates mooring tensions and ship motions was initially built, and calculation accuracy was checked by model experiments. A controller was then designed using the simulator and the overall performance was verified by tank tests. Successful results are shown.

SPECIFICATIONS REQUIRED OF AUTOMATIC MOORING SYSTEM

Determining the specifications of the controller is an important core-portion in the development of a user-friendly automatic mooring system. Therefore, we carefully investigated about the present

conditions of mooring of coasters and possible problems from the operators and crew members, and then set determined the following specifications:

- (a) Electric winches are adopted for the system.
- (b) The winches are controlled to prevent shift of the mooring tension induced by tide level change and draft change while loading.
- (c) The winches are controlled to hold the hull position during controlling for (b).
- (d) It is not necessary to control the motion of the ship (the fluctuation of mooring tension) induced by waves or wind.
- (e) Control of the winches is intermittently performed at a proper time interval for energy saving and winch miniaturization.

Although it was thought possible to control the ship motions induced by external forces such as wind or a surge (Ohashi et al. 1975), this was removed from the specifications based on results of our investigation. Moreover, in consideration of the model experiments, the following conditions were set up in the system design.

- The design is developed for a 20,000t cement carrier.
- The number of mooring lines is four.
- A new-material (Dyneema) (Hoppe 1997) $\phi 30$ mm mooring cable is used for mooring.
- The number of fenders is two.
- The mooring lines and fenders are approximated to linear springs.
- The command to the winch is the adjustable length of the mooring line.
- The dynamic characteristic of the winch is approximated to a first order system.

MODEL OF SHIP

The simulations and model experiments were conducted using a 1/61 scale model ($L_{pp} = 2.5$ m) of a cement carrier. A photograph and principal dimensions of the model ship are shown in Fig.1.

CONSTRUCTING THE SIMULATOR

To develop the automatic mooring system, the added mass coefficients, damping coefficients and wave exciting forces were calculated, and a simulator that calculates the motions of the hull and mooring tensions was built. The origin of the coordinate system is at