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**ASSIGN
BUSTER**

UNIVERSITI TUN HUSSEIN ONN MALAYSIA Faculty of Mechanical and
Manufacturing Engineering

_____ COURSE

INFORMATION COURSE TITLE: ENGINEERING LABORATORY III (BDA 27101)

TOPIC 1: TENSILE TEST 1. INTRODUCTION The tensile experiment is the most common mechanical test that reveals several important mechanical properties, such as: modulus of elasticity, yield strength, ultimate tensile strength, ductility, and toughness. The material to be tested is formed into a shape suitable for gripping in the testing machine, and then pulled at constant rate until it fractures.

The tensile instrument elongates the specimen at a constant rate and has devices to continuously measure and record the applied load and elongation of the specimen. During the stretching of the specimen, changes occur in its physical dimensions and its mechanical properties. The ability to predict the loads that will cause a part to fail depends upon both material properties and the part geometry. This experiment involves testing to determine the relative properties.

2. OBJECTIVES 1. To understand the principles of tensile testing machine. 2.

To observe the stress-strain relationship for several standard materials by performing a tensile test. 3. To obtain approximate values from stress-stain curve such as percentage of elongation, Yield Strength; Tensile Strength and Modulus of Elasticity, E. 3. LEARNING OUTCOMES At the end of this experiment, students should be able to: 1. Conduct experiment and identify the dependent and independent variables.

2. Record, tabulate and analyze the raw data. 3. Indicate the important parameters such as yield strength, elastic, plastic region, maximum load, failure load and explain each parameter. . Determine the modulus of elasticity for each specimen.

5. Understand the stress-strain relationship for several standard materials by performing a tensile test and tensile properties from a stress strain curve.

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Manufacturing Engineering 4. THEORY A tensile test, also known as tension test, is probably the most fundamental type of mechanical test that can be performed on material. Tensile tests are simple, relatively inexpensive, and fully standardized.

By pulling on something, you will very quickly determine how the material will react to forces being applied in tension. As the material is being pulled, you will find its strength along with how much it will elongate. You can learn a lot about a material from tensile testing. As you continue to pull on the material until it breaks, a good, complete tensile profile will be obtained. A curve showing how it reacted to the forces being applied is produced. The point of failure is typically called its “ Ultimate Strength” or UTS on the chart.

For most tensile testing of materials, you will notice that in the initial portion of the test, the relationship between the applied force, and load, and the elongation the specimen exhibits is linear. In this linear region, the line obeys the relationship defined as “ Hooke’s Law” where the ratio of stress to strain is a constant, or $E = \frac{\sigma}{\epsilon}$. E is the slope of the line in this region where stress (σ) is proportional to strain (ϵ) and is called the “ Modulus of Elasticity” or “

Young's Modulus". BDA27101-Edition III/2011 2 UNIVERSITI TUN HUSSEIN ONN MALAYSIA Faculty of Mechanical and Manufacturing Engineering 6. APPARATUS Figure 1: Universal Testing Machine GT-7001-LS10, Tensile Specimen & Vernier Caliper 7.

PROCEDURES In order to obtain uniform and accurate results, it is important that all tests have to be conducted under standard conditions. The American Standard for Testing and Materials (ASTM) has set up standards, which should be followed. The standard method of mechanical testing is specified by ASTM E-8M for metals. Identify the material of each specimen used.

1. Record and measure the specimen parameter such as: diameter; and the gauge length. Fill up Table 1 as d1 and l1. BDA27101-Edition III/2011 4 UNIVERSITI TUN HUSSEIN ONN MALAYSIA Faculty of Mechanical and Manufacturing Engineering 2.

Mount the specimen in the testing machine, figure 1 and test the specimen to fracture (the lab technician and/or your lab instructor will help with the right procedure). 3. Test data will be saved in readable file format and given to your instructor. Arrange with your instructor to get these test data files. 4. When the specimen is removed from the instrument determine all parameters that you have measured earlier and Fill up Table 2 as d2 and l2 .

. Once you have completed the test on all specimens, calculate the percentage of elongation and area of reduction 6. Draw the stress versus strain curve for each specimen and determine the ultimate tensile strength, yield strength and the Young's Modulus for each specimen. In all cases, be sure to write your observations for each test. You need to include these

observations in your report. The general stress strain curve for a typical metal is shown in Figure 2 with all the important properties that can be directly measured.

Figure 2: A schematic stress strain curve for a metallic alloy 8. RESULTS Measure and fill up Table 1 and Table 2 Table 1: Parameter of specimen before testing Shaft Diameter, d_1 (mm) 1 2 3 Average Aluminium Mild Steel BDA27101-Edition III/2011 5 Gauge length, l_1 (mm) 1 2 3 Average UNIVERSITI TUN HUSSEIN ONN MALAYSIA Faculty of Mechanical and Manufacturing Engineering Table 2: Parameter of specimen after testing Shaft Diameter, d_1 (mm) 1 2 3 Average Gauge length, l_1 (mm) 1 2 3 Average Aluminium Mild Steel 9. OBSERVATIONS COURSE INFORMATION COURSE TITLE: ENGINEERING LABORATORY III (BDA 27101) TOPIC 2: TORSION TEST 1. INTRODUCTION Torsion tests allow direct measurement of the shear modulus (G) of a material.

This ability makes torsion testing, although not as common, a useful partner for tensile testing in determining the mechanical properties of a material. There are two kinds of torsion experiments: torque control and angular speed control. Torque control experiments apply a uniformly increasing torque to the specimen and the amount of strain is measured as an angle through which the specimen has turned. Angular speed control turns the specimen at a specific angular speed while the torque is measured.

Angular speed control is the type of experiment we will be doing, thus the directly measured quantity in this experiment will be torque. Young's modulus (E) is related to the shear modulus and finding E with the

experimentally obtained G reinforces this relationship; they are dependent upon one another according to the equation: Where, ν is Poisson's ratio. 2.

OBJECTIVES The main objective of this experiment is to determine the elastic and yield behavior of material when subjected by torque load. 3.

LEARNING OUTCOMES At the end of this experiment, students should be able to: 1. 2. 3. 4. 5. Conduct experiment, record, tabulate and analyze the raw data.

Plot the graph of Twisting angle versus Load torque (N. m). Determine the modulus of rigidity for each specimen Compare the value of modulus of rigidity from experiment with the theory Produce good conclusion from the experiment conducted. BDA27101-Edition III/2011 11UNIVERSITI TUN

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4. THEORY

When a circular shaft is twisted at either end, with no other forces acting upon it, the bar is said to be in pure torsion.

If we let the left-hand end of the shaft remain fixed, then the right-hand end the bar will rotate through an angle () with respect to the left end . See Figure 1 Figure 1 Simultaneously, a longitudinal line on the surface of the bar, such as line nn , will rotate through a small angle with respect to the position nn' . Because of this rotation, a rectangular element on the surface of the bar, such as the element shown in the figure between two cross sections distance dx apart, is distorted. This element is shown again in Figure 2, isolated from the remainder of the bar. Figure 2 During torsion, the

right-hand cross section of the original configuration of the element (abcd) rotates with respect to the opposite face and points b and d move to b' and d', respectively.

The lengths of the sides of the element do not change during this rotation, but the angles at the corners are no longer 90°. Thus, the element is undergoing pure shear and the magnitude of the shear strain is equal to the decrease in the angle bac. BDA27101-Edition III/2011 12 UNIVERSITI TUN HUSSEIN ONN MALAYSIA Faculty of Mechanical and Manufacturing Engineering

This angle is Note: $\tan \theta$ is small. θ is approximately equal to $\tan \theta$ because under pure torsion the angle θ (The distance bb' is the length of a small arc of radius r subtended by the angle θ , which is the angle of rotation of one cross section with respect to the other. Thus, $bb' = r \theta$).

Also, the distance ab is equal to the length of the element, dx . Substituting these expressions into the preceding equation, we have Under pure torsion, the rate of change $d\theta/dx$ of the angle of twist are constant along the length of the bar. This constant is equal to the angle of twist per unit length. Thus, $d\theta/dx = \theta/L$, where L is the length of the shaft.

Then, we have Now, observe that for linear elastic material, the magnitude of the shear stress, τ (shown in Figure 1) is. $\tau = G\theta r$ From here we can establish the relationship between the applied torque T and the angle of twist which it produces. The resultant of the shear stresses shown in Figure 3, below, must be statically equivalent to the total torque T . The shear force

acting on an element of area dA (shown shaded in the figure) is dA , and the moment of this force is also equal to $G\theta^2 dA$. The total torque T is the summation over the entire cross-sectional area of these elemental moments; Thus, where J is equal to the polar moment of inertia of the circular cross section

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Figure 3

Thus, we have (Note that GJ is called the torsional rigidity of the shaft.

) Finally, since the total angle of twist is equal to L , we have that This is the result we want. The experiment you are about to perform will yield data on the torque T and the angle from which we can calculate G , the shear modulus, given the dimensions of the shaft. Important to note that for a solid circular shaft of uniform radius: 5. ADDITIONAL THEORY

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TOPIC 3: SHEAR FORCE OF A BEAM 1. INTRODUCTION This guides describes how to set up and perform Shear Force in a Beam experiments. It clearly demonstrates the principles involved and gives practical support to your studies. Figure 1 shows the Shear Force in a Beam experiment. It consists of a beam which is ' cut'.

To stop the beam collapsing a mechanism, (which allows movement in the shear direction only) bridges the cut on to a load cell thus reacting (and measuring) the shear force. A digital display shows the force from the load cell. A diagram on the left-hand support of the beam shows the beam geometry and hanger positions. Hanger supports are 20mm apart, and have a central groove which positions the hangers. Figure 1: Shear Force In A Beam Experiments. BDA27101-Edition III/2011 22 UNIVERSITI TUN HUSSEIN ONN MALAYSIA Faculty of Mechanical and Manufacturing Engineering 2.

OBJECTIVES The objectives of this experiment are as follows: 1. To comprehend the action of shear in a beam. 2. To measure the shearing force at a normal section of a loaded beam and to check its agreement with theory. 3.

LEARNING OUTCOMES At the end of this experiment, students should be able to: 1. 2. 3. 4. 5. Conduct experiment and identify the dependent and independent variables.

Record, tabulate and analyze the raw data. To draw shear diagram. Compare the theoretical and experimental result Produce good conclusion from the experiment conducted. 4. **THEORY** Beams are defined as structural members supporting loads at various points along the member.

Transverse loadings of beams are classified as concentrated loads or distributed loads. One of the main concerns that should be put into consideration when designing beams for strength is how the material and the cross section of a beam of a given selected span should be selected if the beam is not to fail under a given loading. Applied loads result in internal

forces consisting of a shear force (from the shear stress distribution) and a bending moment (from the normal stress distribution). For prismatic beam, that is straight beam with a uniform cross section; their design depends primarily upon the determination of the largest value of the bending moment and shear force created in the beam by a given loading. The determination of these values and of the critical sections of the beam in which they occur is greatly facilitated by drawing a shear force diagram and bending moment diagram. The variation of the shear force V (N) and the bending moment M (Nm) along the beam may be investigated from these diagrams.

The values of V and M at various points may be obtained either by drawing free body diagram of successive portions of the beam or from relationship that involves the applied load, shear force and bending moment.

Determination of the maximum normal stress (σ_{max}) and maximum shearing stress (τ_{ax}) requires identification of maximum internal shear force and bending moment. Shear force and bending moment at a point are determined by passing a section through the beam and applying an equilibrium analysis on the beam portions on either side of the section as shown in Figure 2 and 3. Sign conventions for shear forces V and V' and bending couples M and M'

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Figure 2:
Beam section at point C (at distance x from left end A) Figure 3: Internal forces (positive shear and positive bending moment) 5.

ADDITIONAL THEORY Before setting up and using the equipment, always: ? ? ? ? Visually inspect all parts, including electrical leads, for damage or wear. Check electrical connections are correct and secure. Check all components are secured correctly and fastenings are sufficiently tight. Position the Test Frame safely.

Make sure it is mounted on a solid, level surface, is steady, and easily accessible. Note: Never apply excessive loads to any part of the equipments. If the meter is only ? 0. 1 N, lightly tap the frame (there may be a little 'stiction' and this should overcome it).

7. PROCEDURES 6. 1 Experiments 1: Shear Force Variation with an Increasing Point Load Figure 5: Force Diagram. The equation we will use in this experiment is: Shear force at cut, = Where a is the distance to the load (not the cut) Distance a = 260mm You may find the following table useful in converting the masses used in the experiment to loads.

Table 1: Grams to Newton's Conversion Table

Mass (Grams)	100	200	300	400	500
Load (Newton)	0. 98	1. 96	2. 94	3. 92	4. 90

90 26 UNIVERSITI TUN HUSSEIN ONN MALAYSIA Faculty of Mechanical and Manufacturing Engineering

Step 1 to 4 of the following instructions may already have been completed for you. 1. Place an assembled Test Frame (refer to the separate instructions supplied with the Test Frame if necessary) on a workbench. Make sure the ' window' of the Test Frame is easily accessible. 2. There are four securing nuts in the top member of the frame.

Slide them to approximately the positions shown in figure 5. 3. With the right-hand end of the experiment resting on the bottom member of the Test Frame, fit the left-hand support to the top member of the frame. Push the support on to the frame to ensure that the internal bars are sitting on the frame squarely. Tighten the support in position by screwing two of the thumbscrews provided into the securing nuts (on the front of the support only).

4. Lift the right-hand support into a position and locate the two remaining thumbscrews into the securing nuts. Push the support on to the frame to ensure the internal bars are sitting on the frame squarely. Position the support horizontally so the rolling pivot is in the middle of its travel. Tighten the thumbscrews. 5.

Make sure the Digital Force Display is 'on'. Connect the mini DIN lead from 'Force Input 1' on the Digital Force display to the socket marked 'Force Output' on the left-hand support of the experiment. Ensure the lead does not touch the beam. 6. Carefully zero the force meter using the dial on the left-hand beam of the experiments.

Gently apply a small load with a finger to the centre of the beam and release. Zero the meter again if necessary. Repeat to ensure the meter returns to zero. 7.

This experiment examines how shear force varies with an increasing point load. Figure 5 shows the force diagram for the beam. 8. Check the Digital Force Display meter reads zero with no load. Place a hanger with a 100 g

mass to the left of the 'cut' (40mm away). Record the Digital Force Display reading in table as in Table 2.

Repeat using masses of 200g, 300g and 500g. Convert the mass into a load (in N). 9. Remember, Shear force at the cut = Displayed force. 10.

Calculate the theoretical shear force at the cut and complete the Table 2. 6.

2 Experiment 2: Shear Force Variation for Various Loading Conditions This experiment examines how shear forces varies at the cut position of the beam for various loading conditions. Figure 6, Figure 7 and Figure 8 show the force diagrams. BDA27101-Edition III/2011 27 UNIVERSITI TUN HUSSEIN ONN MALAYSIA Faculty of Mechanical and Manufacturing Engineering Figure 6: Force Diagram.

Figure 7: Force Diagram. BDA27101-Edition III/2011 28 UNIVERSITI TUN HUSSEIN ONN MALAYSIA Faculty of Mechanical and Manufacturing

Engineering Figure 8: Force Diagram. We will use the statement: " The Shear Force at the 'cut' is equal to the algebraic sum of the forces acting to the left or right of the cut" 1. Check the Digital Force Display meter reads zero with no load.

2. Carefully load the beam with the hangers in the positions shown in Figure 6, using the loads indicated in Table 1. 3. Record the Digital Force Display reading as in Table 3.

Remember, Shear force at the cut (N) = Displayed Force. 4. Calculate the support reactions (RA and RB) and calculate the theoretical shear force at

the cut. 5. Repeat the procedure with the beam loaded as in Figure 7 and Figure 8.

BDA27101-Edition III/2011 29 UNIVERSITI TUN HUSSEIN ONN MALAYSIA

Faculty of Mechanical and Manufacturing Engineering 8. RESULTS 7. 1 Fill up Table 2 for part 1 experiment and Table 3 for Part 2 experiment.

Experiments 1 Table 2: Results for Experiment 1 Mass (g) Experimental

Shear Force (N) Load (N) Theoretical Shear Force (N) 0 100 200 300 400 500

Experiment 2 Table 3: Results for Experiment 2. Figure W1 (N) W2 (N) 6 3.

92 1.

96 3. 92 8 4. 91 RA (N) RB (N) Theoretical Shear Force (N) 0 7 Experimental

Shear Force (N) 3. 92 9. OBSERVATIONS BDA27101-Edition III/2011 37

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