



# Journal of Environmental Science and Technology

ISSN 1994-7887

**science**  
alert

**ANSI***net*  
an open access publisher  
<http://ansinet.com>



## Research Article

# A Preliminary Study of Fixtureless Shipbuilding Practice

<sup>1</sup>M.F. Makhtar, <sup>2</sup>A. Ismail, <sup>3</sup>M.H.M. Suffian, <sup>4</sup>M.A. Rojan, <sup>1</sup>D.A. Hamid, <sup>1</sup>I.M. Ikram, <sup>1</sup>M.T.S.M. Said and <sup>1</sup>N.A.K. Bashah

<sup>1</sup>Institute of Product Design and Manufacturing, Universiti Kuala Lumpur, 119 Jalan, 7/91, Taman Shamelin Perkasa, 3 1/2 Miles, Cheras, Kuala Lumpur, Malaysia

<sup>2</sup>Malaysian Institute of Marine Engineering Technology, Universiti Kuala Lumpur, Dataran Industri Teknologi Kejuruteraan Marin, Bandar Teknologi Maritim, Jalan Pantai Remis, 32200 Lumut, Perak, Malaysia

<sup>3</sup>Malaysian Institute of Aviation Technology, Universiti Kuala Lumpur, Lot 2891, Jalan Jenderam Huku, Kampung Jenderam Hulu, 43900 Dengkil, Selangor, Malaysia

<sup>4</sup>School of Mechatronics Engineering, Universiti Malaysia Perlis, Pauh Putra, 02600 Arau Perlis, Malaysia

## Abstract

Fixtureless Fabrication Method (FFM) is a cognitive method containing knowledge in fabrication of ship hull without using any jig or support during fabrication. The purpose of this method is to avoid any wastage of materials during construction process. Fixture is a jig or support materials that used to stable the structure during construction. Normally, jig or support had been used will be scrapped at the end of the project or after ship already launching. It will be a wastage material as the jig or support just used once during shipbuilding process. This phenomenon occurs due the ships were built as customised product, normally 1 ship per construction. There are two way of using FFM technique in the construction of AHTB, which in upside down construction method and inverted condition that will be started from the main deck of the ship. The FFM for AHTB is a new method to replace the modular construction in order to eliminate utilization of the fixture and reduce fabrication cost. This study describes the preliminary study of fixtureless fabrication process for shipbuilding industry. The construction process of Anchor Handling Tug Boat (AHTB) will be analyzed and evaluated as main subject matter for this study.

**Key words:** Fixtureless, hull fabrication, shipbuilding process, cost effective

**Received:** May 28, 2016

**Accepted:** August 22, 2016

**Published:** October 15, 2016

**Citation:** M.F. Makhtar, A. Ismail, M.H.M. Suffian, M.A. Rojan, D.A. Hamid, I.M. Ikram, M.T.S.M. Said and N.A.K. Bashah, 2016. A preliminary study of fixtureless shipbuilding practice. J. Environ. Sci. Technol., 9: 467-471.

**Corresponding Author:** M.F. Makhtar, Institute of Product Design and Manufacturing, Universiti Kuala Lumpur, 119 Jalan, 7/91, Taman Shamelin Perkasa, 3 1/2 Miles, Cheras, Kuala Lumpur, Malaysia

**Copyright:** © 2016 M.F. Makhtar *et al.* This is an open access article distributed under the terms of the creative commons attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

**Competing Interest:** The authors have declared that no competing interest exists.

**Data Availability:** All relevant data are within the paper and its supporting information files.

## INTRODUCTION

A ship is huge steel operated at the sea. It is fabricated by a large no. of steel structures through joining operation<sup>1</sup>. Shipbuilding is one of the processes in the construction of the ship or floating vessel from a plate to become a complete ship structure<sup>2</sup>. The fabrication of ship started from a pieces of plate and become a block. It is consist of dozans componants and thousand structure elements in the ship hull and outfitting<sup>3</sup>. The technology has a great development and requires high capital . The fabrication of ship will devided into blocks and it is consist more then 2 mid-assembly and a subassembly. A mid-assembly consist a few assembly, while a subassembly consist of steel plates and section<sup>1</sup>. Nowadays, several suitable methods are already had been used for construction, such as modular construction method and multi point erection method. In the construction process, product and costing are very crucial and need to be emphasized. The structure must be stable while construction process. It is to avoid from the failure during construction and caused damage on the structure. Meanwhile, the fabrication process spends a large

amount of costing for the materials<sup>4</sup>. Hence, a fixtureless shipbuilding practice will ease the construction process and minimize the production cost.

A fixtureless shipbuilding practice reveals on how the fabrication of ship hull without any kind of jig or support system and the stability of the structure during construction is supported by the structural member itself. Instead of using conventional fabrication method, which is widely used for ship fabrication practice, this method tend to risk for the people around the construction site and increase construction cost as the entire jig and support system after the construction will be sent as scrap and wastage. The process for the modular construction (conventional) is shown in the Fig. 1, 2. This study will describe the preliminary study of fixtureless fabrication method for v-shape ship hull of anchor handling tug boat.

## MATERIALS AND METHODS

The concept of the Fixtureless Fabrication Method (FFM) quite similar to the modular construction method.

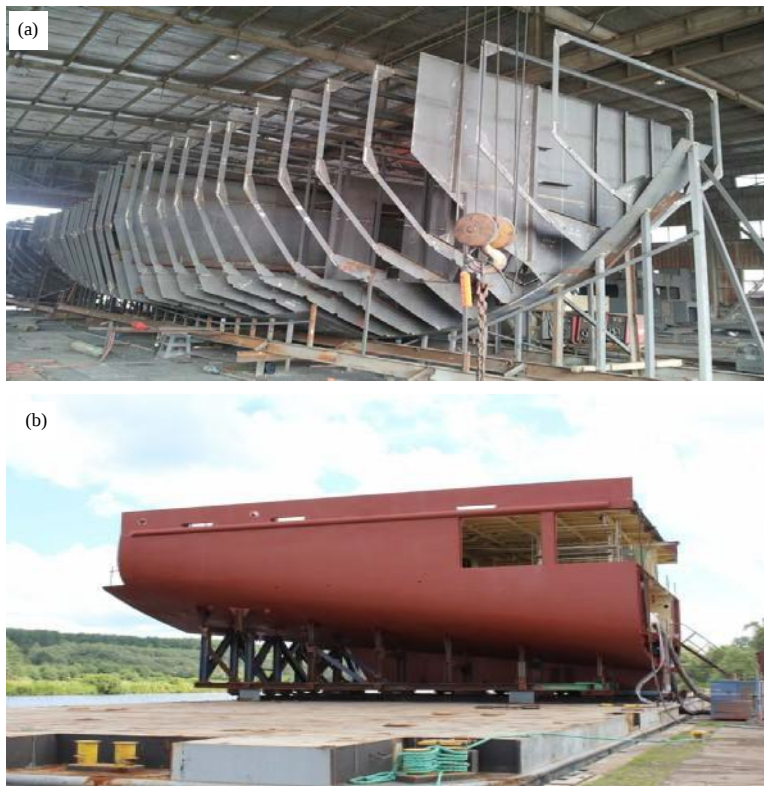


Fig. 1(a-b): Conventional method used to fabricate ship, (Modular construction)

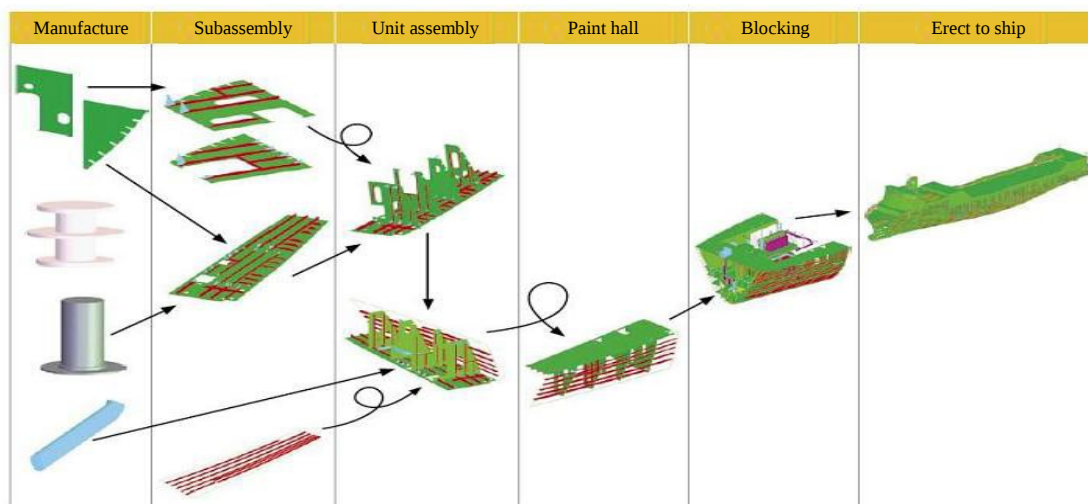


Fig. 2: Modular construction process

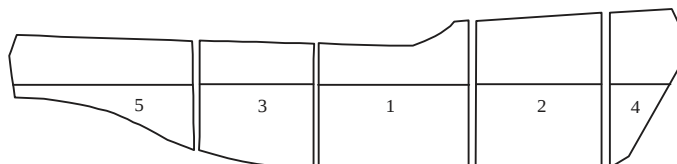


Fig. 3: Block assembly sequences

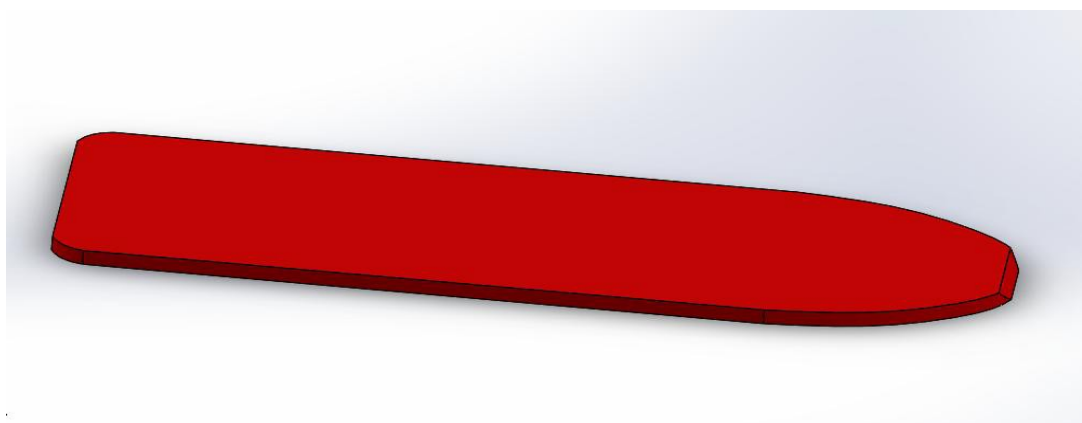


Fig. 4: Fabrication phase

Table 1: Anchor handling tug boat technical specification

|                                    |         |
|------------------------------------|---------|
| Length Overall (LOA)               | 30.10 m |
| Length Between Perpendicular (LBP) | 28.72 m |
| Length Water Line (LWL)            | 30.16 m |
| Breadth moulded                    | 4.20 m  |
| Depth                              | 4.20 m  |

Which is the structure will be fabricated block by block, then will be assembled become as a ship<sup>5</sup> (Fig. 3). The personal particulars of AHTB shows in Table 1.

The fabrication of AHTB using fixtureless fabrication method (FFM) executed in an inverted condition which is started from bottom structure fabrication. The foundation phase need to be fabricated 1st as a foundation structure. Figure 4 showed the foundation phase.

The 2nd phase is to complete the backbone structure, which is containing the middle and forward structure of the ship as shown in Fig. 5. In this phase, the complete structure in the middle and forward structure for the specific area need

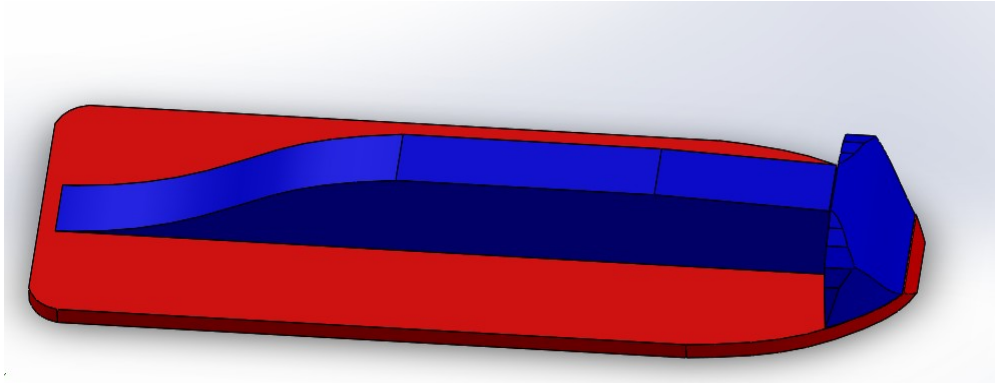


Fig. 5: Backbone phase

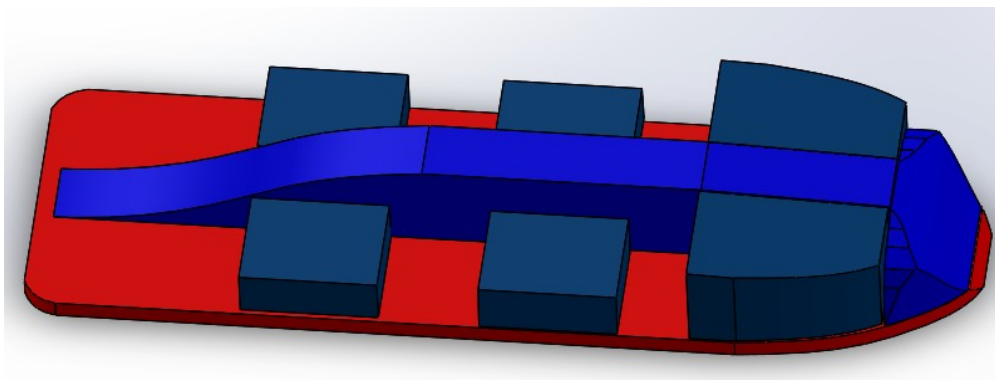


Fig. 6: Blocking phase

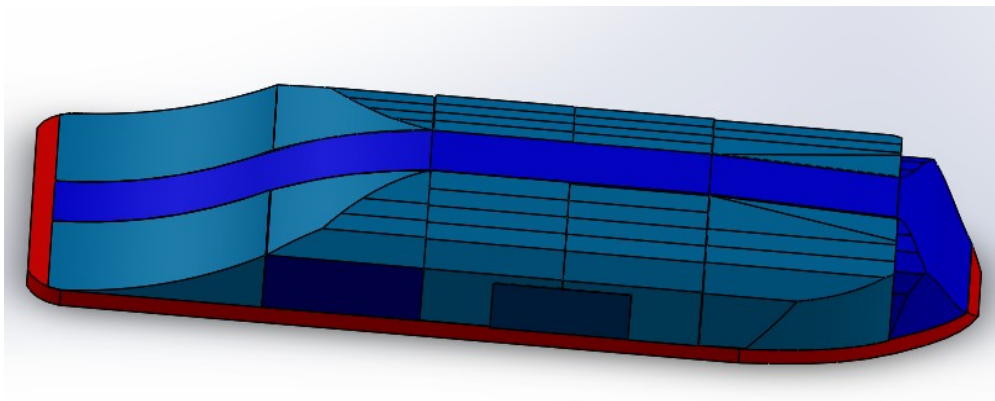


Fig. 7: FFM erection process

to be fabricated completely including the keel, stringer and plating. According to the Fig. 5, the blue structure represents the middle and forward structure.

Figure 6 show that the installation of the support structure on the main deck structure prior block assembly process. This phase called support. In this phase a 6 block

structure will be installed on port and starboard side, forward, middle and aft part to sustain the strength and stability of the foundation structure.

Figure 7 showed the erection phase, which is the last phase in FFM process. In this process the block will be assembled and become a complete hull structure.

The installation of the block should be implemented cautiously follow the block sequences.

## **RESULTS AND DISCUSSION**

In the FFM, the block fabrication process will be fabricated part by part, which is started from bottom to the up. It is called upside down construction method. The process will be conducted in inverted condition which is started from main deck, then continue until bottom plate. This method could eliminate utilization of the fixture and jigs. The foundation phase are very crucial phase to obtain the solid foundation and to accomodate other structure because it stated at the lowest part and it a stable part. In this phase the entire of the main deck structure will be fabricate and it is not necessary any fixture and jigs. The backbone structure will be installed on the foundation structure, which is containing the middle and forward structure of the ship. It is to ensure both of this structure increased the strength to support another block will be installed. The support structure will be insatalled on the main deck prior erection process. Six block structure will be installed on the port, starboard, forward, middle and aft side to sustain stability of the structure and increased the strength of the structure. In this study, the load distribution for each block structure should be emphasized to ensure each load imposed on the foundation structure do not change any physical properties of the material and will lead to the damage and failure on the foundation structure. The installation of the support block should follow the sequences, which has been specified to maintain the stability and the load imposed on the foundation structure. In AHTB fabrication, the cross X installation technique practiced, which is forward port-aft starboard simultaneously then followed by forward starboard-aft port with the same technique. After finish the support block installataion at forward and aft section, the middle structure at the foundation structure will be tend to bending because of the load imposed at the forward and aft section. The effect of this condition, it will deform the foundation structure. To solve this situation, the middle block will be installed after installation of forward and aft block. It will be homogenize the load imposed foundation structure. The blocking phase are the critical part in FFM. The eraction phase are the last phase in the FFM where the rest of block will be installed to complete the fabrication of the hull.

According to the survey had been done for AHTB below then 40 m, the elimination of the fixture can minimize the material cost up to RM 35,000 (8228.52 USD). Other then that, labour cost also showed a big impact, where the FFM technique can be reduced the labour cost as much as 68%, which is RM 124, 000 (29152.47 USD) from total labour cost. The comparison prove the FFM technique could reduced huge amount of labour cost.

## **CONCLUSION**

The FFM could replace the modular construction method because this technique quite similar but the FFM fabrication technique is inverted condition which is the installation technique using upside down construction method. As this era globalization, most of the shipyards already equipped with high technology machineries which could be facilitate to implement this new technique.

## **ACKNOWLEDGMENT**

The authors would like to acknowledge the Universiti Kuala Lumpur for facilities and funding provided.

## **REFERENCES**

1. Booker, J.D., K.G. Swift and N.J. Brown, 2005. Designing for assembly quality: Strategies, guidelines and techniques. *J. Eng. Des.*, 16: 279-295.
2. Eyres, D.J. and G.J. Bruce, 2012. Assembly of Ship Structure. In: *Ship Construction*, Eyres, D.J. and G.J. Bruce (Eds.). 7th Edn., Butterworth-Heinemann, USA., ISBN: 9780080972398, pp: 147-159.
3. Eyres, D.J. and G.J. Bruce, 2012. Design Information for Production. In: *Ship Construction*, Eyres, D.J. and G.J. Bruce (Eds.). 7th Edn., Butterworth-Heinemann, USA., ISBN: 9780080972398, pp: 125-134.
4. Roland, F., L. Manzon, P. Kujala, M. Brede and J.R. Weitzenbock, 2004. Advanced joining techniques in European shipbuilding. *J. Ship Prod.*, 20: 200-210.
5. Zhong, Y., K. Xue and D. Shi, 2013. Assembly unit partitioning for hull structure in shipbuilding. *Comput.-Aided Des.*, 45: 1630-1638.