Experimental Study on Bearing Capacity of Water Striders on Water Surface

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Abstract. The paper developed a measuring device which can measure bearing capacity of water striders on the water surface, the measuring range is 1-10000μN, the precision is 0.1μN. The device includes micro force measurement and feed movement control system, electronic balance and control system can communicate with upper computer through RS232C serial. Through testing determination, the smallest linear feed speed of the device is 1 mm/min, which can satisfy the measurement requirements. The experiment measured the maximum bearing capacity of 5 samples of water striders on the water surface, which is 23.6 times its body weight.

Keywords: Bearing Capacity, Micro force measuring, Water Strider

1 Introduction
Super large bearing capacity of water striders on the water surface caused people keen interest, which become a hot topic[1-3]. Many scientists have conducted a mechanical analysis of the super-large bearing capacity of the water striders on the water surface[4-5]. Jiang Lei[6]measured the maximum bearing capacity of water strider’s a single leg, which is 15 times its own weight, but the bearing capacity of the living water strider on the water surface has not been reported at home and abroad. This paper designed a kind of micro force measuring device, measured the maximum bearing capacity of water striders on the water surface.

2 Design of the micro force measuring device
The schematic diagram of the micro-force measuring device is shown in Figure 1.
2.1 Bearing capacity measurement system

The micro force measuring element of the device selects the electronic balance with an accuracy of 0.01 mg. The position of the balance should be stable to avoid vibration, and should be kept away from heat sources, air conditioners and magnetic equipment to prevent the balance from being disturbed and affecting its accuracy. The electronic balance can be connected to the computer through the serial port communication device, which can transfer the measuring data to the computer, and then analyze the data with Excel software, and display the total, average, standard error, maximum and minimum values by the chart.

2.2 Controller system

The control system is composed of the upper microcomputer and the lower computer(S3C2410), two-stage structure can communicate through the serial interface. The upper computer sends an instruction to the S3C2410. After receiving the upper computer command, the S3C2410 completes the corresponding work task and completes the speed signal acquisition during the motion. The hardware structure of the control system is shown in Figure 2.

**Figure 1. Schematic Diagram Of Measuring Device**

The device can measure the bearing capacity of water striders on the water surface, which include the micro force measurement and the control system. The electronic balance can complete measurement task, its accuracy is 0.1μN. The control system is composed of the computer and the amplifying circuit. The AC servo motor can drive the mechanical transmission device, the minimum feed movement speed is 1mm/min. the measurement data of the electronic balance can transfer to the computer, the computer can analyze the measurement data. The computer can also issue commands to control the balance operation, the CCD camera can record the whole test process.

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The control system can achieve speed control. The speed sensor measures actual speed of the AC servo motor, feeds back to the control system[7-8]. The control system compares the actual speed signal with the received upper machine speed command signal, and adjusts the output speed of the servo motor until it reaches the command requirement of the upper computer. The main function of magnetic coupler is to avoid interference.

3 Bearing capacity measurement test
The selected 5 samples of the water strider which was fixed on the steel ruler with double-sided tape[9-10], and then control the living water strider to press the water surface, the process is shown in Figure 3.

| Measurement item          | A1   | A 2  | A 3  | A 4  | A 5  |
|---------------------------|------|------|------|------|------|
| body weight(μN)           | 204.8| 328.3| 364.6| 390.1| 417.5|
| Maximum bearing capacity(μN)| 4502.1| 7736.1| 8101.7| 8377.0| 8736.7|
| Bearing coefficient       | 22.0 | 23.6 | 22.2 | 21.5 | 20.9 |
The maximum bearing capacity of the living water strider sample is shown in Table1, the bearing coefficient is the ratio of the maximum bearing capacity to its body weight, The research found that the maximum bearing coefficient is about 23.6.

4 Conclusion
This paper developed a measuring instrument, which can measure the bearing capacity of the water strider on the water surface, the measuring range is 1-10000μN, the precision is 0.1μN. The experiment measured the maximum carrying capacity of 5 water strider on the water surface, which is 23.6 times its own body weight.

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