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Design of the Hoisting Device for the Module in the Living Cabin of Medium-Sized Cruise Ship

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Abstract

Aiming at the problem of cabin module lifting in the outfitting process of medium-sized cruise ships, a kind of cabin module lifting device is studied and designed. According to the basic requirements of the actual operation and the characteristics of the cabin module, the design idea and theory are put forward. The solid work software is used for modeling, and then the finite element analysis is carried out through the ANSYS Workbench software according to the actual two working conditions to get the calculation results. The calculation results show that the cage can be used for lifting cabin module, and it can be used repeatedly, with low cost, convenience, rapidity, safety and reliability.

Keywords

Cruise ship; Cabin module; Lifting device; Finite element analysis.

1. Introduction

Nowadays, under the concept of high efficiency, energy saving and environmental protection, the shortcomings of traditional shipbuilding methods have gradually emerged, especially in the transformation of China's shipbuilding industry to high-end. How to effectively achieve high efficiency, environmental protection and energy saving is an urgent need for many shipowners to solve problem. With the continuous development of shipbuilding technology, Europe and other countries have made major reforms in the construction of various marine engineering platforms and the living areas of luxury cruise ships, that is, the modular design of living cabins and the pre-bottled of individual cabin units Compared with the traditional integrated construction of living buildings, the pre-boat installation rate is greatly improved. In addition, the safety of the construction process, construction efficiency, and reduction of material consumption are very effective.

Figure 1 Typical accommodation

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The existing transshipment devices for living cabin modules have their own advantages and disadvantages. They use the method of setting lifting ears on the living cabin module and directly hoisting. Since there are many thin-plate components that make up the cruise cabin unit, it is easier to produce under the action of external force. Deformation; using a general cage device, slipping occurs during the hoisting process of the living cabin module, resulting in hidden safety hazards; using a cabin module elevator has little structural damage, but the elevator has a complex structure, high cost, and inconvenient operation. Therefore, the development of the hoisting technology of the living cabin module needs to move in the direction of improving safety, efficiency and low cost. This paper takes medium-sized cruise ships as the research object, and designs a lifting device for repeated use of cabin modules of cruise ships, which can achieve high efficiency, improve safety, and low-cost lifting, perfect for the lifting technology of cabin modules and Engineering application provides technical reference.

2. Basic requirements for modular lifting of accommodation cabins of medium-sized cruise ships

2.1 Brief introduction of typical living cabin module of medium cruise ship

Most of the cabin modules in the residential area of a medium-sized cruise ship have the same size. The typical single room size (4720mm×1825mm) of the living cabin module and the size of the double room (4720mm×2800mm) are basically the same. Therefore, design research can be carried out based on typical cabin modules. As a typical living cabin, modular design and construction can be adopted, professional prefabricated assembly is applied, and the whole is installed on board. A typical living cabin is shown in Figure 1-1. The living cabin includes a living part and a bathroom unit. In addition, the shower part of the bathroom unit is clearly distinguished from other parts.

2.2 Basic requirements for the hoisting of cabin modules of cruise ships

A typical living cabin module must take into account the lifting safety, the complexity and flexibility of the operating conditions, and meet the following requirements:

I. The load carried by the lifting device is at least 2t, (the mass of the single room is 1.4t, the double room the mass is 1.8t). It can ensure the safety during the lifting process.

II. Equipped with detachable railings, not only to ensure the safety of the cabin module, but also when moving during hoisting, the operator can easily move the cabin module.

III. There is an extended traction rope on the lifting device, which is convenient for handling when loading and unloading the living cabin.

IV. The purpose of equipped with a locking device for fixing the metal cage to your side structure of the ship is to cause safety hazards due to displacement in the air during the operation of the suspension cage.

V. When the cabin module is sliding into the cabin, it is necessary to solve the collision damage of the cabin module that may occur due to the height difference between the decks.

VI. The lifting device requires 4-5 workers to reduce working time and manpower.

3. The design scheme of the lifting device of the living cabin module of the medium-sized cruise ship

3.1 Design ideas and theories.

The lifting device designed this time is made up of beam structure welding, which can provide a sufficient safety structure while reducing the weight of the overall device. According to the design requirements, there must be a lifting platform capable of placing cabin modules for loading and unloading cabin modules. In addition, there must be a device that can fix and position the module to prevent slippage during actual operation. At the same time, because of the height difference when docking the cruise deck, it is necessary to design a guide plate to transfer the cabin module. The core

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of this design is how to realize the lifting of the lifting device. Therefore, it borrows from some large-scale engineering lifting cage devices, combines the characteristics of the cruise cabin module, and adds detachable railings to facilitate the loading and unloading of the cabin module and the work of the operators. The supporting structure increases the overall strength of the lifting device and the position of the lifting lug is designed to ensure the lifting stability of the lifting device.

3.2 An integral part of the lifting device.

The lifting device (6020mm×4500mm×3185mm) of the medium-sized cruise ship cabin module is mainly composed of a lifting platform, a lifting frame, a cabin module guide plate, and a cabin module fixing and protection device, as shown in Figure 2.

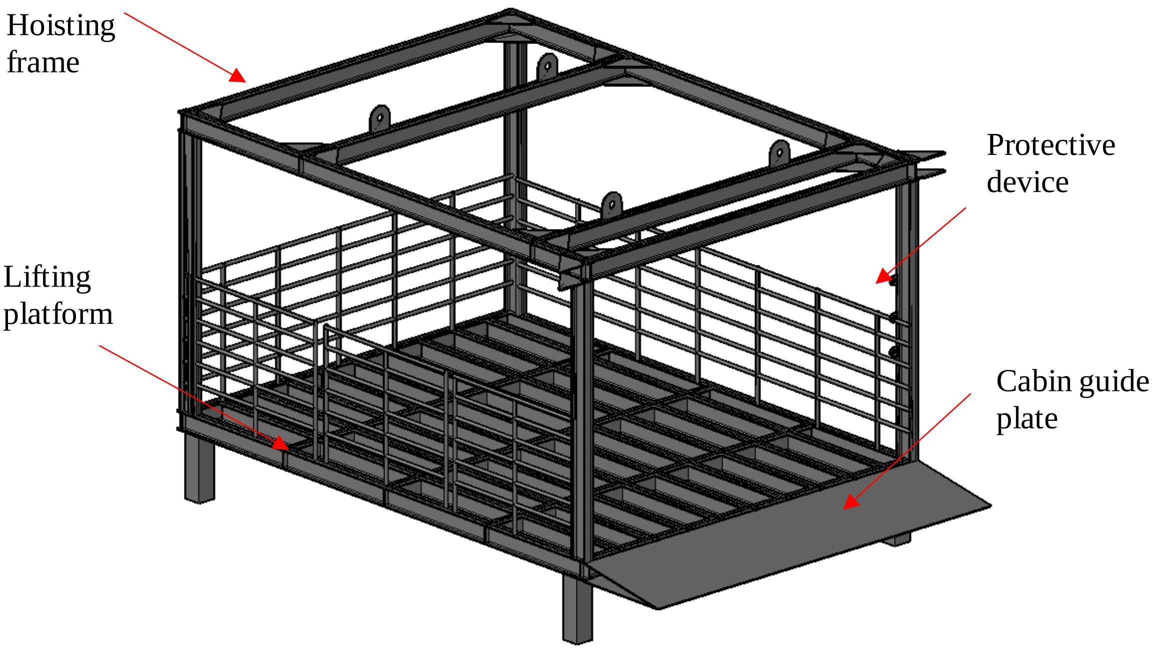

Figure 2 Schematic diagram of the components of the lifting device

3.3 Working principle and steps of lifting device

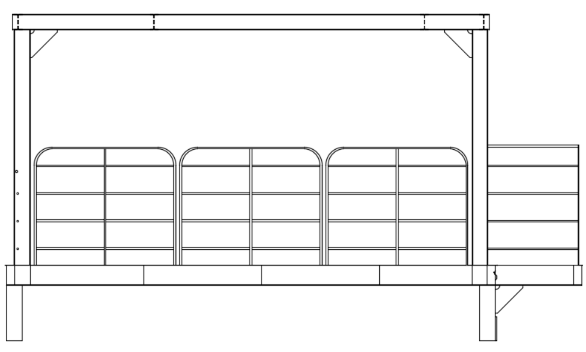

Fig. 3 Loading and unloading diagram of cabin module

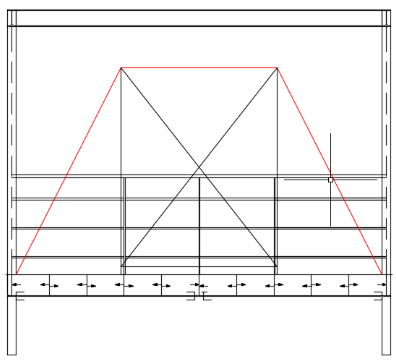

Figure 4 Schematic diagram of cabin module fixation

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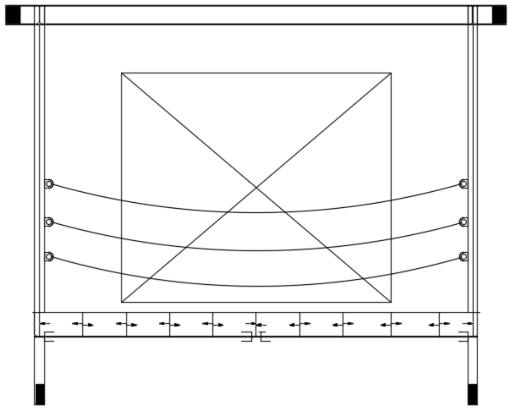

Figure 5 Main view of lifting device

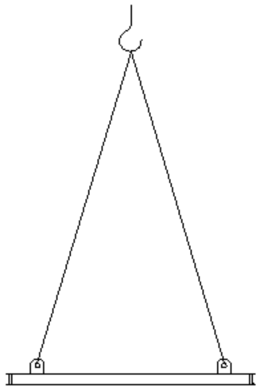

Figure 6 Lifting diagram of lifting device

The lifting device designed in this paper moves the living cabin module from the guide plate at the front end to the lifting platform through the mobile device when working. The operator can enter the platform through the detachable railing on the left to carry out the fixed transfer of the cabin module. , As shown in Figure 3; after the cabin module is transferred to the platform, it is placed on the four corners of the module through the foot pads, which is convenient for transfer and anti-skid, and can also protect the cabin module from collision with the lifting platform. The wire rope is fixed on the lifting device The railing is shown in Figure 4; the front section of the lifting device is designed with a detachable iron chain, and the left side is designed with a detachable railing, which is convenient for the actual operation of the operator, convenient and fast, as shown in Figure 5; finally, the lifting device The four lifting lugs of the two transverse reinforcement structures in the middle of the top of the device realize lifting, as shown in Figure 6.

3.4 Comparative analysis with the same type of lifting device

The traditional hoisting of cabin modules can be divided into two ways: the lifting lugs are provided on the cabin modules and the lifting method is used, or the platform is hoisted with wire ropes.

The lifting lugs are installed in the cabin module by lifting and lifting. The lifting lugs are opened at the top of the cabin module as shown in Figure 7. This method of lifting is because the structure of the cabin module is mostly a thin plate structure, and the lifting The ear, in actual action, will produce uneven force, which will cause uneven force on the upper part of the cabin unit and cause deformation.

Figure 7 Lifting with lifting lug at the top

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The lifting lugs are set at the bottom of the cabin and connected to the lifting row by steel cables, as shown in Figure 8. Usually this method will cause tearing and deformation at the bottom of the cabin module. In addition, the steel cables are left and right during the lifting process. When it swings, it will cause strangulation around the module.

Figure 8 Lifting lug at the bottom

Using the platform to use the steel wire rope hoisting method, as shown in Figure 9, it can be seen that first, the platform is used to place the cabin module on the upper side, a wire rope is fixed to the interruption of the cabin module, and then two slings are used to fix the front and back of the platform. At the end, using the hoisting row to hoist, the wire rope will cause less damage to the cabin module, but this kind of hoisting method has low safety, is prone to slippage, and is difficult to operate.

Figure 9 Lifting with steel wire rope by platform

The new hoisting proposed in this design solves the above traditional hoisting problems very well, is convenient to operate, has higher safety, and provides more comprehensive protection for cabin modules.

4. Strength check

4.1 Build a finite element model

This article first simplified its modeling through CAD software, and then imported it into ANSYS software. Using Soild185 element for modeling, the overall grid size is about 50mm. The number of nodes generated is 210260 and the number of units is 620761. The finite element model is shown in Figure 10.

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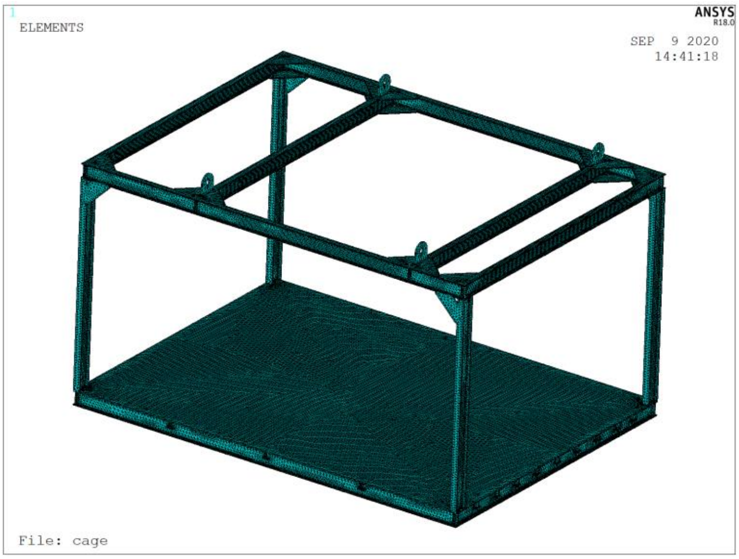

Figure 10 Modeling diagram

4.2 Material properties

Considering factors such as self-weight, strength and stiffness, the tooling material is Q235 material. The mechanical performance parameters of tooling materials are shown in Table

Table 1 Mechanical property parameters of tooling materials

Material	Elastic Modulus /Mpa	Poisson's ratio	Yield strength limit /Mpa
Q235	2.1×105	0.3	235

4.3 Loads and working conditions

4.3.1. No wind lifting conditions

Constraint: In the actual hoisting process, it is set at the position of the hoisting ears to play a complete restraint.

Loading: When there is no wind, the acceleration of gravity is 9810mm/s^2, and the cabin module is 3t (the actual load is 0.3~0.8t, considering the safety, this article uses a 3t load to check). The hoisting platform area is 2.7×10^{7}mm^2, and the surface pressure is 1.1×10-3N/mm^2. The loading diagram is shown in Figure 11

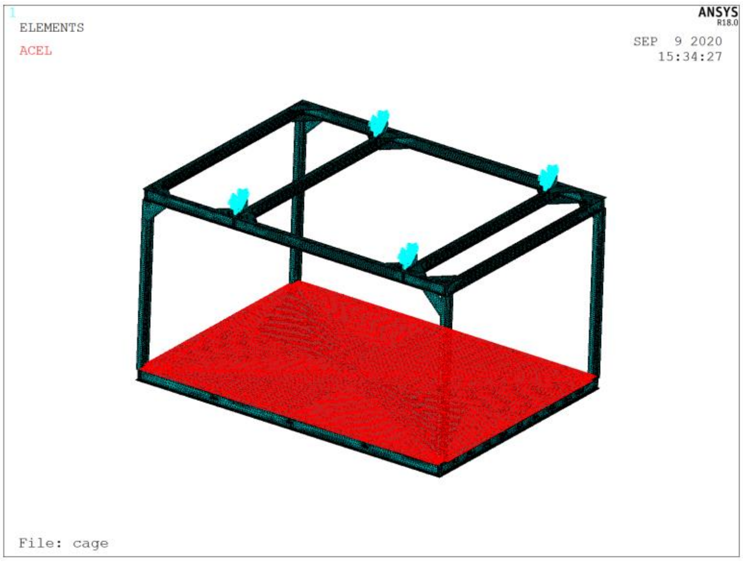

Figure 11 Load setting under windless lifting condition

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4.3.2. Lifting conditions affected by wind

Constraint: In the actual hoisting process, it is set at the position of the hoisting ears to play a complete restraint.

Loading: Set the maximum wind force during the hoisting operation of the cabin to level 5, and the maximum wind speed $V_{\max}$ =10.7m/s

The conversion formula of wind speed and pressure:

$$w_p = v^2 / 1600 \tag{1}$$

Maximum wind speed available $w_p = 7.16 \times 10^{-5} MPa$ Apply wind pressure w_p in the X direction to perform calculations.

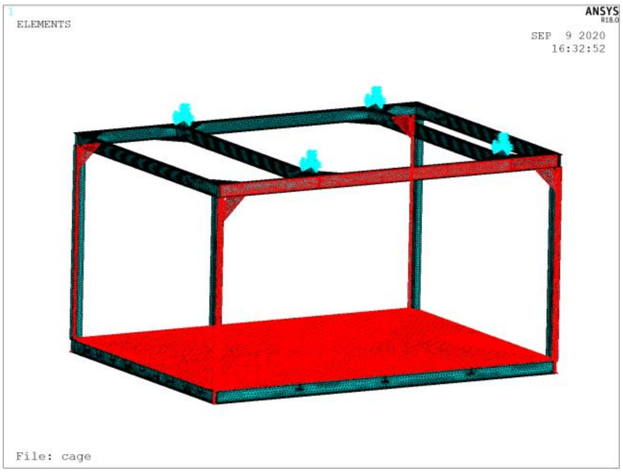

Figure 12 Load setting under windy lifting condition

4.4 Calculation results

4.4.1. No wind lifting conditions

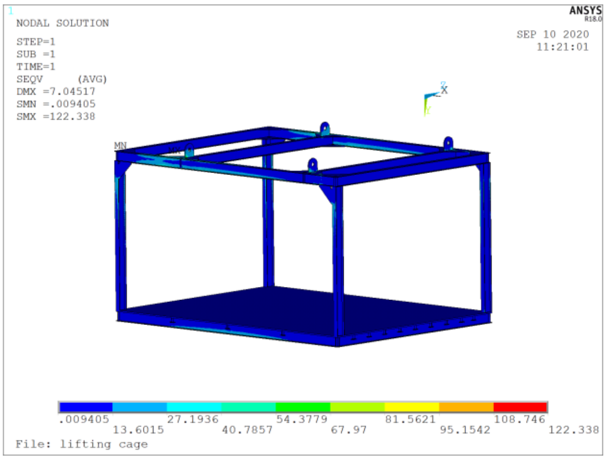

Figure 13 strain diagram of windless lifting condition

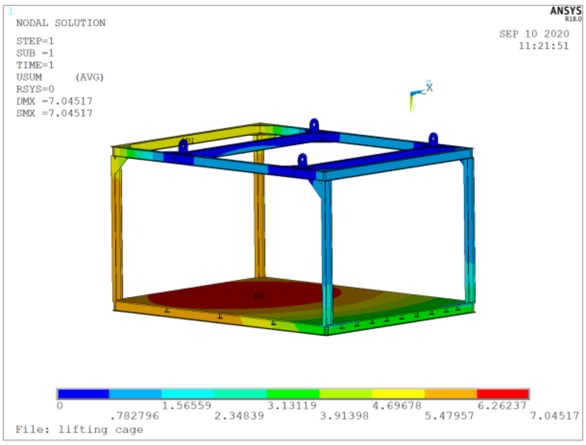

Figure 14 deformation diagram of windless lifting condition

The simulation results of the finite element analysis are shown in Figures 13-14. It can be seen that the maximum composite stress of the overall structure of the lifting device under no wind conditions is 122.38Mpa. According to the "Crane Design Code", the safety factor is 1.48, The allowable stress is 158.748Mpa, the rigidity of the lifting device meets the requirements of static deflection, the effective lifting cantilever length of the lifting device is 3450mm, and the allowable static flexibility $[f_1] = (1/350)/3450 = 9.86mm$. The maximum deformation produced by the hoisting device is 7.045mm, which meets the requirements of working conditions.

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4.4.2. Lifting conditions affected by wind

The simulation results of the finite element analysis are shown in Figures 15-16. It can be seen that the maximum composite stress of the overall structure of the lifting device under wind conditions is 122.4Mpa, and the maximum deformation generated is 7.0448mm, which meets the working conditions demand.

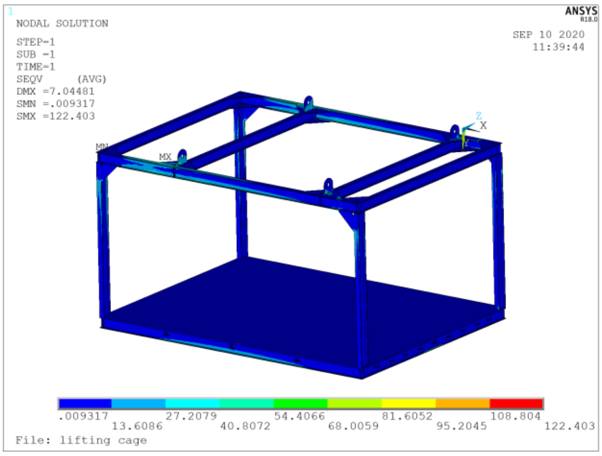

Figure 15 strain diagram under windy lifting condition

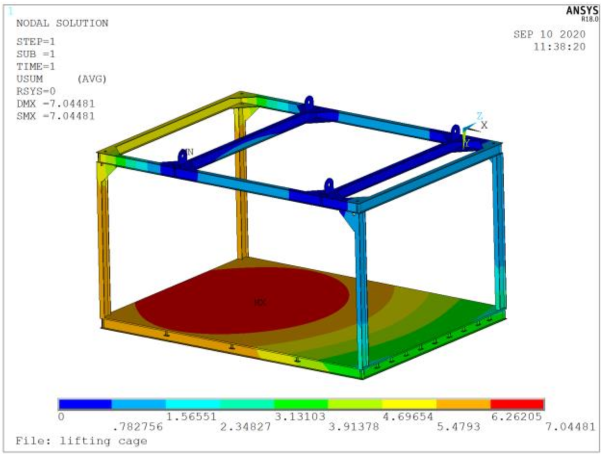

Figure 16 deformation diagram of windy lifting condition

5. Conclusion

This paper takes medium-sized cruise ships as the research object, combines the characteristics of cruise cabin modules and hoisting requirements, in-depth research and proposes a design principle and concept of a living cabin module hoisting device, which is compared with traditional hoisting devices and some foreign shipyards. Based on the reference, a kind of lifting device for living cabin modules suitable for medium-sized cruise ships was designed. Based on some large cages, a guide plate suitable for transfer on the cruise ship deck was designed, and the cabin modules were fixed by wire ropes and The foot pads have detachable guardrails and detachable iron chains that are convenient for workers to operate. The safety, quickness and convenience of the overall device are realized. Finally, the actual operation should mainly consider the lifting under two working conditions, and the finite element analysis of the device. The simulation results show that the strength and rigidity of the device meet the requirements of engineering use, which provides technology for cabin module lifting technology and engineering application.

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