

Composite Materials - Students' Notes

By Hilary Byrne, based on the investigation by Pet White

Introduction

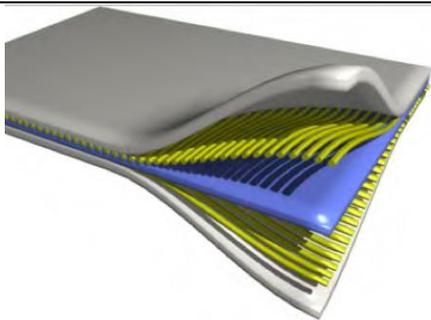
In order to be fast and agile, a race car has to be light, but to be safe, it has to be strong enough to withstand impacts at very high speeds. Steel is very strong, but it is also very heavy. Plastic is very light, but not very strong. How can we design a material so that it is both of these things at once?

Race car	Surfing
	

One solution to this problem is to use a “composite material”.

A composite material is made from two or more materials with different physical or chemical properties that, when combined, produce a material with characteristics different from the individual components.

Some composite materials are called ‘Sandwich structures’. The reason why should be obvious from this picture:

	
http://www.grotecompany.com/applications/sandwich-°©-production/	https://en.wikipedia.org/wiki/Composite_material

Part 1 – Demonstration

Question / Aim

Answer these initial questions with the rest of your class:

What could be the same between the materials used in a modern racing car and a surfboard?

Why do we make composite materials?

How do you think “sandwich structure” composite materials are made?

Today you are a scientist who has been paid to design a strong composite product for as little cost as possible.

The following demonstration is to prepare you for the task.

Plan

This demonstration is planned for you.

Conduct

Your teacher will demonstrate the strength of a plain material and a composite material. Watch the demonstration.

Analysis

Draw and label the equipment and describe what happened.

Discussion

Discuss your observations with the rest of the class.

Conclusion

This demonstration showed the effectiveness of sandwich structures:

- A polystyrene plank is not very strong.
- When additional materials are layered onto the polystyrene it becomes a composite material and its properties change – it becomes stronger.

Part 2 – Initial Investigation

Question / Aim

The initial step in your design of a strong composite material is to discover the properties of your base material and an initial simple composite design.

Repeat your teacher's demonstration of loading a plank and carefully measure the bending. Do this for a plain polystyrene plank and for a composite structure made by putting one full width layer of tape along the top and another along the bottom of the plank.

In Part 3 below, you will try different designs to improve on the simple tape/polystyrene sandwich structure to make it more cost effective.

Plan

Carefully plan your investigation, keep in mind the goal you have been given:

- You will need to work out a way of measuring how much bending there is for each weight added. Talk with your group to decide how you will measure the amount of bending.
- You will need a way to support your plank off the benchtop. Your plank should have a few centimetres resting on the support structures.
- How will you record your data? Some important things to record are, material type, thickness, length, amount of bending, weight being supported etc.
- Write down the procedure you will use.

Once you have planned your investigation you are ready to start taking measurements.

Conduct

Carry out the plan that you designed.

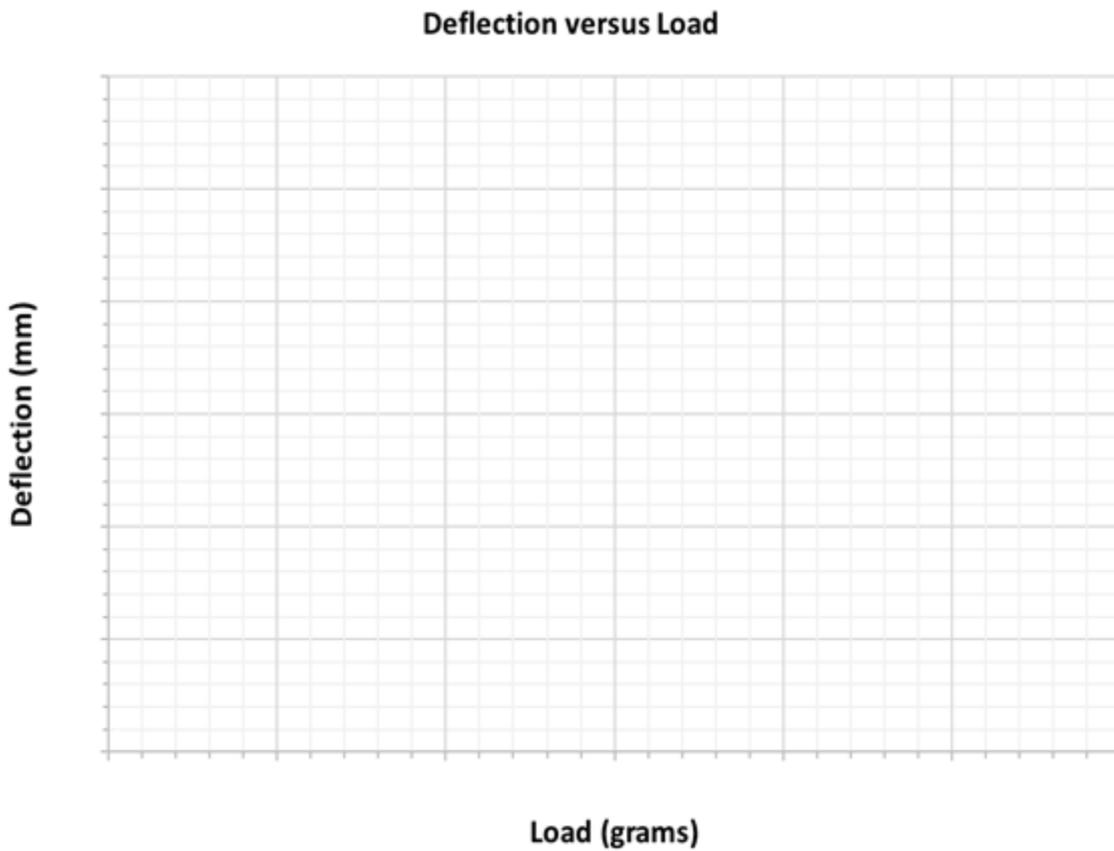
Record your observations in the three columns of the table below.

Record the data in the table below:

Mass (grams)	Amount of bending for Polystyrene (cm)	Amount of bending for Sandwich Structure (cm)

Analysis

Graph your data for the simple polystyrene plank and sandwich structure:



Discussion

Can you explain why you think the sandwich structure works to alter the strength and rigidity?

What is the role of the tape and what properties make it work well?

Would one piece of tape above or below the polystyrene be as effective?

Conclusion

What can you conclude about your simple polystyrene plank and the sandwich structure?

Part 3 – Further Investigation

Question / Aim

Your job now is to create the strongest possible composite material using the least amount of materials (polystyrene and tape) in order to reduce cost.

Plan

Work with your group to develop a few designs for the strongest sandwich structure composite material using the least tape.

Decide how you will collect your data for each trial.

Conduct

Carry out your experiment as planned.

Test each design for strength and rigidity to decide the best design.

Watch out for experimental problems like the plank slipping!

Record your results.

Analysis

Add your new data points to the graph from Part 2.

Discussion

Compare your best design with other groups.

Produce a report that describes the design that works best. Include evidence (data) and an explanation as to why your chosen design is the best (using diagrams and words).

Conclusion

Your report should include a conclusion as to which of your tested designs is the most cost effective.

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