

Research on the Single Floating Off-shore Ship Draft Detection System in Inland Navigation

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Abstract. The waterborne transportation plays more and more important role in the domestic economy. However, shipping ultra-draft issues are becoming a serious problem which will bring unsafe factors and have been affecting the efficiency of inland navigation. Thus, the draft detection are compulsive. In this paper, the single floating off-shore draft detection platform was introduced. Overall composition of the draft detection platform was analysed. Optimization of the detection frame was carried out to release the vortex around the detection frame. The single floating off-shore draft detection platform provides a solution for the draft detection in the narrow channel.

1. Introduction

The waterborne transportation which has advantages of low cost and large volume plays more and more important part in the development of China's economy development. The safety and efficiency of inland navigation, especially in Yangtze River area, is of great importance. However, the number of shipping accidents has been increasing, most of which were caused by exceeding the maximum draught. The accident significantly affects the safety and efficiency of the waterway [1]. Once the super draft happens, the ship may ground in the channel or the ship lock chamber which will bring great danger to the shipping channel.

Draft detection now is undertaken by maritime law enforcement officers through visual inspection. Visual inspection of ship draft is direct but inefficient. In recent years, researchers have been working on the draft detection techniques to improve the waterline inspection of ships [2].

In order to control the ship draft, it is necessary to undertake the draft detection before the ship arrives at the ship lock or the ship elevator.

There are two methods for the draft detection which are the onboard detection and the off-shore detection [3, 4]. There are two ways for the onboard detection technology. one way is to read the water gauge reading manually; the other way is to use some sensor fixed on the ship to get the draft data. This technology is simple and easy to use. However, some ship owners often modify the water gauge by themselves in order to avoid the draft inspection. The off-shore detection technology uses a testing equipment at a distance from the ship to achieve the draft detection. This method does not depend on the ship borne equipment.



In the existing ship draft detection technologies, the fixed off-shore detection system and its supporting structure run on a fixed track which can provide good stability. But the underwater piling must be carried out, so the investment is huge. Besides, a permanent obstruction for the ship will be formed. This method only applies for the shallow waters and will affect the water environment in the long run.

In this paper, an innovative off-shore ship draft detection technology named the single floating draft detection platform was introduced. The principle and the overall composition of the draft detection platform were analyzed. And optimization of the detection frame was carried out. The single floating draft detection platform is suitable for the narrow channel without environment damage.

2. Composition of the draft detection platform

The platform shown in Figure 1 is consisted of a floating platform, a detection frame, elevating mechanisms, an anchor block, anti-swing mechanisms, electrical systems and other ancillary systems. The detection frame is used for the sensor array installation. The hoisting mechanism was designed to apply for different water level. When a certain water is given, the anchor block is adopted to stabilize the platform. Besides, an anti-swing mechanism was put into use to keep the balance condition of the detection frame in the channel. When the detection platform is in use, the detection frame is placed about 7 meters under the water. When the maintenance is needed, the detection frame can be elevated to the water surface.

There are three elevating mechanisms for the vertical columns, two anti-swing mechanisms and an anchor block elevating mechanisms.

The elevating mechanisms is used to control the movement of the vertical columns. And three elevating mechanisms are arranged in the ends and middle of the floating platform. The motor frequency conversion technology was used to control the elevating mechanism. The elevating mechanisms can be controlled to achieve single action and linkage action.

In order to resist the water flow force, two anti-swing mechanisms were used. One end of the wire rope is connected with the horizontal column and the other end is fixed at the vertical columns at two ends of the floating platform. When water flows over the column, one of the anti-swing mechanisms will work. The anchor block is used to realize the movements of the detection frame.

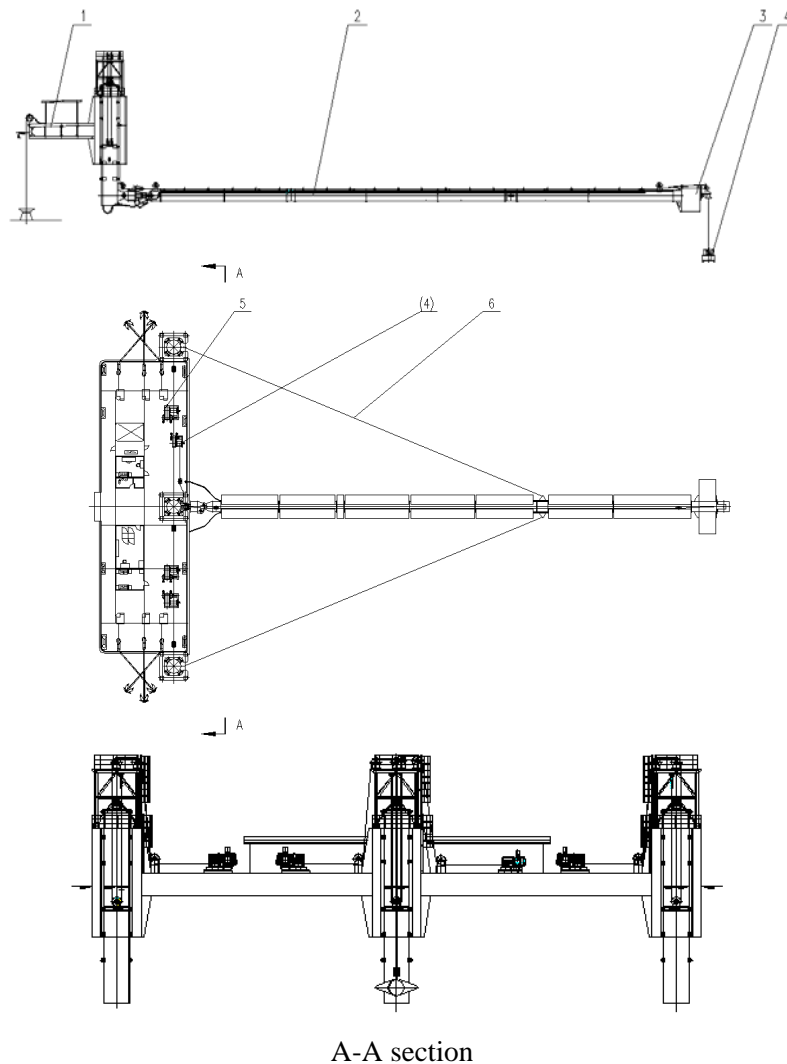


Figure 1. Compositions of the detection platform

1. The floating platform, 2.the detection frame, 3.the anchor block, 4.the lifting device of the anchor block, 5.the lifting device of the column, 6. The anti-swing mechanism.

3. Optimization of the detection frame

The detection frame shown in Figure 2 plays an important part in the draft detection platform. The detection frame provides support for the sensor array installation. The detection frame must be stable in various underwater conditions. Main forces applied to the frame includes the water flow force, weight of the frame, the buoyance and the vortex force.

The detection frame is consisted of the horizontal column, the vertical column, the two-way hinge, rollers, etc. the horizontal column is connected to the middle vertical column via the two-way hinge. In this way, the bending moment and the torque caused by twisting can be released.

The horizontal column and the vertical column are circular pipe structures to reduce the flow resistance.

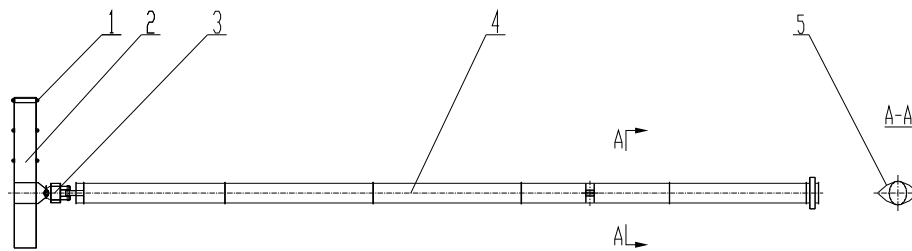


Figure 2. Structure of the detection frame

1. The roller, 2.the vertical column, 3.the two-way hinge, 4. The horizontal column, 5.the guiding plate.

In order to suppress the vortex for the horizontal column, simulations were undertaken to investigate the performance. According to the simulation, the circular pipe structure can cause serious vortex when water flows over the horizontal column shown in Figure 3.

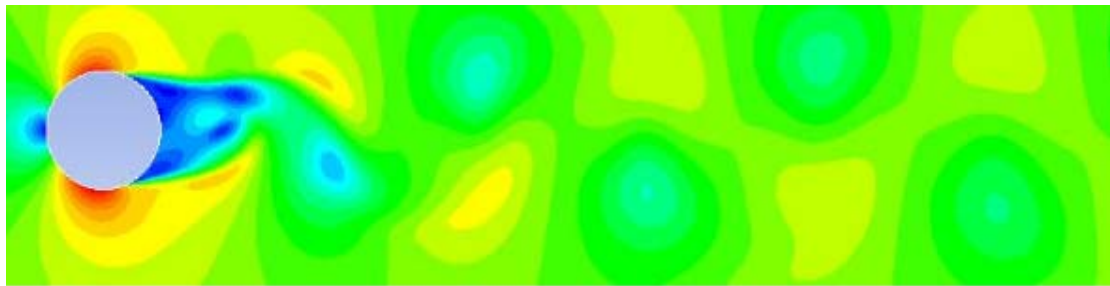


Figure 3. Simulation result of the horizontal column without the guiding plate

The shape optimization for the horizontal column was necessary and further optimization was carried out to reduce the vortex around the horizontal column. The guiding plate shown in Figure 4 was introduced to reduce the vortex [5-7]. And the simulation shown in Figure 5 reveals that the optimized horizontal column can effectively suppress the vortex to keep the column stable under the water.

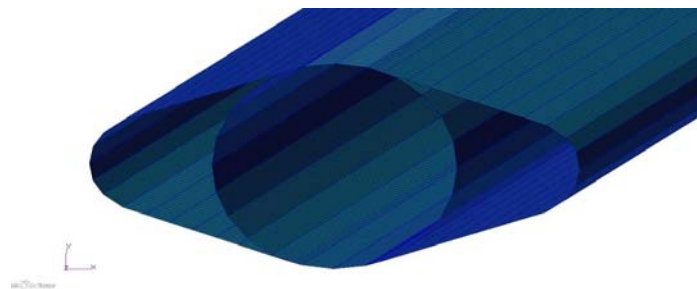


Figure 4. Structure of the horizontal column with the guiding plate

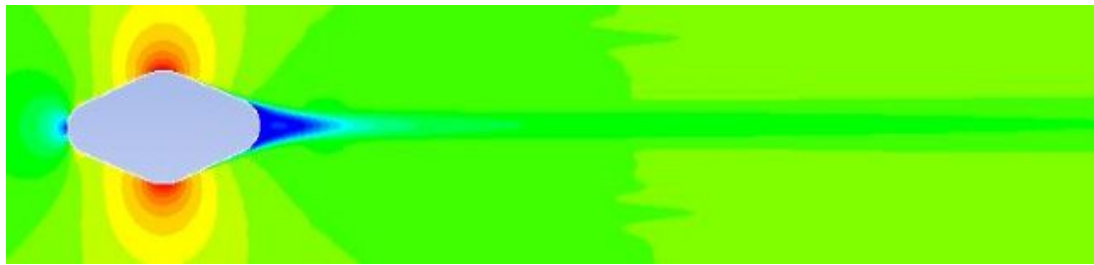


Figure 5. Simulation result of the horizontal column with the guiding plate

4. Conclusion

In this paper, the single floating off-shore ship draft detection platform was introduced. The composition of the draft detection platform was presented. Compared to other ship draft detection systems, this method has the advantages of flexible arrangement, good stabilization and Mobile convenience combined with the structure optimization, end-anchored traction and other technologies. The single floating draft detection platform provides a solution for the draft detection in the narrow channel and there are a good effect and an application prospect.

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