University of Sunderland

Faculty of Applied Sciences

Department of Computing, Engineering and Technology

EAT103 – Applied Mechanics

Assignment 1 of 2, 2016-2017

The following learning outcomes will be assessed:

Knowledge
- An understanding of the fundamental concepts, laws and analytic methods for the solution of applied mechanics problems

Skills
- Proficiency in the use of mechanical technology, and the ability to evaluate and appraise the results of practical experiments.

Important Information

You are required to submit your work within the bounds of the University Infringement of Assessment Regulations (see your Programme Guide). Plagiarism, paraphrasing and downloading large amounts of information from external sources, will not be tolerated and will be dealt with severely. Although you should make full use of any source material, which would normally be an occasional sentence and/or paragraph (referenced) followed by your own critical analysis/evaluation. You will receive no marks for work that is not your own. Your work may be subject to checks for originality which can include use of an electronic plagiarism detection service.

Where you are asked to submit an individual piece of work, the work must be entirely your own. The safety of your assessments is your responsibility. You must not permit another student access to your work.
Where referencing is required, unless otherwise stated, the Harvard referencing system must be used (see your Programme Guide).
Please ensure that you retain a duplicate of your assignment. We are required to send samples of student work to the external examiners for moderation purposes. It will also safeguard in the unlikely event of your work going astray.

Submission Date and Time	Before 4pm, Monday 12th December 2016
Submission Location	St Peters Library, Prospect Building

Engineering Mechanics Assignment 1: Laboratory investigation

This is an individual assignment, in which you will carry out some experimental work and produce a technical report concerning the following topic:

- Stiffness of different materials

A significant part of the assignment should involve the acquisition of experimental results using equipment in the Mechanics Laboratory. To carry out this experiment you should work in groups of 3 or 4 people. The names of members of your group **must** be listed on your report front sheet. The report, however, must be an individual effort and **not** produced as group work. When carrying out laboratory work you must always inform one of the technicians, who will also provide you with equipment where necessary.

More details of the topic listed above are appended to this assignment.

Submission Requirements

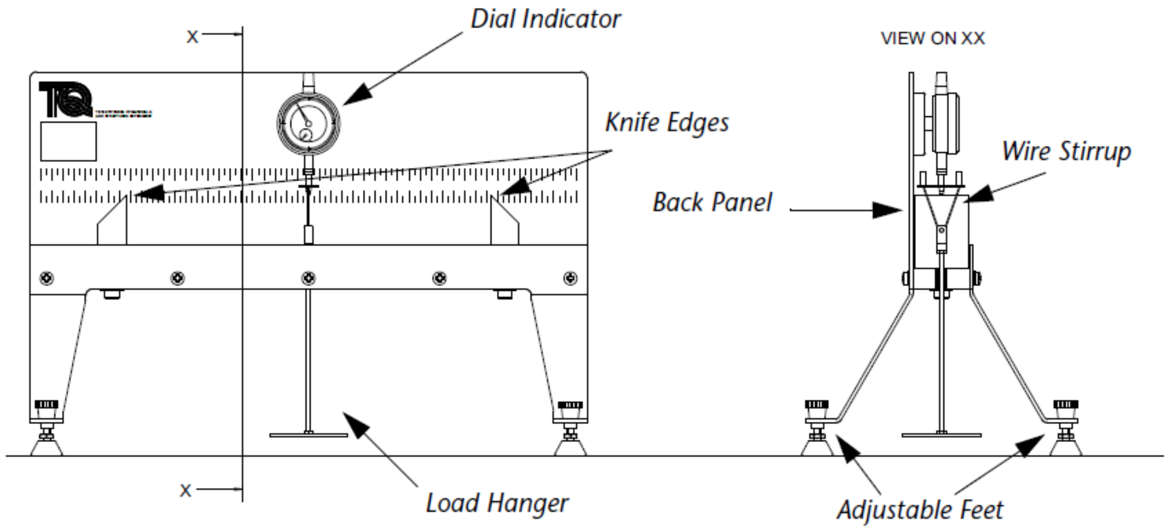
You should submit a report for the experiment you complete. Pay attention to presentation, since untidy or illegible work will be penalised. Your report should be typed, with relevant figures, tables of results, graphs, and analysis.

Note that you are not required to complete a full laboratory report, but need only concentrate on the areas described in the relevant marking scheme, given on the next page.

Laboratory Report Marking Scheme

Page	Item	Marks
Front Page	**Title of Experiment** Student name and number Other group member names	
1	**Abstract** A self-contained summary of what you did and your main findings and conclusions. Maximum length: **<u>200 words</u>**. You should include a Word count at the end of the abstract.	**20**
2	**Results** Full and complete table of experimental readings. Well-presented and fully labelled graphs for procedure **1a** and **1b.**	 **10** **20**
3	**Summary Table for 1a and 1b:** • **1a** - Gradient of load v deflection for brass, aluminium and mild steel. • **1b –** Comparison of experimental and theoretical values of Youngs modulus (**E**) for brass, aluminium and mild steel	**10** **20**
4	**Discussion** • A critical discussion of the accuracy of the results. • An error analysis, which includes a description of the main sources of error/inaccuracy.	**20**

Stiffness of materials:



Objective: To achieve an understanding of the stiffness of different materials under load.

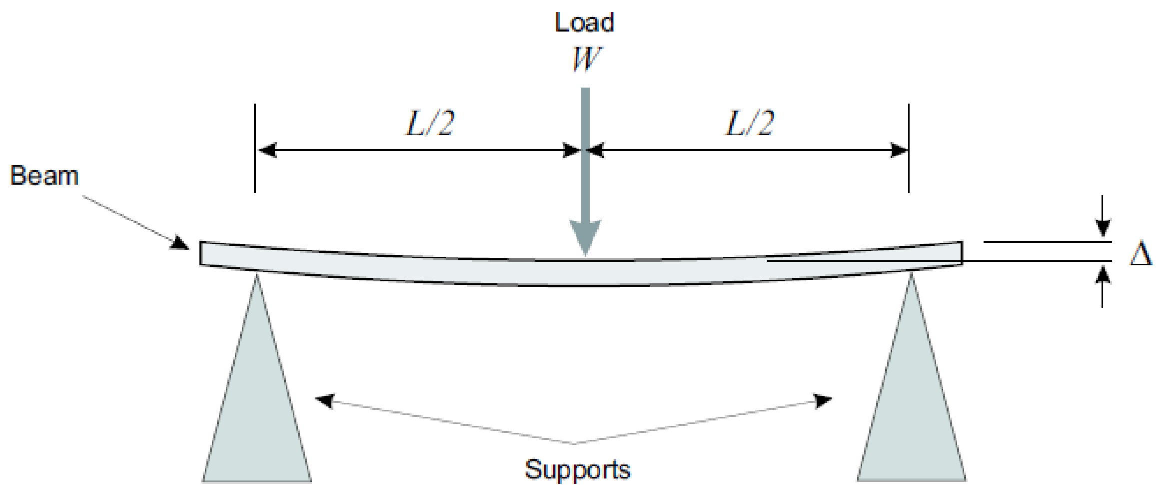
Stiffness is an important property for many applications of materials. The stiffness of a structure depends on both the properties of the material from which it is made and on the geometry of the structure.

The TE16 apparatus uses an example of a very simple structure, a beam in three point bending. The apparatus explores the effects of material and geometry on the stiffness of the simple structure. Included with the apparatus is a selection of test beams or ‘specimens’ made from different materials and cross sectional dimensions.

The apparatus is very simple to use, the operator places the specimen into the apparatus and applies a load. A dial indicator measures the deflection of the specimen at the point of loading.

The apparatus is simple and demonstrated in the diagram.

Theory: Deflection of a simply supported beam.



This formula applies to beams which are subjected to a central load acting at a right angle to their length.

The equation for the deflection of a beam supported between two points is given by:

$$\Delta = \frac{WL^3}{48K}$$

Where:

W = Load (N)
Δ = deflection (m)
L = Length (m)
K = Flexural rigidity constant

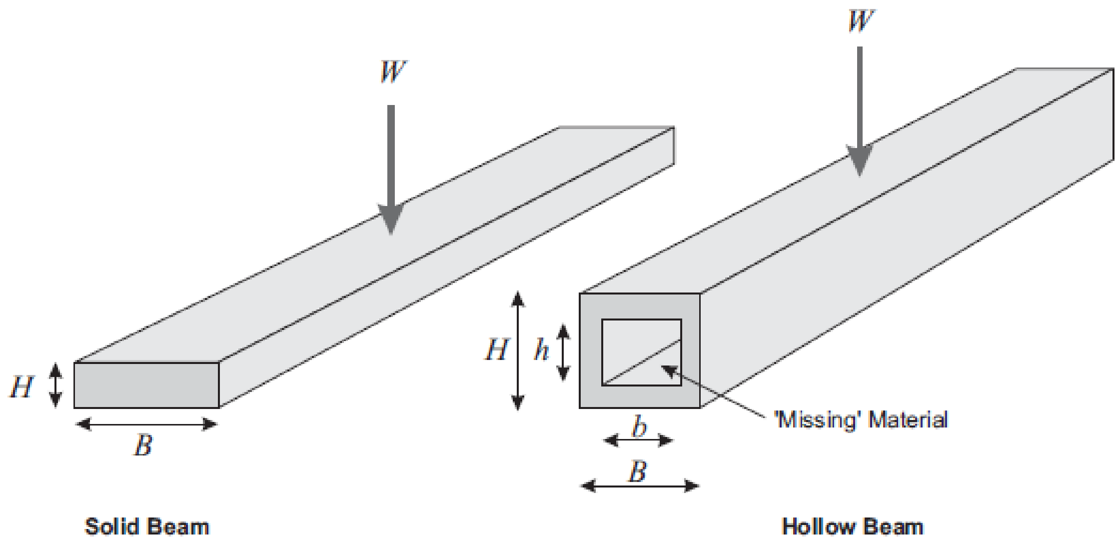
K may be calculated due to the second moment of area of the material ***I***, and the value of Young's modulus ***E***

$$K = E.I$$

Some standard values of (***E***) for the following materials:

Brass	105Gpa
Aluminium	69GPa
Mild Steel	200GPa

Second moment of area (***I***) for solid and hollow beams:



For a solid beam of rectangular cross section:

$$I = \frac{BH^3}{12}$$

For a hollow beam of with consistent wall thickness **(not required for this experiment)**:

$$I = \frac{(BH^3 - bh^3)}{12}$$

The units of ***I*** are $\mathbf{m^4}$

Procedure 1a

Complete this procedure for 3 specimens:

- Brass
- Aluminium
- Mild Steel

1. Construct a table of results as shown below:

Load (***W***) Newtons	Deflection (Δ) in mm
0	
5	
10	
15	
25	
Experiment: 1a	
Material:	
Beam size:	

2. Set up the apparatus with knife edges at 400 mm apart (200 mm each side of the zero line). Use the flat solid specimen (nominal 19.05 mm x 3.2 mm) – **accurately** measure its dimensions and record them in the table. **You are to use a set of vernier calipers for this.**
3. Carefully apply a load of 5 N to the load hanger and record the deflection.
4. Continue to add 5 N loads. In your results table , record the deflection at each increment of load up to 25 N.
5. Remove the load.
6. Plot a graph of Load in Newtons versus Deflection in mm.

Action!

Comment on your graph and results.

What is the relationship between load and deflection?

What does the gradient of each graph indicate?

Procedure 1b

Complete this procedure for 3 specimens:

- Brass
- Aluminium
- Mild Steel

1. Construct a table of results as shown below:

Load (***W***) Newtons	Deflection (Δ) in mm	$48\Delta I$	$\frac{48\Delta I}{L^3}$
0			
5			
10			
15			
20			
25			
Experiment 1b		Material:	
B =	H =	I =	
L =	L^3 =		

2. ***Accurately*** measure the cross section of the specimen and calculate the second moment of area (***I***) value. Record the answers into your table.
3. Use the specimen and set up the apparatus with knife edges at *L* = 400 mm apart (200 mm each side of the zero line).
4. Place the specimen across the knife edges. Apply a load of 5 N and record the deflection. Increase the load in steps of 5 N up to a maximum 25 N. Record the deflection for each load.
6. Complete column 3 and 4 in the table ($48\Delta I$ and $\frac{48\Delta I}{L^3}$).
9. Plot a graph of Load (*W*) against $\frac{48\Delta I}{L^3}$). Calculate the gradient to derive a value of *E* (modulus of elasticity) for each specimen.

Action!

Comment on your graph and results.

Do the values of *E* compare with those given in this manual or other published material?

How do you think the second moment of area affects the Stiffness?