MATERIALS TESTING LABORATORY

FACULTY OF ENGINEERING

CHULALONGKORN UNIVERSITY

Party No. .... Date of tested ....

Name .... Graded by ....

TEST No. S7

BRINELL HARDNESS TEST OF FERROUS METALS

PURPOSE To study the Brinell Hardness Test and to determine the Brinell Hardness Number (BHN) of the steel and the cast iron specimens.

REFERENCE ASTM A370 E10

SPECIMEN Two pieces of steel and cast iron

APPARATUS Brinell hardness test equipment and microscope

Revised by PPS @ May 1998

HARDNESS OF METALS

Hardness is a measurement of resistance of metals to abrasion, cutting, scratching, etc. Brinell hardness test is widely used to determine the resistance to permanent indentation.

BRINELL METHOD

The Brinell test involves pressing a hardened steel ball into a test specimen. In accordance with the ASTM Specifications, the provisions of which are followed herein, it is customary to use a 10-mm dia. ball and a load of 3,000 kg for hard metals, 1,500 kg for metals of intermediate hardness, and 500 kg for soft materials. In the standard test, the full load is applied for a minimum of 15 seconds for ferrous metals and 30 seconds for softer metals, after which interval the load is released and the diameter of the indentation is measured to the nearest 0.02 mm with a microscope.

The Brinell Hardness Number, BHN is nominally the pressure per unit area, in kilogram per square millimeter, of the indentation that remains after the load is removed. It is obtained by dividing the applied load by the area of the surface of the indentation, witch is assumed to be spherical.

Brinell Hardness Number, BHN = Load on Ball / Indented area

$$= P / (0.5 \pi D (D - \sqrt{(D^2 - d^2)})) \qquad (1)$$

where d, D = diameter of indentation and ball respectively, mm

P = ball load, kg

Estimated tensile strength of steel specimen = 510 x BHN psi or (2.a)

= 36 x BHN ksc (2.b)

PROCEDURE

1. The distance from the center of indentation to the edge of the specimen or to the center of the adjacent indentations should be greater than 2.5 times the diameter of indentation. The thickness of the specimen is to be at least 10 times the depth of indentation.

2. The full load is applied continuously for 30 seconds for the steel, after which interval the load is released.

3. Measure the diameter of indentation to the nearest 0.02 mm with the microscope. The diameter is taking as the average of two readings taken at right angles to each other.

4. Make at least five determinations for each kind of specimen.

DATA

Diameter of the hardened steel ball, D = ... mm

Steel Specimen

Indentation No.	Load, P (kg)	Dia. of Indentation, d (mm)	Area of Indentation (mm^2)	BHN (kg/sq. mm)

Cast Iron

Indentation No.	Load, P (kg)	Dia. of Indentation, d (mm)	Area of Indentation (mm^2)	BHN (kg/sq. mm)

SAMPLE OF CALCULATION

Specimen No. ....

Brinell Hardness Number, BHN = $P / (0.5\pi D(D - \sqrt{(D^2 - d^2)}))$

= ....

= .... kg/sq. mm

Estimated tensile strength of steel = 510 x BHN

= ....

= .... psi

= 36 x BHN

= ....

= .... ksc

RESULTS

Average Brinell Hardness Number of steel = ... kg./sq. mm

Average Brinell Hardness Number of Cast Iron = ... kg./sq. mm

Estimated tensile strength of steel = ... psi

= .... ksc

DISCUSSION AND CONCLUSIONS

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TEST No. T6

HARDNESS TEST OF WOOD

PURPOSE	To determine the hardness of wood
REFERENCES	ASTM
SPECIMEN	Clear wood 5 x 5 x 15 cm size
APPARATUS	A universal testing machine and wood hardness test equipment

Revised by PPS @ May 1998

HARDNESS OF WOOD

Hardness of wood is a measure of its resistance to indentation, The standard hardness test, made to determine the resistance of wood to indentation by a steel punch or ball, is of value for comparative purpose only. There is little or no consistent difference between the hardness of the radial and tangential surfaces, but end hardness generally exceeds that determined from the sides of the place. For this reason, wood products in which hardness is the governing factor, such as paving blocks, are so used that the end grain is exposed to service loads. The hardness tool consists of a punch with a hardness steel hemispherical end having a diameter of 1.13 cm and giving a projected area of 1 sq. cm. The load required to imbed the ball to one-half its diameter is the measure of hardness of wood.

PROCEDURE

1. Fit the hardness tool into the movable head of the testing machine.

2. Weigh the specimen to the nearest gram. Place the specimen on the platform of the testing machine.

3. The load is applied through the ball continuously throughout the test at a speed of movable cross head of 8 mm per minute.

4. Record the load at which the ball has penetrated to one half its diameter by tightening of the collar against the specimen.

5. Make two penetrations on tangential surface and also on radial surface and one penetration one each end. The penetration shall be far enough from the edge to prevent splitting.

DATA AND RESULTS

Specimen	Weight (gm)	Penetration Load (kg)					
		Tangential		Radial		End	
		1	2	1	2	1	2

DISCUSSION AND CONCLUSIONS

MATERIALS TESTING LABORATORY

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Party No. .... Date of tested ....

Name .... Graded by ....

TEST No. T11

TEST OF TIMBER BOLTED JOINT (LOAD PARALLELED TO GRAIN)

PURPOSE To study the behavior of bolted joints when the load is applied paralleled to the grain in compression and to determine

1. Load at Proportional Limit
2. Bearing stress at Proportional Limit of the timber specimen
3. Indicated load at first relaxation
4. Maximum load observed at a total slip of 15 mm
5. Type of joint failure

REFERENCE ASTM D1761

SPECIMEN Clear wood 5 x 10 x 40 cm, bolts and two metal splice plates

APPARATUS A testing machine with a load range of about 5,000 kg and two dial gages with accuracy of 0.01 mm

Revised by PPS @ May 1998

PROCEDURE

1. Measure thickness and width of the specimen to 0.1 mm and weigh it to the nearest 0.1 gm.

2. Record size of the bolt and diameter of the bolt hole (usually 1/8 inches greater than blot diameter). Bearing plates or washers should be used and the bolt should not be tightly drawn.

3. The bolted joint shall be tested paralleled to the grain of wood in compression. Use the spherical bearing block in applying the load. Gages are attached on both sides to measure the slip of the joint.

4. Apply an initial load of 100 kg and set the dial gages to read zero. Mark a point 15 mm from the edge of the splice plate.

5. Apply the load continuously throughout the test at a rate of motion of the movable cross head of 0.8 mm per minute.

6. Take readings of the applied load and the corresponding slip with the load increment of 100 kg up to the first relaxation of the load indicated on the testing machine. Report this indicated load.

7. Continue the test until a total slip of 15 mm is reached and record the maximum load observed. Note and sketch the kind of failure of the joint.

8. Plot the load-slip curve with the applied load as the ordinate and the slip as abscissa. Determine the load at the proportional limit and the bearing stress at the proportional limit.

DATA

	Specimen No. 1	Specimen No. 2	Specimen No. 3	Specimen No. 4
Thickness of specimen (cm)	....	....	....	....
Width of specimen (cm)	....	....	....	....
Thickness of splice plate (cm)	....	....	....	....
Diameter of bolt (cm)	....	....	....	....
Diameter of bolt hole (cm)	....	....	....	....
Load at first relaxation (kg)	....	....	....	....
Max. load observed at 15 mm slip (kg)	....	....	....	....

Table for joint slip (mm) for Specimen No. ....

Load (kg)	Gage No. 1 (mm)	Gage No. 2 (mm)	Average (mm)

Sketch of Joint Failure

Table for joint slip (mm) for Specimen No. ....

Load (kg)	Gage No. 1 (mm)	Gage No. 2 (mm)	Average (mm)

Sketch of Joint Failure

SAMPLE OF CALCULATION

Specimen No. ....

Load at the Proportional Limit, P_{PL}	=	....	kg
Length of bolt in wood specimen, L	=	....	cm
Diameter of bolt, d	=	....	cm
Bearing stress at PL	=	P_{PL} / (L d)	
	=	....	ksc

SUMMARY OF RESULTS

	Specimen No. 1	Specimen No. 2	Specimen No. 3	Specimen No. 4
Load at PL (kg)	....	....	....	....
Bearing stress at PL (ksc)	....	....	....	....
Indicated load at first relaxation (kg)	....	....	....	....
Load observed at 15 mm slip (kg)	....	....	....	....

DISCUSSION AND CONCLUSIONS