

High Performance Steel Plates for Shipbuilding Applications

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ABSTRACT

A demand for heavy thick plates with a good combination of high strength, toughness, and weldability has been widely growing in recent years for large container ship building. The successful application of thermo-mechanical control process (TMCP) with the recent innovative technology has induced the development of EH36, EH40, and EH47 grade steel plates.

The alloying elements such as boron, copper, and nickel were added and the rolling and cooling processes were strongly and precisely controlled to improve the strength and toughness at the same time. EH36 steel plate for high heat input welding was successfully developed with good toughness at the HAZ by increasing thermal stability of TiN particles at the high temperature.

KEY WORDS: ultra large container ship, heavy thick plate, TMCP, EH36, EH40, EH47, high heat input welding

INTRODUCTION

With its foreign trade rapidly expanding and with economic growth continuing at a substantial rate, container ships have been becoming larger and faster. The size of a container ship is normally stated by the maximum number of TEU-sized containers that is able to carry. The abbreviation "TEU" stands for "twenty-foot equivalent unit". The ultra large container ships (ULCS) of around 9,000~13,000 TEU are now being built in several shipyards. It has been reported (tWijnolst, 1999) that in about 10 years the ULCS would handle some 18,000 TEU with a ship breadth of 60 m and a maximum draught of 21 m. Lately, this ship size would be classified as a post-Suezmax ship, as the cross-section of the ship is too big for the present Suez Canal. Also, it is called as "Malaccamax", because that a draught of 21 m is the maximum permissible draught through the Malacca Strait.

The transportation cost per container for such a big ship is thought to be about 30% lower than that of a typical 5,000-6,000 TEU container vessel today.

The larger container ships have typically required the extensive use of heavy thick plates with higher strength and good toughness rather than

other types of ships due to their capacity to load much more containers stacked on the open upper deck. The cross-section and steel grades for Hull structure of container ships are shown in Fig.1. As container ship size increases from 6000 TEU to 8000 TEU, the EH40 grade (yield strength ≥ 390 MPa) is used instead of EH36 grade for the upper deck and hatch coaming. For larger than 13,000 TEU container ship, EH47 is expected to be used. By using higher strength grade steels, the plate thickness could be thinner even for the same size of container ship.

The steel plates are cut and patched into blocks, and then finally assembled into container ship by welding at the inside of dry dock. The high heat input welding such as EGW (Electro-Gas Welding) is needed for increasing productivity and quality of weld joint of heavy thick plates.

EH36, EH40, and EH47 grade steels have been developed to be welded under the general condition with high heat input up to 300kJ/cm., which make it possible to weld 40mm thick plate by one pass EGW and remaining portion is filled by FCAW. The welding productivity could be increased more than twice if high heat input welding of 600kJ/cm were applied for one pass EGW on 80 mm thick plate. The special EH36 grade steel for high heat input welding has been also developed.

This paper deals with the design concepts and performances of recently developed EH36, EH40, and EH47 for high strength purpose and EH36 for high heat input welding.

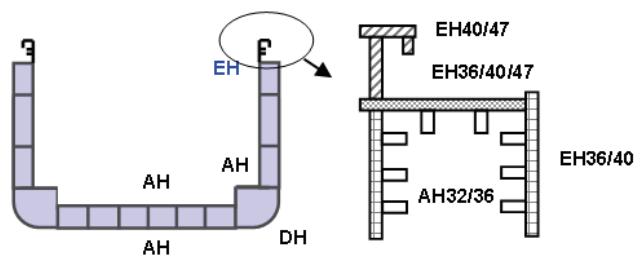


Fig.1. Cross-section and steel grades for Hull structure of container ships.