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Research and development of two-claw anchor tensile test support device

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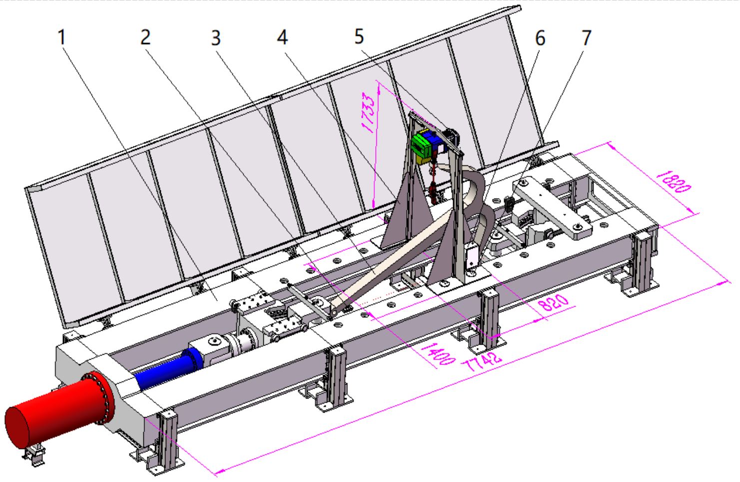
Abstract. In order to realize the mechanical performance test of the two-claw anchor on the basis of the horizontal tensile test bench. According to the anchor test standard of the anchor, a novel test support device has been developed, which can realize the function of on-line real-time measurement for different types of anchors. The detailed dimensions and analysis process of the device are given. Through the finite element analysis and optimization, the support device has the advantages of light weight, low cost, simple structure, and time saving on-line measurement.

1. Introduction

Anchor is an important tool in mooring equipment and is a basic essential element for safe operation of ships. Special two-claw anchors are widely used in small and medium-sized ships for various operations and are critical to the safety of the ship. In response, the state has developed the corresponding test standard "SC/T 8009-2000".According to the requirements of national standards, the tensile test is an experiment that must be carried out before the two-claw anchor is shipped from the factory.

The existing tensile testing methods at home and abroad prefabricate an anchor pit on the ground, hook the anchor claw of the anchor to be tested into the anchor pit, and then apply the required pulling force to the anchor by the tension device. Different anchors need to be prefabricated with different specifications of anchor pits, so the test cost is high. In addition, since the existing equipment cannot measure the distance, the test efficiency is low and the labor intensity is large.

The test support device described herein is a two-claw anchor tensile test support device [1] based on a 200T horizontal tensile test stand. The support device is designed with a simple gantry device to fix the anchor to be tested, and it is fixed to the 200T tensile test stand by pins. By using the designed sensor device and computer to conduct experiments, the distance between the real-time online measurement markers proposed in the experiment was successfully solved to determine whether the anchor was qualified or not [2].And through the finite element analysis [3], in the case of the strength, the height and weight of the device are reasonably reduced, and the manufacturing cost is greatly saved.



1-bedroom tensile test bench;
2-sensor and its fixture;
3-test anchor;
4-gantry;
5-electric hoist;
6-control box;
7-pin

Figure 1. Mode of the device.

2. Structural design and parameters of the support device

The test device can perform tensile load test on the two-claw anchor, which greatly ensures the safety of equipment such as ships. The test load requirements of the object are as follows: two claw anchors weighing 570KG(570 SC/T 8009-2000).The three-dimensional model of the support device is shown in Figure 1.The gantry structure of the device is 1.4 meters long, 0.82 meters wide and 1.773 meters high. The mechanism of the supporting device is mainly divided into a beam welding member and a column welding member, they are made of 45 steel plate and square tube and the welded parts are bolted together.

Figure 2. Picture of the device.

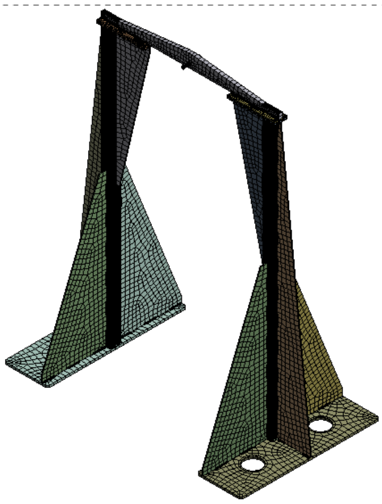


Figure 3. Finite element model.

3. Introduction

The device has been successfully installed and commissioned at the Zhoushan Institute of Quality and Technical Supervision, Calibration and Testing, and is measured by the National Metallurgical Research Institute. The result is that all aspects of performance have reached national first-class standards. The complete support structure is shown in Figure 2.

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4. Structural analysis of the supporting device

4.1. Grid and attributes

Simplifying as much detail or place as possible in the model does not affect the overall stress and the calculation of the actual structure is retained as needed. Then, the simplified SOLIDWORKS model is imported into ANSYS and the model is meshed with hexahedron mesh after geometric cleaning [5].Using the hexahedron element type, 39,518 unit numbers and 238,056 node numbers are obtained. The finite element model is built as shown in Figure 3. The frame material shall be 45 steel, the ultimate strength is 600MPa, the yield limit is 355Mpa, the elastic modulus yield limit is 209Gpa, the Poisson's ratio is 0.369, and the density is 7.89 g/cm^3.

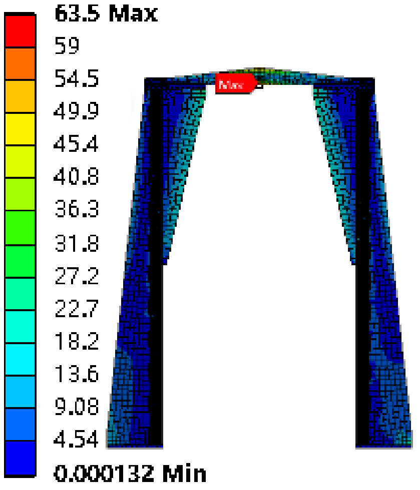

Figure 4. Stress analysis cloud diagram.

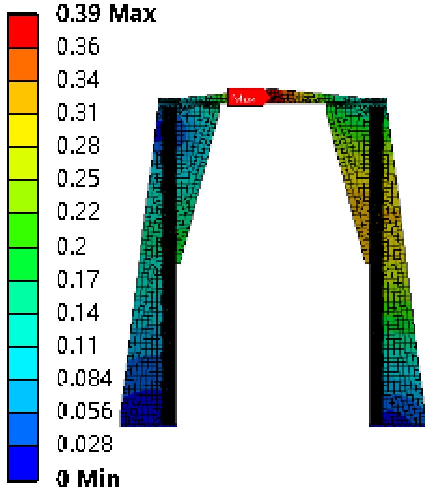

Figure 5. Displacement analysis cloud diagram.

4.2. Load and constraint processing

Combined with Figure 3, the boundary conditions of the applied model relative to the global coordinate system are as follows.

(1)Adding restrictions: adding Y-direction support to the bottom surface of bottom plate of welded parts of the gantry column , and adding fixed constraints around the four pin holes of the bottom plate;

(2)Applying a load: Apply a vertical load of 10000 N on the axis of the center hole of the welded of beam.

4.3. Result analysis

The analysis results are shown in Figure 4 and Figure 5. The reaction stress analysis cloud diagram is shown in Figure 4. The maximum reaction stress is 63.5Mpa, which appears at the lowermost end in the middle of the beam and is smaller than the yield strength of the material. The displacement analysis cloud diagram is shown in Figure 5. The maximum displacement is 0.39mm, which appears at the bottom of the beam and meets the design requirements.

5. Software design for online measurement

The industrial computer of the test support device is programmed in the VB.NET language by using the software Visual Studio. The program communicates the laser rangefinder sensor with the ipc's serial port, reads and displays the value of the measured distance on the window, displays it through the curve, and saves the value as a text document or image. The window of the program is shown in Figure 6.

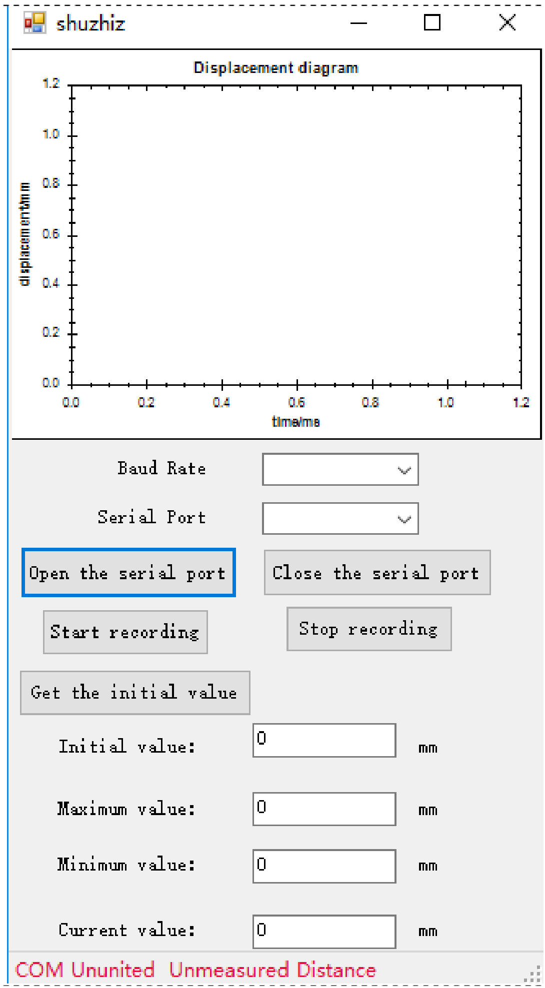

Figure 6. Operation window.

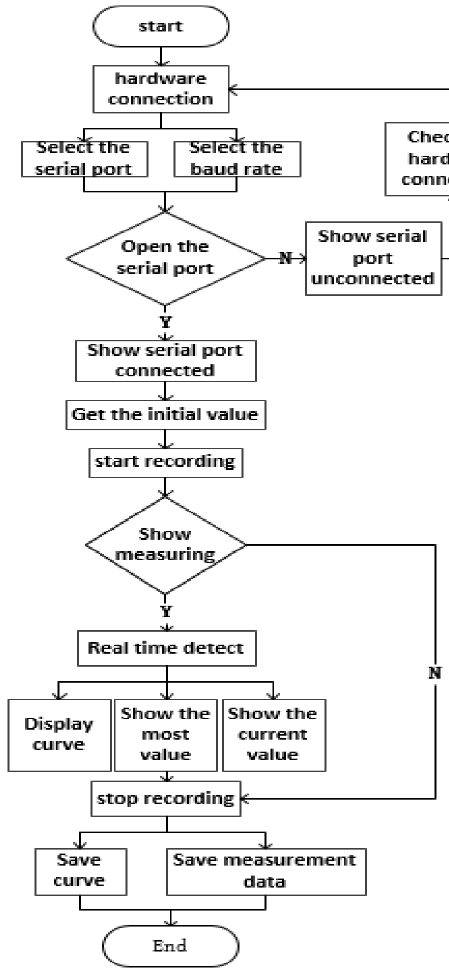

Figure 7. Operation flow chart.

The operation flow is shown in Figure 7. First connect the distance measuring sensor to the computer through the RS232 adapter. Secondly, select the corresponding serial port and baud rate on the operation window. When it is determined to open the serial port, if the serial port is successfully opened, the serial port in the lower left corner is not connected, it will be displayed as the RS232 serial port is connected, indicating that the sensor and the computer successfully communicate, otherwise the serial port is not connected, indicating that the sensor is successfully communicating. Before measuring, first click the Get initial value button, the program accepts the command issued by the sensor, and converts it into hexadecimal, and finally displays the processed value in the initial value window. At the beginning of the measurement, click the button to start recording, the program loops to accept the sensor's command, and performs the hex conversion, and displays the current value in the window; at the same time, the current value is compared with the historical value, and the maximum value and the minimum value are displayed in the window; at the same time, the program reads the displacement and time, draws the time displacement curve, and displays it on the window. After the measurement is finished, click the stop record button, the program saves the measured historical displacement data output as a text format document, and saves the time shift curve.

6. Conclusions

The traditional support device cannot be used for anchors of various specifications, so the device utilization rate is low and the test cost is high. Moreover, the distance between the marked points is manually measured before and after the test, so the test efficiency is low and the labor intensity is large. The test support device designed in the present invention solves the above problems in the prior art, and provides a test machine which is small in size and suitable for ordinary horizontal tension. And the anchor tensile test of different types of anchors is satisfied, the cost of the anchor tensile test is reduced, and the efficiency of the anchor tensile test is improved. Finally, the finite element analysis shows that the structural design of the device meets the design requirements.

Acknowledgments

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