Full STEM Ahead Long Island – Composites
Resources for Your Classroom

Background: A composite material is made from two or more other materials. People develop composite materials to perform better than the original materials could. Some composites are stronger, some are more durable, and some are improved in other ways. Composites have been developed for centuries. Clay bricks are composites. So are many of the materials used in airplanes and race cars—even surfboards. Composites have an important role in manufacturing. They can help make products more efficient, environmentally friendly, and less expensive. There are many careers in the composite industry, including design engineers, production engineers, manufacturers, and so much more.

Objective: Introduce students to composites and manufacturing. Provide students an opportunity to design, create, and test simple composites.

Vocabulary:
Below are terms commonly used when learning about composites -

Resin	Matrix	Abrasion	Oxidation
Polymer	CNC	Epoxy	Thermoforming
Stress	Autoclave	Fabrication	Micro-cracking

Materials:
Jumbo marshmallows, butter, chocolate chips, puffed rice cereal, cupcake wrappers, baking spatula, rule, microwave, microwave container, zinc-plate nails, wooden block (3 x 3 x 1/2 inches), scale, lab worksheets from TeachEngineering.org

Procedure:
Composites have been utilized for thousands of years and were even mentioned in the classic Greek myth of Icarus and Daedalus. When we think of the myth, the composite connection is a simple recipe –

Wax (matrix ingredient) + Feathers (reinforcement material) = Wings (composite material)

This simple equation holds true today. The development of everyday materials like concrete and fiberglass are composite materials developed from one reinforcement material and one matrix material resulting in a new composite having different qualities and structure than the two ingredients on their own.

Today you will work in groups to act as engineers! You'll work to develop the best composite material – one that is strong and lightweight. Why? Because you've been commissioned by to ensure Long Island's safety in the event of a hurricane. As many areas are below sea-level, you'll propose a composite material to protect our shorelines. Each group will create a couple of composite samples, measure its mass and volume for its density, and then test its strength. Distribute the materials and lab sheet to each group.

The marshmallows and butter mixture are going to act as today's matrix and the reinforcement material will be comprised of either the chocolate chips or the puffed cereal. It's up to each individual group to determine by mass, how much of each component is contained over three composite samples.

Begin by labeling each cupcake wrapper with your sample number to easily identify which composite material best meets today's objective (strong, but lightweight). Measure out butter and marshmallow in a microwave dish, once softened, remove and stir. Add in the reinforcement material until well-mixed. Then pour your composite mixture into the wrapper for cooling.

Once the composite has cooled, remove it from the wrapper and mold it to be the same size as a jumbo marshmallow. Measure the mass and dimensions – height, diameter, volume, area, and density. Now we'll test each composite material for its strength. Using the Young's modulus (a measure of a materials stiffness), you'll determine with composite is best suited for our shores.

To calculate the findings, first place the wooden block on top of your composite. Measure its new height. Then calculate the force applied to the block – weight = mass (g) x 9.8N/kg and the distance the sample compressed – distance = original height – compressed height. With both findings we'll now be able to calculate strain and stress. Strain is the ratio of the material's compressed length to its original length (deformation due to stress). Stress is the pressure acting to compress a material.

Strain = compression divided by original height
Stress = applied force divided by sample surface area

Repeat for each sample. Once you've analyzed each composite, determine which of your samples is ideal for protecting Long Island's shoreline from a hurricane. Why?

Lesson Resources:
There are great activities for students of all ages encouraging teamwork and the Engineering Design Process. All lessons are aligned with NGSS learning standards -

Battle of the Beams
https://www.teachengineering.org/activities/view/uoh_matlsci_lesson01_activity1

Chocolate Composites!
https://sites.udel.edu/k12engineering/2018/12/17/chocolate-composites/

Three Little Pigs – Strength in Structures
http://daytonregionalstemcenter.org/wp-content/uploads/2013/08/Fractured-Fairy-Tales-Web-version.pdf

Composites in Aerospace
https://www.nasa.gov/sites/default/files/atoms/files/composites_k-12.pdf