Advances in Forming Heavy Plate Structures

By Dr. Hyunok Kim | EWI | Applications Engineer, Modeling

New materials forming innovations are enabling manufacturers to achieve greater competitive advantages by improving product performance, quality, and cost. The application of these new advanced materials and net-shape forming methods can reduce materials usage, weight, manufacturing operations, and cost, while improving structural performance. However, optimization of part designs, forming processes, and tooling designs to achieve these benefits requires an understanding of material formability, forming process parameters, tooling friction and wear, and quality control methods.

Typical hull structures of ship have pre-formed and welded plates of various sizes, with multiple radii of curvature (Figure 1). Most U.S. shipbuilders currently employ traditional forming technologies (e.g. press bending and line heating) that are labor intensive and heavily dependent on operator skill. A common practice is to use a press to form a major radius of curvature and then use a line heating method with an oxy-fuel torch and water hose to form the completed shape (Figure 2). Thermal line forming is difficult, uncomfortable, and takes significant labor-hours to obtain a single formed plate. These traditional, labor-intensive methods also limit the ability to design more streamlined hull shapes that could improve speed and energy efficiency of the vessels.

EWI is now conducting a project for the National Shipbuilding Research Program (NSRP) on "Evaluation of model based engineering (MBE) and advanced forming technology for complex hull manufacturing". This project aims to characterize U.S. and foreign shipbuilding forming processes as well as the latest MBE tools and novel forming technologies available worldwide.

In this project, EWI is working with three major U.S. shipbuilding companies to identify the forming applications that can benefit from the use of MBE tools and advanced forming methods to reduce production costs. A gap analysis is being performed to compare the current forming practices in U.S. shipyards with advanced forming technologies being used elsewhere in the world. Examples of the technologies being evaluated include a Navy ManTech project for US shipbuilding companies during which EWI demonstrated the ability to form complex compound curvature hull plates with robotic induction heating integrated with MBE tools (Figure 2). Figure 3 illustrates a new automated cold forming method that is currently being deployed in an overseas shipyard to form hull structures. In addition, an automated line heating system has been developed in other shipyards. The process includes a computation algorithm to calculate the required line heating paths from the input of 2-D or 3-D part design, automatic material handling and induction line heating, and a laser based measurement device for the feedback control.

At the conclusion of the current NSRP project, an implementation roadmap and business case will be established to describe a path to implement advanced forming processes and MBE tools in U.S. shipyards for the top three target applications. Advanced forming technology is expected to enable shipyards to reduce forming process-related man-hours by 50 to 75% by achieving better dimensional control and faster process cycles.

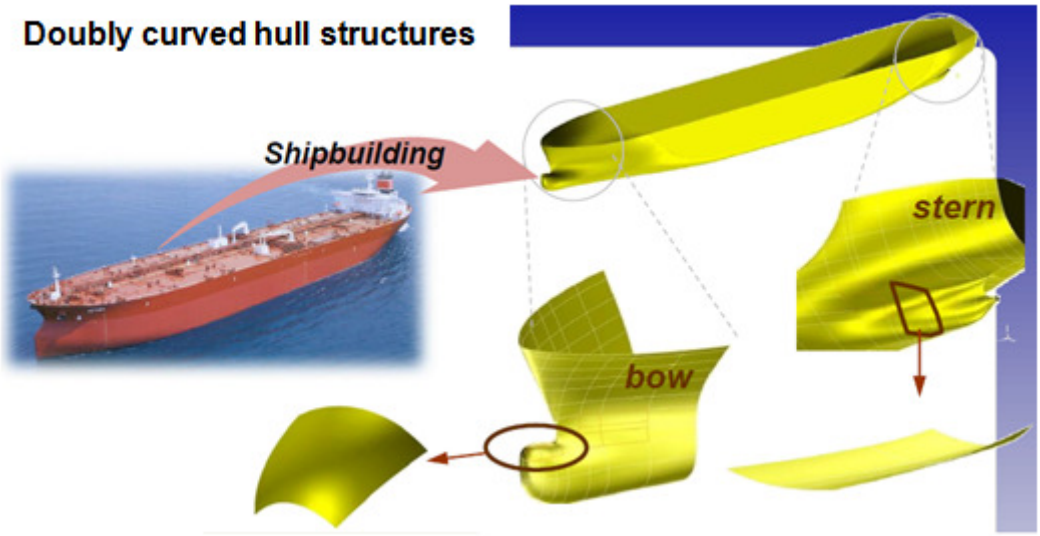

Figure 1: Various hull structures for ship vessels (Courtesy of KAIST)

Figure 2: A conventional line heating process (left) and an automatic line heating device developed by EWI for Navy ManTech project (right)

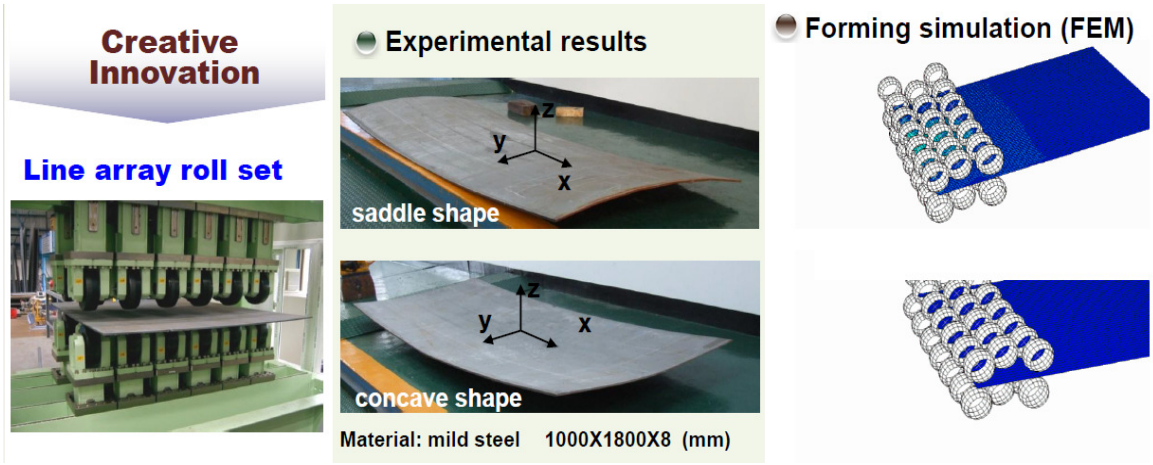

Figure 3: Line Array Roller Set Forming (LARSF) (Courtesy of KAIST)

About the Author

Dr. Hyunok Kim is an applications engineer in the Modeling group at EWI. He will be an integral member of the forming center that EWI is currently planning.

Learn More

Contact Dr. Kim at hkim@ewi.org or 614.688.5239 for further information.