Nature Sunday Academy Lesson

Title – Engineered Building Products

Description:

The main purpose of these activities is to acquaint the students with the common engineered building products used in residential construction. They will understand different kinds of wood composite materials, their important physical and mechanical properties. As moisture is a major factor for the deterioration of building products, students will determine the moisture characteristics of these materials. This exercise will help them to understand the relationship between moisture absorption and dimensional stability.

The second activity is designed to demonstrate how material characteristics are relevant to engineering design applications. The experiment will involve construction of a 3 ply-plywood material using veneer in two different directions. The samples will be made placing veneer grain directions in parallel and perpendicular directions. Flexural strength will be measured to validate the effect of grain direction.

Cultural Connection:

Objectives:

Student will familiarize with fundamental properties of engineered building product.

Standards Covered: 9-10, .1.1., .1.4., .1.5., .2.2., .2.3.,.2.7., .2.8., .6.2., .6.3.

11-12, .2.5., .2.6., .6.2., .6.3., .7.4.

Session Organization:

11.00 – 11.15 AM - Cultural Connection

11.15 – 11.30 AM – Introduction/Presentation

11.30 -12.30 PM – Activity 1

12.30 – 1.00 PM – Lunch

1.00 – 1.15 PM – Initiate Activity 2

1.15 – 2.15 PM – Activity 1 Completion

2.15 – 3.00 PM – Activity 2 Completion

Materials List:

Markers - 4

Fast curing glue

Veneer sheets – 30 (3”x12”)

Weighing Scale - 2

Calipers - 4

Plastic Trays – 4

Glue applicator (brush) - 4

Compression jig - 1

Testing Jig – 1

Micrometer - 1

Tap Water

Paper Towel

Timer

Engineered Material Samples

Vocabulary – Definitions:

Wood Composites

Water Absorption

Thickness Swelling

Veneers

Adhesive

Load Deflection Curve

Modulus of Elasticity (MOE)

Modulus of Rupture (MOR) or Flexural Strength

Activity 1:

Summary

Students will test water absorption properties of different wood composite materials. Each group will get six different composite materials for testing. General guidelines will be provided how to conduct this experiment. They will measure the dimensions and weight of these materials before soaking in water. Samples will be soaked in water for 2hrs as per ASTM standards. After two hours sample will be taken out of water and weighted and measured again. Changes in dimensions, volume and weight will be reported by the students. This activity will enable students to understand how moisture can affect the integrity of these products.

Engineering Connection

Students will understand the advantages and limitations of engineered wood products to moisture.

Safety

Avoid any water spills on the floor.

Use of latex gloves is recommended.

Requirements

Each group will get 6 samples for testing.

Store all the measurement data on computer or notebook.

Procedure

1. Divide students into a group of 3-4 students.
2. Obtain a caliper and weighing scale.
3. Label the samples.
4. Weigh the sample in grams (W1).
5. Measure and dimensions in millimeter (length L1, width, W1 and thickness. T1)
6. Calculate the volume of the sample (V1). (LxWxH)
7. Completely soak the samples in water for 2 hours.
8. After 2hrs take the samples out and dry with dry paper towel quickly.
9. Again take the weight of sample (W2) and measure the dimensions, L2, W2, T2.
10. Calculate the volume after the soak (V2).
11. Calculate % water absorption (WA).

$$\%\ Water\ Absorption = \frac{(W2 - W1)}{W1} *100$$

12. Calculate % thickness swelling (TS).

$$\%\ Thickness\ Swelling = \frac{(T2 - T1)}{T1} *100$$

13. Calculate % volumetric change (VC).

$$\%\ Thickness\ Swelling = \frac{(V2 - V1)}{V1} *100$$

Results

Materials	1	2	3	4	5	6
%WA						
%TS						
%VC						

Questions

1. How do engineered wood composites react to moisture?
2. What is the range of moisture uptake by different composites?
3. Which composite material performed the best?
4. Which composite will you recommend for exterior or interior applications?
5. Based on the equation described above can you calculate the linear expansion of these materials?
6. How is this property related to windows and doors performance?

Activity 2

Summary

Students will construct a 3 ply plywood panel using wood veneers and test their strength properties. Multiple layers of veneers will be laminated in two directions (along and across the wood grain) to understand the effect of fiber orientation on the strength properties of wood composites. Each group will construct two different kinds of panels. General guidelines will be provided how to conduct this experiment. They will record the grain direction of each veneer layer and number of veneers used to make a panel. Amount of glue, pressure and temperature used to laminate and cure the panels will be documented. After curing the samples for 30 minutes, samples will be tested for strength. A graph will be plotted showing load and deflection. Material properties modulus of elasticity (MOE) and flexural strength (MOR) will be discussed ASTM D 1037 standard). This activity will enable students to understand how plywood is manufactured and how wood grain direction impacts its strength.

Engineering Connection

Students will understand how grain direction of wood veneers can impact the strength properties of engineered wood products.

Safety

Avoid spilling glue on floor and clothes.

Use latex gloves when applying glue.

Handle veneers with care.

Requirements

Each group will construct 2 different samples for testing.

Store all the measurement data on computer or notebook.

Procedure

1. Divide students into a group of 3-4 students.
2. Select 10-12 clean veneers for making panels.
3. Mark the direction of wood grains on each veneer.
4. Weigh the exact amount of the glue to be applied

5. Spread the glue on one side of veneer.
6. For 3-ply plywood panels top and bottom veneers should be laid with wood grain parallel to each other and middle layer perpendicular to the other two.
7. Laminate veneers using compression jig.
8. Record temperature, humidity and time required for curing the plywood panels.
9. Cure the plywood panels for 30 min.
10. After curing place each sample on the testing jig.
11. Place micrometer in the middle of the sample.
12. Apply load (L) and record the deflection (D) of panels in millimeters.
13. Plot a graph between load on x-axis and deflection on y-axis. The three loads are 200g, 400g and 600g.
14. MOE for the panels. It is measured in pascals or psi.

$$MOE = \frac{Stress}{Strain}$$

$$E = \frac{P_1 L^3}{4bd^3 y_1}$$

Where – E = Modulus of Elasticity (KPa)

P1 = Proportional Load (Newton)

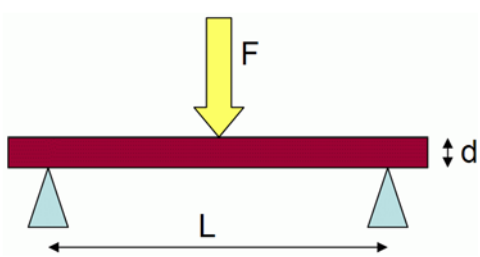
y1 = Deflection at proportional load (mm)

L – Span (mm), b = width (mm), d = thickness (mm)

15. MOR (σ) of the panels. It is measured in pascals or psi.

F-Force (load), L-Span, b-width, d-thickness

$$\sigma = \frac{3FL}{2bd^2}$$



Results

Materials	3 ply-Parallel			3 ply-Perpendicular		
Loads (gram)						
Deflection (mm)						

Questions

1. How is plywood rated in the market?
2. Why is plywood better than particle boards?
3. Why orientation of wood grain is important?
4. Which plywood veneer orientation is stronger?
5. How plywood rating is related to strength?
6. What is MOE and how it is measured?
7. What is flexural strength?