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A square and circular pattern conceptual stowage techniques for container and RORO ships

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Abstract:

This work addresses the problem of stowage plans in handling containers and ro-ro cargoes in ships. Containers on board a container ship are placed in vertical stacks, located in many bays. Since the access to the containers is only from the top of the stack, a common situation is that specific container unloading will take the shifting of many other containers. This process of relocating the containers in the port operation is called container shifting. A container ship calling at many ports may encounter a large number of shifting operations, some of which can be avoided by efficient stowage planning. In general, the stowage plan must also take into account stability and strength requirements, as well as several other constraints on the placement of containers.

This work deal with stowage planning in order to minimize the number of shifts in an unloading operation in a port without considering stability and several other constraints. Here two stowage concepts suggested one is a square pattern and the next one is a circular pattern. The square pattern is meant for containers cargo and the circular pattern is meant for Roll-on Roll-off cargo.

1 Introduction

The innovation of shipping cargoes through containers is one of the most efficient systems introduced through the history of world sea trade. This system has enabled the shipping professional to achieve all the objectives of logistics management like cost reduction, time reduction, and space utilization. All the cargoes can be moved from the source only via road transport and then it will be shifted to rail and sea transport. Shifting cargoes from one mode to another is one of the most important hurdles in international shipping. Containerization has overcome this hurdle by introducing the concept of unitization and standardization. The majority of the cargoes are easily stuffed in a container and are able to load and unload easily from one mode to another mode of transport. Hence the concept of multimodal transport is developed all over the globe. Along with the growth of container transport, the demand for roll-on roll-off cargo shipping is also gradually increasing due to the ease of loading and unloading.

After the pandemic, there is a growth of demand in shipping cargoes globally. Due to this a lot of ship owners were building new ships with very high capacity to handle the rising need in the market. Also, the efficiency of the load and discharge operation is based on the stowage plan. A stowage plan decides the way how a container or ro-ro cargo can be positioned in a ship. This plan is done based on the number of cargoes and containers booked in the given period of time. The movement of container and ro-ro cargoes are very different with respect to the structure and design of the ship. But both ships are built to ship the cargoes efficiently in a short time based on the stowage plan that shows which cargoes go first. Though the cargoes are loaded based on the stowage plan, the need for shifting or relocating arises due to intermediate port calls and new cargoes to be loaded. These cargoes may need to be discharged in the later ports hence need to be swapped in the bottom of the ship's bay or layout.

2 Statement of the Problem

The paper focuses on the problem of operating a container ship and ro-ro ships which need to be called in different ports for loading and unloading the containers/cargoes respectively. The problem that needs to be addressed is the efficiency that can be brought in loading and unloading the container in a less period of time. This will help the fleet operator by reducing the port operation time and money spent for terminal charges, berth charges, port dues, etc. Since the shipping industry covers the majority of the global trade with respect to volume any small impact in improving the efficiency will benefit the whole world. Hence the research on this area is very much important for all logistics and supply chain professionals.

There are other small problems that come along with this like number of ports to be handled, based on which they need to stack the containers. The space utilization of the ship is based on the number of containers available. The difference in the size and weight of the container is also important to plan the positioning of these containers in the bay. Sometimes they may need to shift the container from the feeder ship to mother ships which come from a different location. All this shifting work has to be carried out in a rapid manner to achieve better efficiency in shipping operations.

3 Conceptual Stowage Pattern for Container and Ro-Ro Ships

3.1 Containers

The container is unitized equipment that follows global rules for standardizing and tracking cargoes. The container operation has facilitated the multimodal transport business very effectively. It made it very easy to load and unload the goods from road-rail,

rail-sea, and road-sea. These containers are built to withstand severe weather and condition to protect the cargo from any damage. The standard containers are measured as TEU's-Twenty feet equivalent unit with a measurement of 20feet. But the size of the containers may vary with height variation like standard container 8'6" and high-cube container with 9'6" high. The 40 feet and 45feet containers are also used for the cargoes which need more space capacity than the weight capacity. The below figure in Fig. 1 shows the general container size and structure.

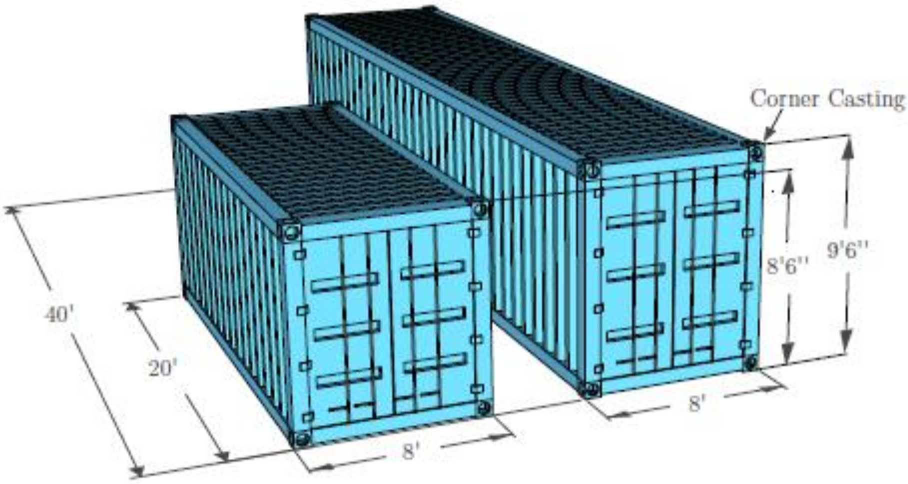


Fig 1. Container size and structure- 20' and 40'ft containers

3.2 Container vessels

The container vessels are built dedicatedly to handle container cargo. The vessel is structured in a cellular layout format, where the containers can be safely stored. The rising demand in the global market and the ease of carrying any type of cargoes in the container has made more shippers send their commodities in containers rather than general cargo. In the early days, the capacity of the ships is very little, but due to the latest technology in the ship construction industry, the number of teus loaded in a single ship has been reached up to 24000teus. This capacity increase has put more pressure on developing an optimum and efficient model of loading and discharge of containers in the port.

3.3 Typical structure of a container Ship

The below pictures shows the typical structure of a ship in which the container is loaded and unloaded vertically. The division in the below figure 2 shows the bay, where the storing of containers is divided and stacked consecutively. These structures are built in a way to hold the containers tightly by lashing. They were stored safely and protected with leak-proof hatch covers. These spaces where the containers are stored under the hatch are called cargo hold. Another container with general cargo which doesn't need weather protection will be loaded on the top of the hatch.

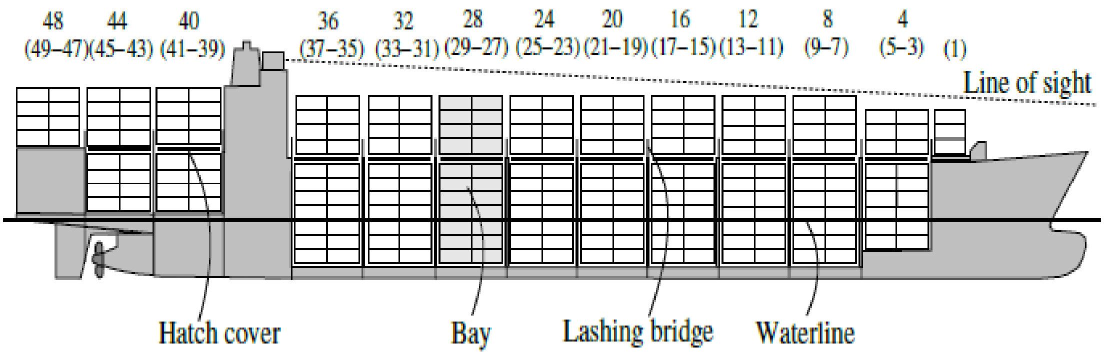


Fig 2. Container ship layout and bay plan for loading and unloading

3.4 RO-RO Ships

The Ro-Ro ship's structure is built in a way to handle cargoes that can roll. This is will be carried over by loading and unloading by means of ramps built on the backside of the ship. This ramp will be used to bridge the ship with a port berth. In ro-ro ships, the cargoes are measured in Lanes in meters to calculate the space occupied by a vehicle or cargo in a given deck of the ship. Some ro-ro ships are built to handle only car/truck cargo; few are designed to handle all types of cargo.

Based on the layout of the container ship and Ro-Ro ship the load and discharge operation will not be the same. For instance, the shifting process and relocating of containers are very often in container ships. Whereas in the ro-ro ship the cargoes can be planned well in advance based on the stowage plan, hence the requirement of relocating is very low compared to containers. But there is a need for designing the efficient layout of ro-ro ships with respect to easy movement of the cargo in and out. Usually, the ro-ro cargoes are driven or rolled inside the ship through a ramp which consumes more time to stack the cargo one by one. With this circular layout, we conceptualize the process of moving and stacking the cargo in a circular pattern to improve the storage utilization and storage process.

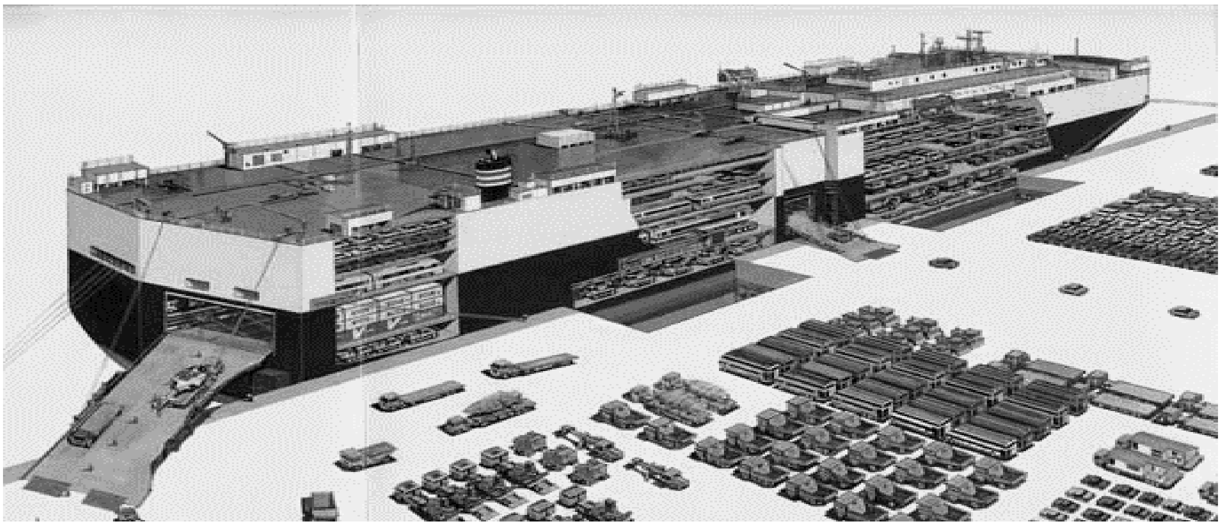


Fig 3. Ro-Ro Ship structure and cargo loading feature through the ramp

4. Square pattern stowage:

The stowage plan is the base for reducing the shifting cost and siding cost of the ship. As it's done quickly cost can be reduced considerably. Rapid shifting completely depends on the stowage plan. Even though so many programs are available conceptually strong plan is required so that storing retrieving containers will not take more shifting costs. This conceptual model will enhance the research on automated storage and retrieval plans in shipping operations.

Here the rectangular pattern is suggested for stowage. This cuboid represents a collection of a number of squares (Z1, Z2, Z3…...Zn), here Z1 is with least priority, and Z2, Z3…...Zn is in the increased manner with Zn with top priority.

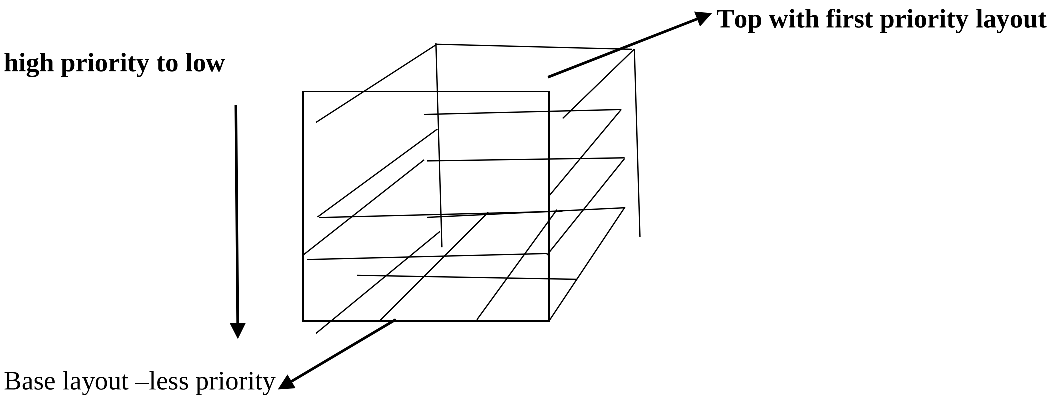


Fig 3. Square pattern stowage concept

4.1 Base square plan

This base square Z1 includes two square patterns: 1st priority lane and 2nd priority lane. Like this Z2, Z3 … Zn all are having two priority lanes.

4.1.1 1st priority lane

This first priority lane consists of corner empty spaces, it enables to adjust containers to retrieve and store at a specific place**.**

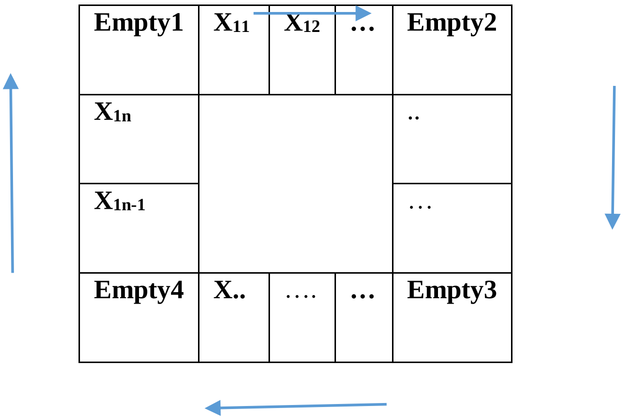


Fig 4. Square pattern stowage concept for 1st priority lane

It is two-part in Z1, the above outer square is part 1 and the below square is the inner part of Z1 with the first cell starting with X11, X12….X1n. there are "n" number of small squares. Here all corners should be kept empty so that, it is possible to adjust the remaining container to retrieve a specific container.

4.2.2 2nd priority lane

Second priority lane squares lie inside all the Z1, Z2…Zn squares. This lane covers containers with the least priority but it is easy to retrieve with the help of 1st priority square patterns empty corner points.

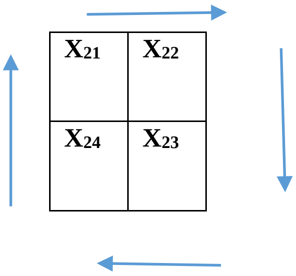
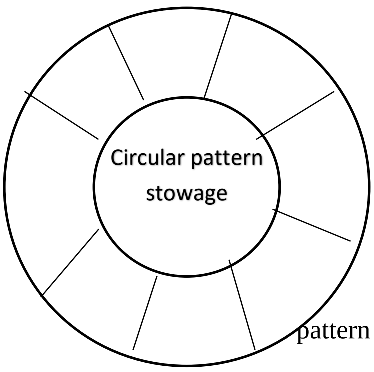


Fig 5. Square pattern stowage concept for 2nd priority lane

5. Circular pattern stowage:

A circular stowage is the extended version of regular where the last load is connected to the first load in the RORO ships. It is a linear storage method, the first and last containers are connected to each other, so easily we can access the container. Thus forming a circle-like structure.it is very easy to access the cargo. But this system has stability and space problem due to that huge gaps between the loads. Hence this model is opting for easy shifting rather than space utilization.



pattern stowage concept

6. Conclusion

The above square and circular pattern for the stowage plan is introduced to create a scope for alternate layout development in the ship building architecture. The square pattern is meant for developing the structure for container ships whereas the circular pattern is meant for developing a structure for RORO ships. This structure can able to give the flexibleness to handle container in container ship and vehicles in the RORO ship by reducing the handling. There are limitations in this concept as the above stowage structures are developed in a generic view. Hence applying the concept to practical ship building needs a lot of structural change in ship structure. Also the concept is developed without considering the stability and space utilization. But this concept can open a platform for developing the ship building industry and bringing scope for automation in cargo handling.

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