



University of
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Hardness Testing

9

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Safety is a state in which hazards and conditions leading to physical, psychological, or material harm are controlled to preserve the health and well-being of individuals and the community.

Before starting the experiment in laboratory, we must follow safety rules:

- 1.** Put on protective clothing like lab coat, a pair of safety glasses and a pair of disposable gloves.
- 2.** Do not taste or sniff chemicals.
- 3.** Rings and jewellery must not be worn.
- 4.** Long and loose hair must be contained.
- 5.** Close fitting / protective clothing must be worn.

Objectives

A variety of tests used to determine material's hardness, we are going to talk about the three main test methods, that are used in this text, Brinell and Vickers test.

MATERIALS :

- steel
- aluminium
- brass
- Personal protective and safety equipment (lab coat).

APPARATUS :

- Hardness test device for Brinell test
- Hardness test device to perform Vickers test

Materials and Apparatus

Experimental procedure

The experiment was performed to determine the hardness of the Steel, Aluminum, and Brass, using two different hardness tests.

We start with Brinell test, using 2.5mm steel ball indenter, following these steps:



1. Load the indenter on the testing device.
2. Start with aluminum specimen, hold the piece on the device and set the load to be equal to 306.5 N.
3. We turned the indicator 3 rotations.
4. (15) seconds later, we looked through the microscope, and find the values for G1 and G2 which the left is (G1) and to the right is (G2), in order to calculate the indentation diameter(d):

$$G1=3*100+19=319\text{mm}$$

$$G2=5*100+0=500\text{mm}$$

5. Then, calculate the indentation diameter(d) as follows: $d = 0.004(G2 - G1) = 0.724\text{mm}$, So, The actual Brinell Hardness number (HBW)

$$* \text{ HBW calculated} = 74.31$$

$$* \text{ HBW from the table} = 74.1$$

6. Repeat the same procedure on the brass specimen, applying 612.9 N force gives us:

$$G1=2*100+32=232\text{mm}$$

$$G2=4*100+4433=433\text{mm}$$

$$d=0.004(G2 - G1) = 0.804\text{mm}$$

$$* \text{ HBW calculated} = 119.86$$

$$* \text{ HBW from the table} = 121$$

7. For steel, the applied force was 1839, following the same steps:

$$G1=2.5*100+41=291\text{mm}$$

$$G2=5*100+2=552\text{mm}$$

$$d=1.044\text{mm}$$

$$* \text{ HBW calculated} = 209.11$$

$$* \text{ HBW from the table} = 208$$

We made the pointer of the device rotate 3 rotations in each test

Test time was 15 seconds.

Experimental procedure

Finally, we went to the Vickers hardness device, to complete our tests.



1. We set the magnification power of the lens at 5x and changed the light to Vickers. The test time was 15 seconds and 3 rotations for the three materials:

aluminum, brass, and steel. When testing brass, the load applied is 612.9 N Steel 1839 N Aluminum 306.5 N In Vickers there are two diameters:

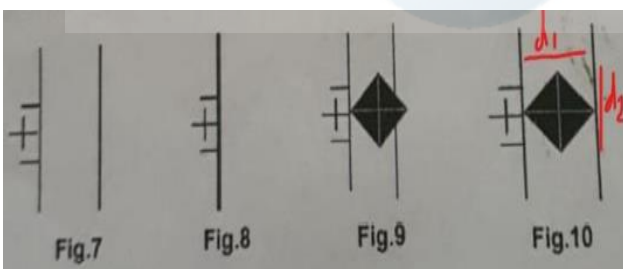
- Aluminum: $d_1 = 40.69 \mu\text{m}$ $d_2 = 40.38 \mu\text{m}$, The Vickers hardness number $HV = 113.1$ (from the table)

- Brass: $d_1 = 30.50 \mu\text{m}$, $d_2 = 29.14 \mu\text{m}$, The Vickers hardness number = 221.4 (from the table)

- Steel: $d_1 = 23.75 \mu\text{m}$ $d_2 = 23.81 \mu\text{m}$ The Vickers hardness number = 376.7 (from the table)

this test uses a diamond indenter, in the form of a right pyramid with a square base and an angle of 136 degrees between opposite faces, which produces a square indentation with two main diagonals, and their average is taken. "The indentation shape shown below"

Note that hardness numbers are unit-less. The Vickers test is more suitable than the Brinell test because the indentation made by the diamond is much smaller than that made in the Brinell test.



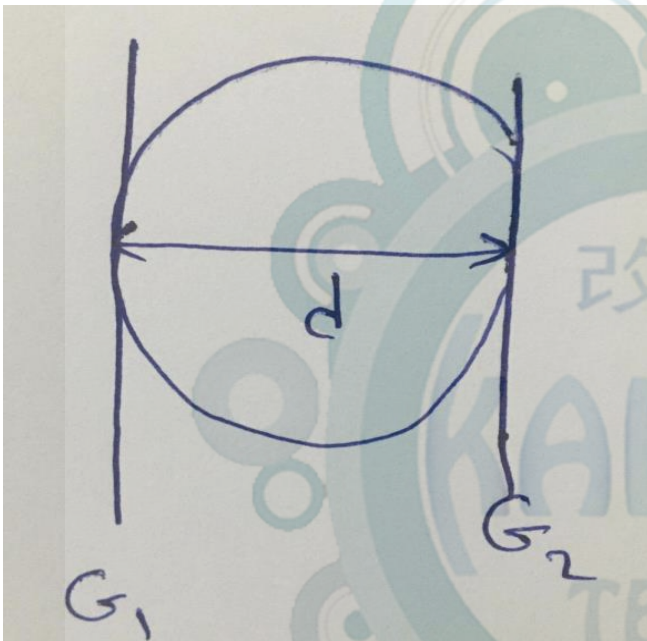
Results and discussion

In this experiment we use two different hardness tests (Brinell and Vickers). We did our tests on three metallic specimens, and we started our experiment with Brinell test followed by Vickers test. In each test, we tested the aluminum specimen, Brass, and Steel respectively the time of each cycle was 15 seconds, with three rotations of the device pointer. *Note that the same settings were applied in each test. *Results:

Brass: HV = 221.4

Steel: HV = 376.7

1) Brinell:

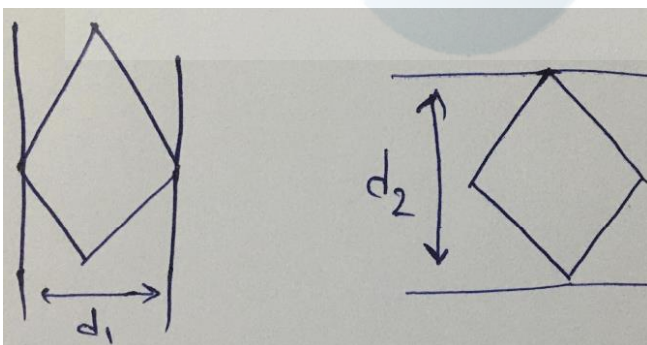


*Al: HBW=74.1

*Brass: HBW=121

*Steel: HBW=208

2) Vickers:



Al: HV = 113.1

Conclusion

In this experiment we focused on measuring the hardness of three metallic specimens (aluminum, steel, and brass), using three main test methods, Brinell, Rockwell, and Vickers. We conclude that neither Aluminum nor Brass is harder than Steel, and this result is strongly supported by the three tests.

References

❖References

- YouTube videos
- The manual
- Notes during the la

