UNIVERSITY OF WOLLONGONG IN DUBAI

ENGG102 Project 1A Beam Design and Reflection Report

Assignment Cover Sheet:

Student Name	Student ID number	Student submitting work (x)
Habiba Abdelsamie	6471377	x
Odai Awad	6306706	
Abbas Bhaiji	6345438	

Subject number and name	ENGG102: Fundamentals of Engineering mechanics
Subject coordinator	Dr. Sana Amir
Title of Assignment	Balsa Beam Test Report 1A
Date and time due	17Th October 2019 11:59P.M
Lab Number	2
Team Number or group name	K
Total number of pages	18

Student declaration and acknowledgement (must be read by all students)

- By submitting this assignment online, the submitting student declares on behalf of the team that:

1. All team members have read the subject outline for this subject, and this assessment item meets

the requirements of the subject detailed therein.

2. This assessment is entirely our own work, except where we have included fully documented references to the work of others. The material contained in this assessment item has not previously been submitted for assessment.

3. Acknowledgement of source information is in accordance with the guidelines or referencing style specified in the subject outline.

4. All team members are aware of the late submission policy and penalty.

5. The submitting student undertakes to communicate all feedback with the other team members.

Place a compressed photo of your structure or team here (optional)

Contribution:

Student Name	**Student ID Number**	**Section worked upon by member**
Habiba Abdelsamie	6471377	- Purpose - Brainstorming of the first design

		- Table of results - Comparison - Reflection - Objectives - References - Appendix.
Odai Awad	6306706	- Beam sketches - Brainstorming of the second design
Abbas Bhaiji	6345438	- Purpose - Brainstorming on the first design - Brainstorming on the second design - Design conclusion (why we chose hollow beam) - Conclusion

Assessment sheet:

Lab session number: 2 Instructor's name: Ms. Ayesha Qureshi

Team number: 11, group K Date and time of exercise: 2nd of October 2019 at 10:30

Aspect	Comment	Mark
Appendix A: Minutes of Team Meetings (evidence of teamwork)	**Minus 2 marks if Minutes of Team Meetings (more than one!) are not included with this Report**	
Appendix B: A completed copy of your Team Ground Rules Contract Form	**Minus 2 marks if a copy of your Team Ground Rules Contract Form is not included with this Report**	
Structure of report, team information etc (as per "what report should contain")	0.5 mark for each item 3-12 (see Report structure provided above)	/5
Overall Presentation	Neatness Spelling Grammar Diagrams Professionalism	/10
Brainstorming and rationale: List 2 distinct proposals Reasons for selection of prototype	Must show evidence of developing at least two distinct design ideas and variations/improvements to one.	/5
Description of beam Drawing/sketches with dimensions	Describe the principle behind the design. Accurate line drawings or neat and clear sketches with all important dimensions (should enable tutor to build the same structure)	/20
Results including comparison with other team(s) WHAT happened!	Comparison table of all results. Discussion of results with commentary on table and main factual findings. Describe the main failure mechanisms.	/10
Reflections – identify some reasons for the performance of your beam and other teams. WHY it happened! Consider the various aspects of the task (fabrication, material use). Discuss how it might be improved, what knowledge might be needed, & design criteria considered.	To achieve top marks (35-40/40) in this section your report must demonstrate clear and insightful reflection considering own solution and others in the class. Demonstrates further reading and critical analysis. To achieve 25-35/40 your report must describe the performances of your solution and some others. Itemisation of knowledge gaps and some critique of designs. To achieve 0-25/40: Describes own solution with limited reference to other beams.	/40
Mapping of learning outcomes	Identifies all the relevant outcomes from subject outline and discusses how well each is addressed.	/5
Conclusion	1 or 2 paragraphs that draw appropriate conclusions from evidence presented in report. Include the main results, both numerical and qualitative.	/5
Total		/100

Balsa Beam Design and Test

By: Habiba Abdelsamie, Odai Awad, Abbas Bhaiji

Content Page:

Statement of Purpose:

The purpose of this experiment was to determine whether different kinds of beams such as an I beam or a hollow beam would make a difference in the deflection when different amounts of masses up to 2.5kg are placed on the center of the beam over a 400mm span. Our aim was to design and build a beam that when put under stress of different weights, the deflection would stay between the range of 1mm – 6.5mm. Each group was assigned to design a beam that would pass a deflection test using their own dimensions and materials chosen.

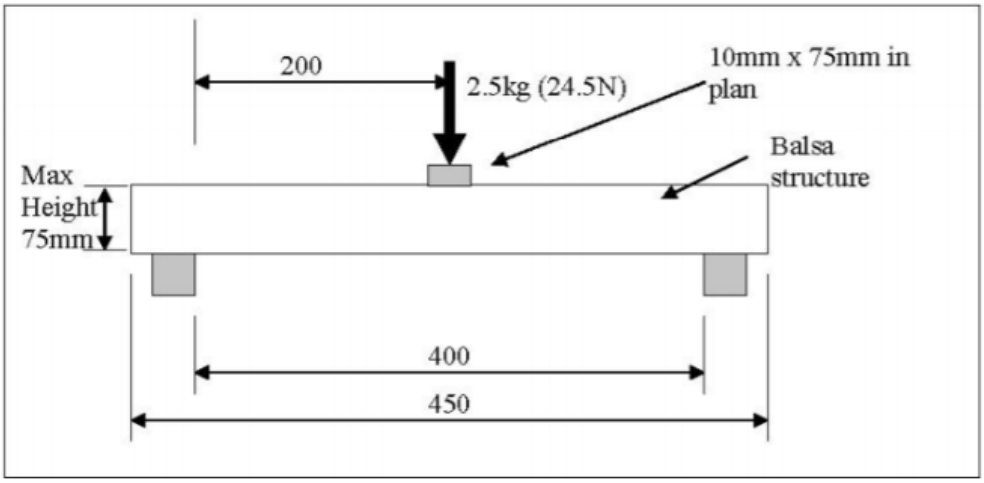


Figure 1 Longitudinal View of Beam

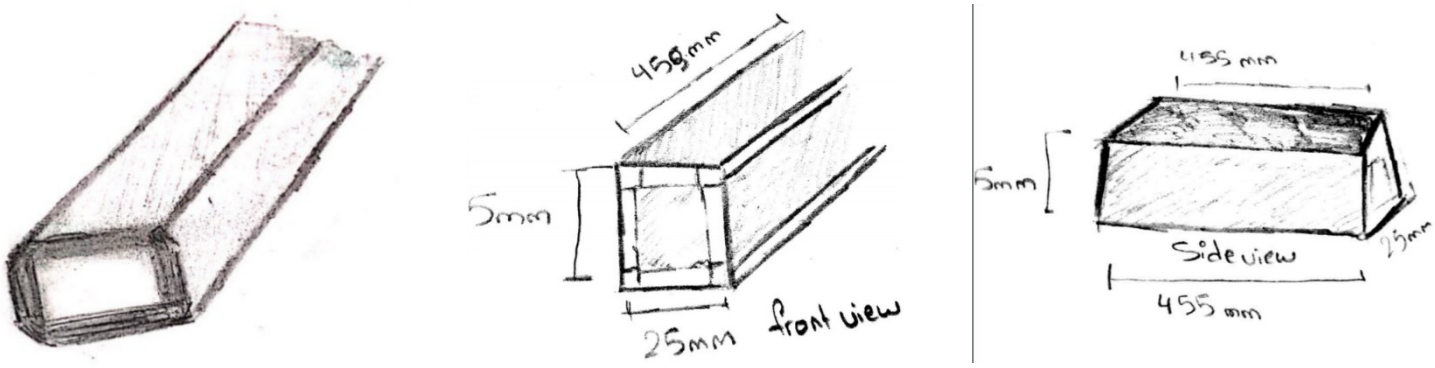
Brainstorming:

To design a beam structure that can carry a central mass of 2.5 kg over a span of 400 mm where the deflection must be more than 1 mm but less than 6.5mm. The materials we chose to use for the beam were 1 balsa sheet (9.15 *80*5mm) and 1 wooden rectangle (9.15*10*5mm).

<u>Design 1:</u> box shape (hollow on the inside)

- **Cut the balsa sheet in half**
- **Trim the wood rectangle in half**
- **Make sure all pieces are equivalent in length**
- **Use hot glue to combine all the pieces**

<u>Design Sketch:</u>



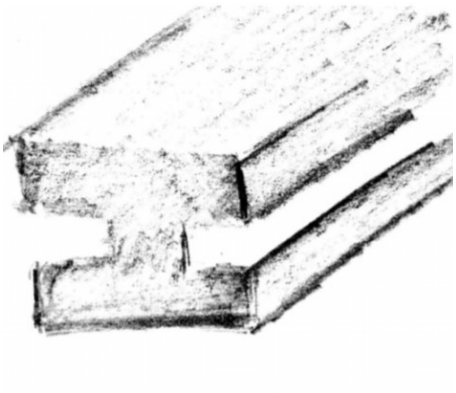
<u>Design 2</u>: I-beam

An I beam is a beam that looks like I shape, the horizontal elements of it is called flanges. The horizontal elements are usually known as web, I beams are usually constructed from steel.

A hollow beam has a thicker inner web which will help it carry a bigger load/pressure on it more than the I beam, besides that the hollow beam is heavier in weight, which means it takes more force than the I beam which means it can bend or crack easily due to the high forces being placed on it. I beam is lighter than the hollow beam however it is not always ideal to have a lighter beam. Suppliers prefer

hollow beam more than I beam because it costs less. The hollow beam in terms of twisting and stretching is qualified to stay as it is, while I beam is acceptable to get bent easily due to the large force acting on it.

Design Sketch:



- **Why we chose the hollow beam design:**

We decided to choose the hollow beam design instead of the I beam because firstly it is much easier to design and construct compared to the I beam and the dimensions of a hollow beam would be easier to cut and assemble together. We felt like the hollow beam would hold more weight than the I beam would because it would be supported on all 4 sides so it wouldn’t break as easily as an I beam would which would have less support on all sides.

Team	Type of beam	Deflection mm	M C
1 (I)	Box shape	5.19	Y
2 (K)	Box shape	5.58	Y
3 (J)	I – beam	3.98	y
4 (H)	I – beam	11.06	Y

Table of Results:

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Total		/100

Comparison:

In groups (1, I and 2, K), the chosen design for the beam was the “box shape “where both beams passed the deflection test under a load of (2.5 kilograms) with a value of (5.19 mm and 5.58mm). Both groups used one balsa sheet and one rectangular piece with different dimensions (440*40*25mm and 440*19*5mm), yet they both met their criteria and no failure occurred. Both groups had well- constructed beams that looked skillfully designed.

While in group (3, J), the chosen beam design was an (I –shape) where one balsa sheet and 2 rectangular pieces with dimensions of (450*30*25mm). Even though the group chose a different design and different dimensions, the beam passed the deflection test under the load of (2.5 kilograms) with a value of (3.98mm) and met their criteria with no failure. The beam looks well-designed and neat with high fabrication effort.

In group (4), their beam design was also an (I-shape) where they used one balsa sheet and 2 rectangular pieces they had the same design as group (3) but their beam did not pass the deflection test with a value of (11.06mm). They did meet their criteria but they failed the load test due to the lack of brainstorming. Their fabrication effort was medium, the beam looked well-constructed but perhaps, too large.

Reflection:

- **Fabrication and design of the beam**

The balsa wood was easy to work with since it was very soft and flexible to handle the applied load, we were able to easily adjust the dimensions to make sure it would follow the design structure that was brainstormed.

For our design, we chose a hollow shaped beam which meant that all sides should be equivalent so that the weight divides equally on the beam when the load is added. We made sure all of the rectangular pieces were symmetrical to avoid any mistakes when they were placed on top of each other.

- **Second attempt**

If we were to design the hollow beam again, it would allow us to adjust the dimensions and perfect the shape of the beam so that it would look neater and well-constructed. We would also use less materials during the process to save resources and decrease the cost of manufacturing which is crucial in the engineering industry. We can also explore new beam designs with different dimensions which would allow the beam to hold a greater load without breaking.

The fabrication process was very simple and did not require too much work. Each member in the group knew the design structure and knew what to do to achieve the beam design brainstormed. The roles were divided between the group members where Odai was in charge of cutting and trimming the balsa wood sheets and rectangular pieces with a saw following the dimensions assigned by Habiba. Habiba worked on coming up with dimensions that would be stable enough for the beam to follow the applied load. Abbas was in charge of putting the pieces together and gluing the trimmed pieces to each other quickly enough to make sure the structure was stable before the glue dried.

- **Performance of the Beam Relative to Other Groups:**

Understanding of How Beams Behave:

The purpose of this beam design was to construct a beam design that would deflect in a range of (1mm - 6.5mm) when an applied load of (2.5) kilograms was applied on it. The beam design was based on the specific instructions given to the group members by the lab instructor.

Knowledge of beams prior to the experiment:

According to the group members' previous knowledge of the different forces and how they affect the materials they act on. As learned in school, different materials react differently towards the amount of stress applied on them. Each material has a specific amount of stress where it starts to deforms and eventually reaches the fracturing point. The group members used this information acquired from school to apply during the lab session to construct a beam that can handle the applied stress and deflect but avoid ultimate fracture. Even though the group members didn't have any previous knowledge about calculating deflection, they were able to use their common sense and understanding to choose the right beam design.

Knowledge gained during exercise:

Throughout this lab session, the group members were able to understand which beam designs were suitable to pass the deflection test. They were also capable do identify and analyze why some beams passed and why some did not by considering their dimensions and the rectangular pieces used. The group members gained the knowledge about the basic steps in constructing beams: using the same dimensions in all pieces, make sure all sides are equivalent to have a neat looking beam, using the right materials that can handle stress without getting fractured. The group members also learnt how to save materials not waste them and construct structures without wasting resources.

Gaps identified and how to improve:

Some ways we can improve our beam is to use more specific dimensions and better equipment for cutting and measuring the materials, preferable power tools to be very accurate in the measurements of the dimensions for the beam. Use of CAD would be the most accurate way to design beams. Another way to improve the beam is to use calculations to calculate the exact deflection required. Another way is to use silicon instead of hot glue to make sure the beam stays stable and does not get fractured.

Additional literature read to support responses:

The group members looked at different resources and videos about the structure of buildings and how they use beams made of steel, experimenting it and seeing how it would hold up in real life applications such as buildings and warehouses. The group used a slide presentation called" Beam design" by *PLTW* which provided a large amount of information about the various types of forces and how they affect different material bodies. This can be very helpful in the second attempt where the group can apply this knowledge in their beam design.

Team Decision-Making and Agreement:

The collaboration and teamwork was evident in our group since each member shared their different ideas and thoughts to construct the beam. There were many topics that were discussed between the team members to reach an agreement between all the group members. Deciding the beam design was quite challenging since the group members had to acknowledge the advantages and disadvantages of each design to avoid any errors. The group members debated on which rectangular pieces to use considering the different sizes and thicknesses, but eventually an agreement was made.

Objectives:

1. Describe the role of abstraction, simplification and the use of assumption and mathematical relationships in solving problems encountered by engineers
    - The members of the group calculated the dimensions of the beam using mathematical problems to ensure success in the structure of the beam. They used their prior knowledge in calculating dimensions to create a successful beam just like actual engineers in a specific amount of time and followed all of the requirements and instructions given.
2. Apply logical engineering design practices to multi-faceted problems involving engineering mechanics
    - Brainstorming the beam design in detail to ensure its success in the deflection test with a limited amount of knowledge was quite the challenge, but the members put in their greatest amount of effort and the results were impressive.
3. Describe the impact of the application of engineering mechanics on engineering activities across a number of engineering disciplines
    - Engineering mechanics plays a great role in creating stable structures therefore, the members had to make sure the right materials and dimensions were used to be able to handle the load applied and estimate the effect of the forces on the beam without breaking it.
4. Demonstrate self-directed learning related to solving problems in engineering
    - The members relied on their very basic knowledge to choose the materials and create exact dimensions for the beam to pass the deflection test. Each member contributed in a way to reach the required results.

7. Work as a productive member of a team, recognizing roles, responsibilities and accountabilities of individuals in a team.

- The work was divided between the group members and each member took responsibility. Each member contributed in the project by expressing their ideas and variety of thoughts to ensure success in the beam design.

Conclusion:

This experiment showed us that the use of a hollow beam proved to be effective under the stress of 2.5 kilograms and would stay within the deflection limit, other groups who used different beams such as an I beam had a higher deflection compared to our results. According to the deflection test, the value of deflection in our beam was (5.58) which concludes that the structure was built using correct dimensions. Our group's beam showed the most successful results out of all the other groups, meaning our design and build was the most practical.

References:

- http://teachersinstitute.yale.edu/curriculum/units/2001/5/01.05.04.x.html
- https://theconstructor.org › practical-guide › bending-test-wooden-beam
- https://www.scribd.com › doc › Bending-Test-on-Wooden-Beam
- civilarc.com › bending-test-wooden-beam
- https://www.coursehero.com › ... › MEE › MEE 210
- https://www.scribd.com/document/288313887/Basic-Engineering-Mechanics-notes
- https://www.gfschools.org/site/handlers/filedownload.ashx?moduleinstanceid=171&dataid=707&FileName=Beam-Design.pdf

Meeting Form:

Contract form: For a team to be effective, it is a requirement that all team members understannd their responsibilities to one another. It can be useful to discuss and agree certain project ground rules.

All team members agree to-

1. Come to class and team meetings on time.
2. Come to meetings with assignments and necessary preparations done.
3. Respect one another.
4. Help each other when the need arises.

Additional Rules:

5. Respect other's opinions and ideas.
6. Consult other group members before making any decisions.

If a team member fails to meet the ground rules, other members are expected to take the following actions-

Step 1: Speak to him and make sure he/ understands the importance of teamwork.

If not resolved-

Step 2: Speak to the lab instructor.

If still not resolved-

Step 3: Meet your subject coordinator as a group

Lab session number: 2

1) Habiba Abdelsamie
2) Odai Awad
3) Abbas Bhaiji