Laboratory Session 3

Project 1 Attempt B: Determine the Young's Modulus for Balsa

PART 1 - Students' Handouts

Student Learning Outcomes (SLO):

This week's activities will focus on Learning Outcomes 3, 5, 6 as below -

1- (LO3) Apply logical engineering design practices to multi-faceted problems involving engineering mechanics
2- (LO5) Undertake and present calculations and design in reports in a professional manner.
3- (LO6) Work in a team to carry out design project work

Announcements:

1. *Bring your **textbook** and drawing instrument (rulers, protractors, pencils) next week.*
2. *Teams must begin work on the Redesign of Balsa Beam (see moodle handouts end of this week).*
3. ***Teams must post Young's Modulus Experiment data within one week of their labratory class**. Failure to do so will incur 5% penalty in Project 1B Design Report.*
4. *Note that E_{Balsa} is between 1.1 and 2.8 GPa, but varies. Do your research.*

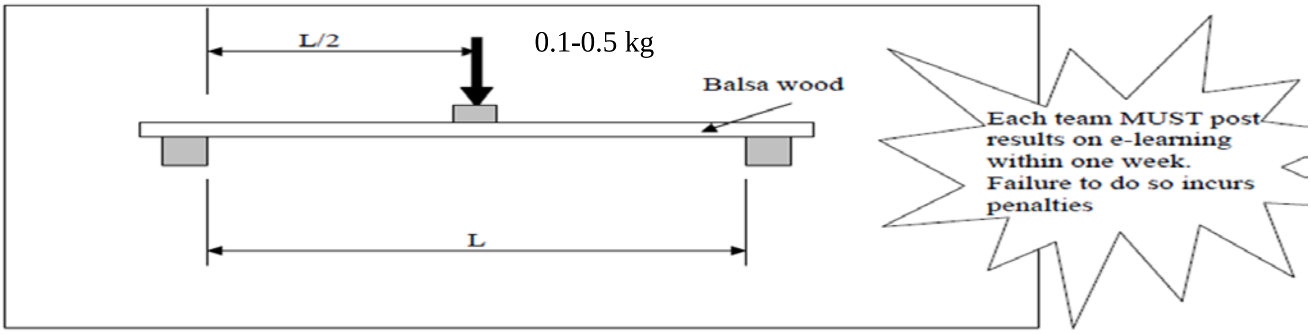
Task1: Discussion on subject learning outcomes (SLOs)

Map the ENGG102 SLOs to what you achieved doing the Balsa Beam building exercise last week. Which outcomes from those listed in the Subject Outline do you think are the most important for you personally and for engineering students in general? Consider what you have written in your Project 1A Design and Reflection Reports. Please refer to your ENGG102 Subject Outline.

Task 2: Young's Modulus for Balsa Experiment

Week 3 laboratory task: The objective is to verify the deflection relationship discussed in lectures and to obtain experimental values of Young's modulus for balsa. The basic method is set out in the table below. More details area provided in the PART 2 - Student Handout.

TEAM	BEAM 1	SPAN (L)	BEAM 2	SPAN (L)	METHOD (Full details in Young's Modulus Exp. Student Handout)
TEST	12.6 x 9.4		12.6 x 6.2		1. Each Team is allocated a Beam, a Span and 15mins to complete 2. Test beam both upright and lying sideways 3. Place the smallest load at the midpoint of the upright beam 4. Measure the deflection at the midpoint 5. Repeat, increasing the load until 500g is reached* 6. Suggest use 50g, 100g, 200g, 250g, 300g, 350g, 400g, 500g loads* 7. Enter your results on the Excel template provided 8. Turn the beam sideways and repeat Steps 3 to 7 9. Plot Deflection vs. Load on the graph provided for each orientation 10. Draw the line of best fit in each case 11. Find the Slope and use to calculate an estimate for E_{Balsa} * = larger loads may not be possible for the longer spans
A	12.6 x 9.4x450	400			
B	12.6 x 9.4x350	300			
C	*12.6 x 9.4x250*	*200*			
D	12.6 x 9.4x150	100			
E			12.6x6.2x300	250	
F			12.6x6.2x250	200	
G			12.6x6.2x200	150	
H			*12.6x6.2x150*	*100*	
I					



Your Tutor will demonstrate the setup to the first Team with all teams watching. While Team 1 completes their test, all other Teams move on to Task 3 with the rest of the group. Your Tutor will advise when it is your turn to complete the experiment.

You will have a maximum of 15 minutes per team.

Task 3: Homework - Redesign of Balsa Beam (Prep for Project 1B)

Redesign the balsa beam for a span of 600mm as homework during weeks 3 - 5. After E-modulus experiment, **discuss and redesign the beam. This will be the preliminary redesign.** Details are provided on the ENGG102 Project 1B – Student Handout. Continue the design as homework.

You will need to use the new knowledge and skills you have gained via the lectures and tutorials over the weeks 1 to 5 and apply it to your preliminary and final redesign – using the Young's Modulus value you'd find in today's experiment (if considered accurate enough!).

A copy of the draft design report is to be brought to your next week 4 laboratory class and signed off by the tutor. You will also need to develop another Excel worksheet to enable fast re-design of your beam and have that ready for use in week 4. **In week 4 and 5, you will do the final redesign of the beam. In week 5, you will also test your final redesign. Final report submission is in week 6.**

Important:

1. You **MUST** post your Young's Modulus Experiment data **within one week** of this laboratory class. Failure to do so will incur 5% penalty in Project 1B Design Report. The full report must be attached as an Appendix to Project 1B Design Report due in week 6.

2. Start the redesign your Balsa Beam and preparing for Project 1B: Closely follow the suggestions for the Report Structure provided and check the requirements of the Project 1B Assessment Marking Sheet. Deviations or Omissions = lost marks!

3. Pre-reading for next week: Everything available on Moodle related to Project 1A and B.

PART 2 - Students' Handouts

Determine the Young's Modulus for Balsa

- **Guidelines**
- This is a cross team task.
- Each team will do one of the experiments posted in the table in part 1 of this handout.
- The whole class will then **share the results to find E for Balsa**.
- There are two different beams, 12.6 x 9.4 & 12.6 x 6.2mm^2 cross section.
- Each team will test **one beam at one span and in its two orientations.** (eg; upright b = 6.2, h = 12.6mm and sideways b = 12.6, h = 6.2mm). Measure the exact dimensions of your beam.
- The deadline for posting your experiment results for sharing is one week after your tutorial.
- **Failure to post your results on time will be penalised by deducting 5% from the Project 1B Final Report.**
- The results of this task will be incorporated into your Project 1B Final Report - ie your second attempt at designing a balsa wood beam.
- The completed spreadsheet and graphs from this Task 3 are to be attached to your Project 1B Final Report as Appendix A.

Objectives:

1- Plot graph of deflection versus Load P for each beam/orientation and from the slopes determine E for balsa.

2- Check the validity of the simply supported beam deflection formula, $\delta = PL^3/48EI$

By combining your results with other teams' results you will plot deflection versus L^3 to verify the general deflection formula to check whether there is a cubic relationship between the deflection of a simply supported beam, and its length L under a central point load.

3 - Testing your beam both upright and sideways will demonstrate the relative stiffness increase obtained by increasing the second moment of area.

Basic Equipment Setup:

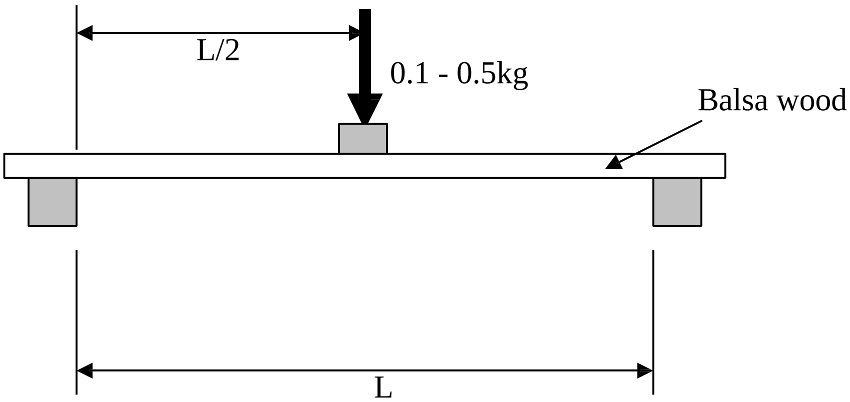


Figure 1: Side View of Balsa Beam being tested

Detailed Procedure:

Part A - Experiment:

1. Check with your tutor which beam and span your team is to test.
   (See also the table on page 1, part 1 of this handout)
2. Position the support blocks to provide the required span (between 100mm and 400mm).
3. Measure the actual dimensions of your balsa beam. Take the average of 3 readings along its length. These will be your *b* and *h* values.
4. Set up the testing mechanism and take initial reading of the deflection dial gauge before loading. Make sure the gage is in contact with your balsa beam.
5. Apply load in increments and record the deflection on the Excel template provided. Use the smaller loads for long spans eg. (10g to 250g) for 400mm and 300mm spans and use bigger loads for short spans eg. (250g to 500) for 100mm and 150 spans. Aim for at least six loads and readings for each orientation.
6. Repeat loadings up to the maximum and check that the dial gauge pointer comes back to near initial reading each time.
7. Keeping the span the same, rotate the beam into its second orientation and repeat steps 3 to 6.

Part B - Analysis:

8. **Plot a graph of Deflection versus Load.** Estimate your draft value for Young's modulus for balsa from the slope of the lines and the formula $\delta=PL^3/48EI$.
9. **Use the form provided** below for recording your experimental data and **copy your data to the Excel spreadsheet** available from the Moodle site for week 4.
10. **Post your results** - i.e .your estimated draft value of E for balsa - on your Tutorial's Moodle Forum space within one week and **attach your draft Excel file** to support your determination of E. Make sure your filename clearly indicates your Team name (ie Team A etc) and what Test (ie 1 - 8) you did.
11. **Download the results from all the other teams** from the Forum and **merge the data.**
12. **Analyse the merged data** and plot new graphs of deflection versus L^3/I, where I is the second moment of area of the balsa beam ($bh^3/12$), where b is the width of cross section and h is the height or depth).
13. **Visually estimate the slope** of the **line of best fit** through these data points and use this information to find your final estimated value of E for balsa.

What to do next???

The final result for Young's Modulus, E for Balsa, will be used by your Team as part of -

- Homework - **Preliminary design** of Balsa Beam (Prep for Project 1B) during week 3 and classwork in lab of week 4.
- In week 4, you can also start working o your final redesign.
- The **Final redesign and testing in week** 5 lab.
- Work on your Project 1B Final Report - i.e. your second attempt at designing a balsa wood beam. Submission is in week 6.

TEAM:			**Date:**			
Group Members	**Name 1**		**Name 2**		**Name 3**	
Tutor's Name						

Beam1/2 Orientation Upright b = mm h = mm

L	L^3	b	h	I	M	P = M*9.81m/s^2	Deflection δ	
(mm)	(mm^3)	(mm)	(mm)	(mm^4)	(kg)	(N)	(mm)	

Beam2/2 Orientation Sideways: b = mm h = mm

Beam orientation: