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A Study on the Design of a Continuous Flow Production System and Process Innovation

Methodology in Panel Assembly Lines of Shipbuilding

Authors

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Abstract

The bottlenecks of the panel block assembly lines in shipbuilding are frequently happened because of the limited facilities and equipment, the increase of construction demand and the simultaneous production of various types of ships. And there are various problems scattered in assembly lines like the work delay of panel blocks, convergence of panel blocks at the end process of assembly lines, a temporary stop of work processes and loss of working hours by the unsteady arrival time interval of panel blocks. As such causes, the production planning is not exactly achieved and urgent works happen occasionally. So it is difficult to control a kind of resources and build a continuous flow production system. In this study we propose the methodology (HYPAPS; HYundai heavy industries, Panel Assembly Production System) for building the continuous flow production system to solve lots of problems in the panel block assembly lines. In order to set up a continuous flow production system, we apply load leveling methods by the work period of panel blocks, the division of panel block assembly lines, control programs of the rate of progress by color flags and standard work orders.

1. Introduction

This paper provides a continuous flow production system and a method for implementing the same which overcome the problems encountered in a flow of panel block assembly lines in a panel assembly factory of HHI (Hyundai Heavy Industries co. ltd). The panel assembly factory, which is an object of this paper, assembles the blocks of a ship center portion while occupying 50% of the total ship shares. The panel assembly factory consists of an automatic panel welding line and panel block assembly lines. In the automatic panel welding line, a main panel used in the upper and lower sides of the block is manufactured and supplied to panel block assembly lines. The panel block assembly lines manufacture various types and sizes of panel blocks by using the main panel and sub assembly block from the automatic panel welding line and sub assembly shop. *Figure 1* shows a panel assembly factory layout and material flow status.

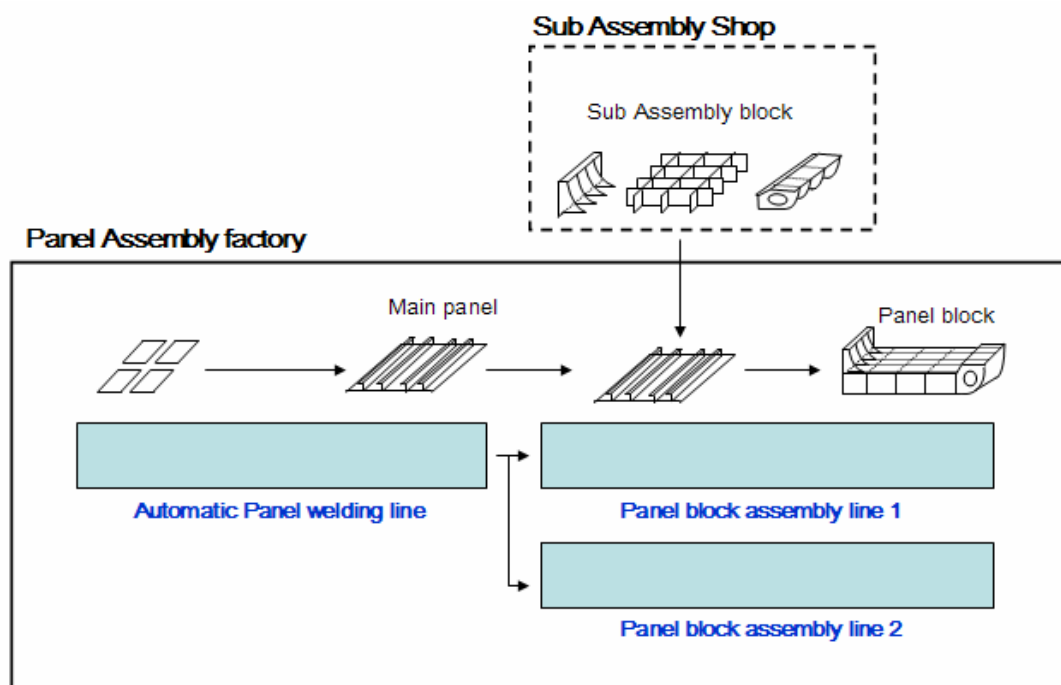


Figure 1. The panel assembly factory layout and material flow

The (panel block) assembly lines have the following features. First, the assembly lines manufacture various kinds of panel blocks for ships. A side shell block, an engine block, a bench block and a deck block with respect to the kinds of ships of CNTR, COT/PC, LPG, LNG are manufactured. *Figure 2* shows a typical type of blocks manufactured in assembly lines.

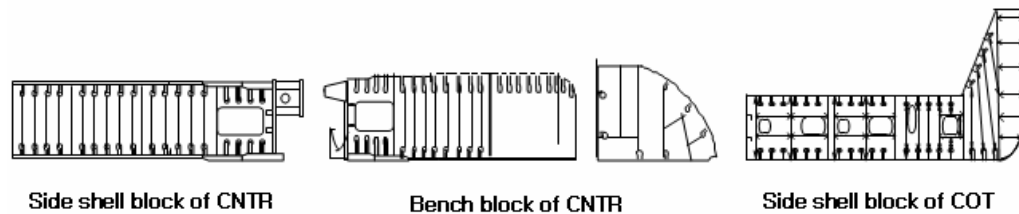


Figure 2. A typical type of panel blocks

Second, the assembly lines have a shorter workplace as compared to the production flow of the panel blocks. In case of the panel assembly factory, since it is built in the 1980s, it is impossible to cope with the amount of ships. Third, the panel blocks have a large work period difference. The assembly lines of the panel assembly factory manufacture various kinds and sizes of the blocks, so the work periods needed for the assembly of blocks are different. The period needed for the assembly work of the blocks is 5~6 days depending on the panel blocks.

2. Problem analysis and solutions

The panel block assembly lines have various problems due to constraints disclosed in the introduction. The different work periods of panel blocks are subject to non-fixed work completion periods, and the number of the blocks per day discharged from assembly lines changes within a range of 2~8 blocks. The non-fixed block discharge phenomenon may cause the work space of assembly lines to remain temporarily or to lack, so that the use ratio of the

workplace is decreased, and the work efficiency is worsened. Namely, the blocks may be gathered at the end of assembly lines, and the assembly work is focused. The work space for storing the main panels manufactured in the previous process(automatic panel welding line) may temporarily lack, so that a continuous material flow supply is not obtained, and the work delay and over stock problems occur. The panel blocks may be stacked with no smooth flow, and the panel blocks are stacked at the end of assembly lines. Since the number of the discharging panel blocks per day is not constant, the basic reasons are summarized in that the problems occur in the non-continuous material flow due to the different work periods in the assembly lines. So, this paper suggests a continuous flow production system based on a standardization work period so as to overcome the above problems. *Figure 3* shows a logic tree diagram for the problem analysis.

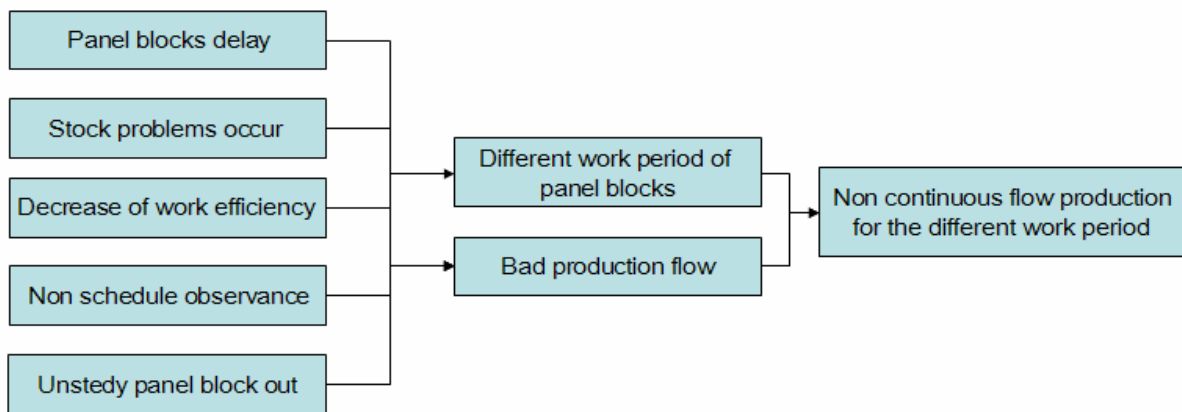


Figure 3. A logic tree diagram for the problem analysis

3. Construction of continuous flow production system

(HYPAPS; HYundai heavy industries, Panel Assembly Production System)

In order to build the continuous flow production system in the panel block assembly lines, which is an object of this paper, it is needed to make the work periods of various blocks constant in the assembly lines. In this study, in order to build the continuous flow production

system, the four steps consisting of a standardization work period, a workplace divide management, a color flag indication method, a standardization work amount and work period are sequentially adapted.

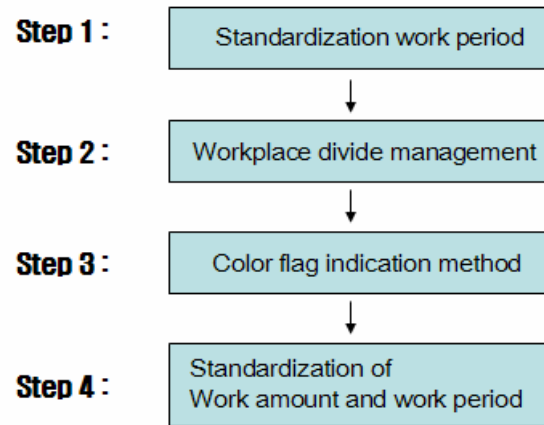


Figure 4. The construction methodology of continuous flow production system (HYPAPS)

Step 1: Standardization work period

In the panel block-based standardization work period, the standard work days for making the assembly period of different blocks constant are determined, and the work period for keeping it by the panel blocks is adjusted.

The panel block assembly lines may have one among 5 days to 8 days which are the work period of the panel blocks. In this study, in case that the work periods are determined with above 7 days, the length of assembly lines may be shortened, so that it is impossible to adapt the two-steps workplace divide management. Therefore, it was omitted in the standard work period. In the present research, in order to determine the standard work days for panel block assembly lines, about 24% enhancement was achieved when the work days are five as a result of the simulation test as compared to the current manufacture method. When it was 6 days, about 8% enhancement was achievement as compared to the current manufacture method. So, in the present research, the standard work days are 5 which are determined for coping with

the increase of ship markets and for obtaining an excellent productivity.

Step 2: Workplace divide management

In the divide management of the assembly workplace, the assembly lines are divided into standard work days, and the work status of the panel blocks are managed by the divided workplace. Since the work status of the panel blocks can be checked in the divide management, it is possible to efficiently manage the work proceeding and work numbers of the panel blocks. In this study, since the standard work days are 5, we divide 5 sections for the panel block assembly lines. Here, since the lengths of panel blocks are different, the panel blocks may be placed between sections. In the present research, boundary of the sections is called a Baton-Touch Zone (BTZ) and is classified as a checking zone of the panel block assembly work. Sometimes a section provides a certain work load to the following section inevitably, so that a balanced work condition is broken. So, it is needed to cooperate in this BTZ before and after section. *Figure 5* shows the BTZ in which the assembly lines are divided with the standard work days.

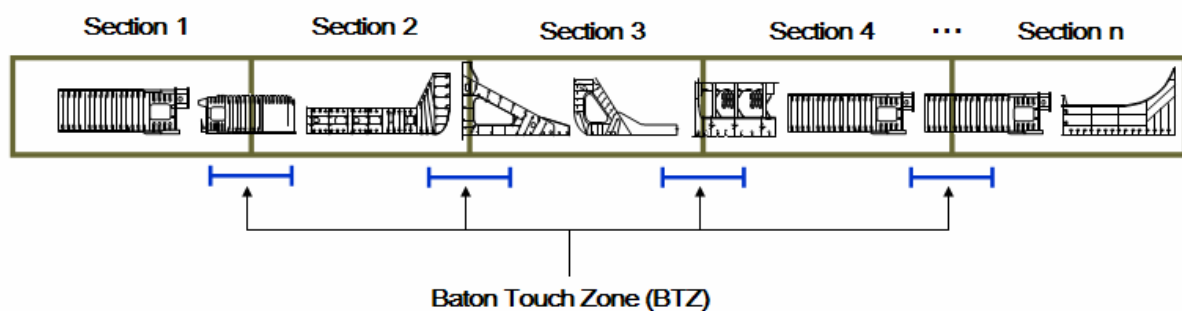


Figure 5. The workplace divide management and Baton touch zone (n = standard work days)

Step 3: Color flag indication method

In this study, the standard work days of the panel block are determined for constantly maintaining the manufacturing speed of the panel blocks, and the work section are separated

by means of the standard work days. However, when the locations and work proceeding of the panel blocks are not effectively managed, the work speed cannot be constantly maintained. So, this study suggests the color flag indication method in which the work days are indicated for the locations of the panel blocks and the work proceeding management.

In the color flag indication method, the work days are indicated by using the color flags while matching with the work days of the panel blocks. In this study, for the five days of the standard work days, the numbers from 1 to 5 are provided to the flags of blue, green, yellow, orange and red. For example, when a panel block has 3 days after inputting in the assembly lines, the yellow flag with the number of 3 is attached to the panel block. So, the manager can easily recognize what dates the panel blocks have passed in the assembly lines.

If the date of the flag is not matched with the date-based section, the panel block may have a problem in the current work, or the panel block has a problem. In this case, the manager should overcome the problems while managing the panel blocks. *Figure 6* shows a color flag indication method and problem management.

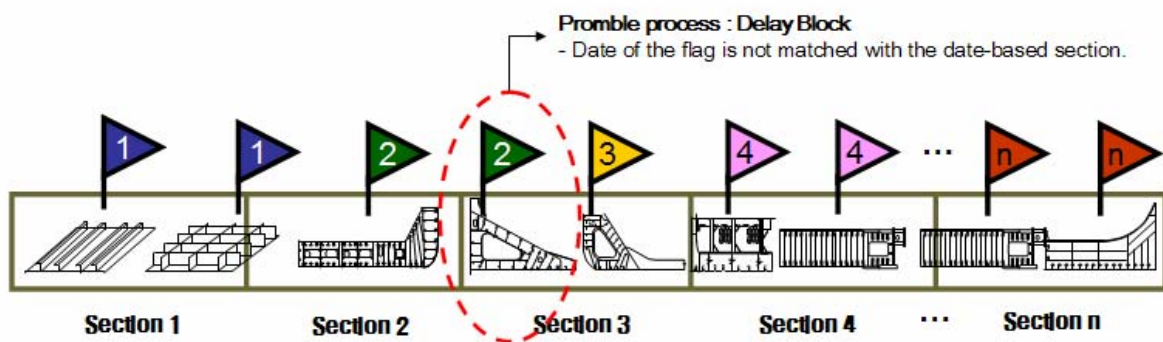


Figure 6. A color flag indication method and problem management

(n = standard work days)

Step 4: Work amount and work period standardization

In order to manage the panel blocks having various types and work periods with the

standard work days, the work amount should be standardized based on the standard work days. If the standardization work is not done, the standard work days cannot be kept based on the work method of the panel blocks. In this study, so as to prevent some exceptions of the block works, the work standardization sheet corresponding to the kinds of ships and panel blocks is made. *Figure 7* shows part of the work standardization sheet by the kinds of ships and panel blocks.

Item		Panel block assembly line										
Block location		1	2	3	4	5	6	7	8	9	10	
Work date		1st day		2nd day		3rd day		4th day		5th day		
CNTR	Work	loading of sub ass'y block , material arrange		L-BHD tact W/D, SUPTG preparation		H/C loading and tact W/D, Outfitting T/O		T/O tact W/D, Outfitting Ass'y		Back heating, Block out		
				L-BHD sub ass'y		L-BHD sub ass'y , T/O Preparation		L-BHD/ UD Welding		Block out		
	S/SHELL	Tact welder			2		3		3		3	
		Welder			4		12		1		1	
	E/ROOM	Tact welder			1		2		2		3	
		Welder			1		8		1		1	
	BENCH	Tact welder			2		3		2		0	
		Welder			1		0		0		0	
COT	Work	loading of sub ass'y block , material arrange		L-BHD tact W/D, Hopper tact W/D		UD loading and tact W/D, Outfitting T/O		L-BHD and Hopper T/O, tact W/D		Bact Heating Block out		
				L-BHD/ Hopper W/D, SUPTG		L-BHD/ Hopper Ass'y and welding		L-BHD+ Hopper joint W/D		Block out		
	S/SHELL	Tact welder			3		3		4		4	
		Welder			2		22		2		2	

Figure 7. An example of the work standardization sheet

4. Conclusion

This paper proposes a continuous flow production system in order to overcome various problems such as production flow problems in the panel block assembly lines. The present research provides the continuous flow production system in four steps (HYPAPS). In the first step, standardization work period, in the second step, workplace divide management, in the

third step, the color flag indication method, and in the fourth step, the work amount and period standardization. As a result of the simulation test based on the methods proposed in this paper, it is possible to enhance the productivity 20% as compared to the current production method. It is possible to keep the discharge panel blocks per day in 5.4. As a result after adapting to the assembly lines, it was possible to stabilize the discharge panel blocks, and with a stable work proceeding management, the stabilization is assembly lines and previous process are obtained. In addition, it is possible to decrease the work delay and loss in the entire lines of the panel assembly factory. *Figure 8* shows a result of simulation test using the HYPAPS methodology.

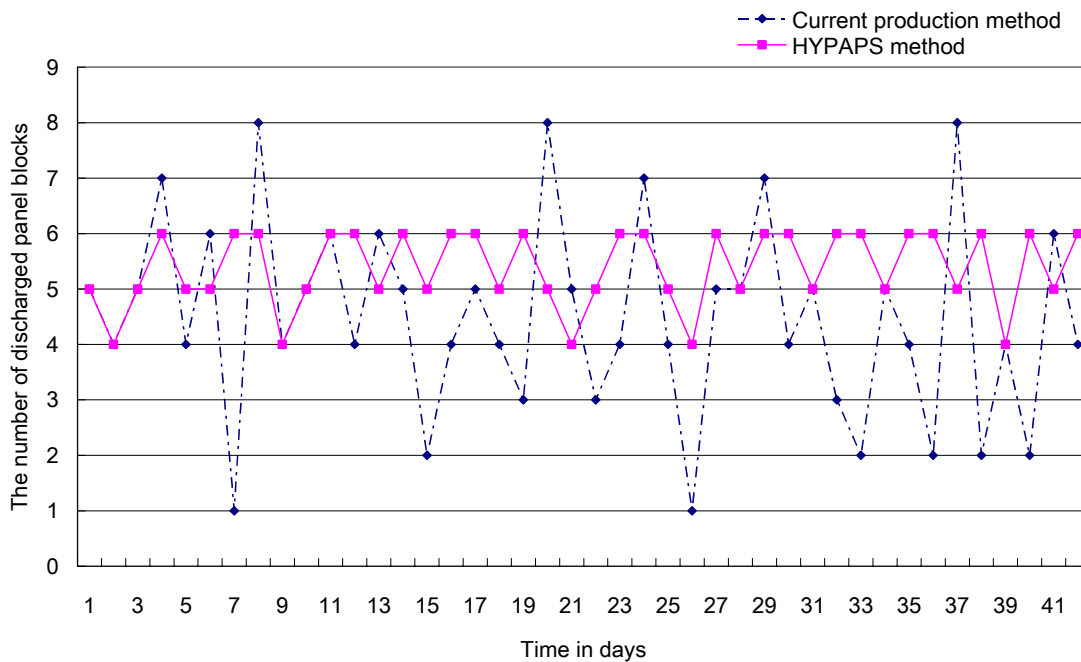


Figure 8. A result of simulation test using the HYPAPS methodology

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