Brinell Hardness Test Report

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Objective

To measure the resistance of a material to plastic deformation by determining its Brinell hardness number (BHN). The experiment was conducted on Aluminium and Nylon specimens.

Important Terminologies

- **Brinell Hardness Number (BHN):** A dimensionless quantity calculated by dividing the applied load by the surface area of the indentation. It is expressed in Brinell hardness units (HB).
- **Hardness:** The measure of resistance to indentation or scratching.
- **Indenter:** A ball or tungsten carbide cone used to create an indentation on the test material.
- **Load:** The force applied to the test material during the Brinell hardness test.

Experimental Procedure

Preparation of the Specimen

The Aluminium and Nylon specimens were cleaned and machined to ensure smooth and flat surfaces, free from any contaminants.

Selection of Load and Indenter

A steel indenter ball with a 10 mm diameter was used. The load was selected based on the material properties, using a 43 kgf force for the experiment, scaled appropriately from the standard 500-3000 kgf.

Machine Setup

The KDom lab apparatus was modified for the experiment by attaching 75 cm long rods to both the top and bottom of the setup, allowing dynamic load application through cylindrical rods.

Indentation

The specimen was positioned under the indenter, and the load was applied dynamically and statically. The load was maintained for a predetermined dwell time to allow for proper indentation.

Measurement of Indentation

The diameter of the indentation was measured using digital vernier calipers, with four measurements taken to obtain an average value.

Calculation of Brinell Hardness Number (BHN)

The Brinell hardness number was calculated using the formula:

$$\text{BHN} = \frac{2P}{\pi D(D - \sqrt{D^2 - d^2})} \tag{1}$$

where P is the applied load, D is the diameter of the indenter, and d is the diameter of the indentation.

Materials Procured

- Aluminium beams (75 cm each) to replace shorter beams in the existing setup.
- 2 Gym weights (20 kgs each).
- Stainless steel plate (to rest the weight).
- Steel rod (to attach the indenter).
- Steel ball (10 mm diameter, used as the indenter).
- Aluminium and Nylon plates (test specimens).

Observations

Dynamic Mode

The 3.4 kg steel plate was dropped onto the specimen from a specific height, but inaccuracies led to the decision to shift to a static approach.

Static Mode

The static approach involved placing the 40 kg gym plates and the 3.4 kg steel plate onto the test specimens, allowing for accurate measurement of the indentation diameter.

Results

- **For Aluminium:** The theoretical Brinell hardness number is 15 HB. The experiment yielded an indentation diameter of 1.7 mm, resulting in an experimental BHN of 18.98 HB (Relative error: 26.53%).
- **For Nylon:** The theoretical Brinell hardness number is 10 HB. The experiment yielded an indentation diameter of 2.5 mm, resulting in an experimental BHN of 8.7 HB (Relative error: 13%).

Sources of Error

- Inaccurate connections between L-clamps, screws, and beams caused structural instability.
- Test specimens were not securely held in place, leading to inaccuracies.
- Microstructural errors in the specimens at the time of manufacturing affected hardness measurements.
- In the dynamic mode, friction between the plate holes and aluminium rods hindered unrestricted load dropping, despite the use of lubricants.

Conclusion

The experiment successfully determined the Brinell hardness numbers for Aluminium and Nylon, although some discrepancies were observed due to various sources of error. The static method proved more reliable than the dynamic approach, providing more consistent and accurate results.

Documentation

All photos and videos related to the experiment have been attached in the following Google Drive link: ME218 SDE