



Aeroelastic Wind Loading
2024 NHERI Wall of Wind Experimental Facility REU
Florida International University
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Summary- Students will undergo a lesson over aeroelastic wind loading to experience in person the different effects of these loads. The lesson will cover three load types, along-wind, across-wind, and torsional (twisting). The lesson will also explain why we research wind by showing the effects hurricanes have on coastal structures. This will be demonstrated on a test model and later will be tested on the student's model to provide an understanding of the design of a building. Creativity is encouraged in the plan and will be shown in the various models.

Engineering Connection- This lesson plan will connect the effects of hurricanes on Florida student's lives to the relevance of wind engineering. Since they are kids from Florida, they will likely be familiar with the damage that hurricanes can do to the built environment. The students will learn how wind engineering is necessary to understand and prevent the damage done during high-speed windstorm events.

Audience- Upper Elementary, specifically 3rd through 5th grade

Lesson Objectives- Students will understand the concept of Wind Loads on objects and their significance in the context of hurricanes in Florida. Specifically, they will identify the 3 load types (longitudinal, vibrations, and torsional) that result in buildings moving from wind, and how these loads apply to real world disasters. They will learn how and why the Wall of Wind conducts experiments to determine these wind loads on buildings and objects. Students will also create their own buildings out of marshmallows and toothpicks to observe which geometry is the most aerodynamic.

Educational Standards- We are interested in exploring forces and motion with students, specifically aiming to improve their skills in obtaining, evaluating, and communicating information in the discipline of life sciences. We also hope this lesson will encourage students to think creatively to solve problems. We hope our activity will help them understand cause and effect in model design and relate these concepts back to the real issue of hurricanes in Florida.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.</p> <ul style="list-style-type: none"> • <u>Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.</u> <hr/> <p>Connections to Nature of Science</p> <p>Science Knowledge is Based on Empirical Evidence</p> <ul style="list-style-type: none"> • Science findings are based on recognizing patterns. 	<p>PS2.A: Forces and Motion</p> <ul style="list-style-type: none"> • The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) 	<p>Patterns</p> <ul style="list-style-type: none"> • Patterns of change can be used to make predictions.

Material List- Model Building:

- Toothpicks and popsicle stick
- Marshmallows
- Fan (Handheld, apartment, commercial scale).
- Chocolate and graham crackers (for base)
- Tap/glue if food items do not work

Introduction- The introduction and background knowledge will be similar. This introduction may be as simple as asking the students to raise their hands or share if they or a family member's home has ever been affected by a hurricane. This will allow them to feel a personal stake in the knowledge provided the rest of the day.

Procedure- Explain how someone else can implement your lesson plan by creating a list of instructions separated by the secondary titles below.

- **Background knowledge**
 - Show the damage made possible by hurricanes. Images of coastal homes damaged or demolished. Be sure to show the difference in scope of damage between houses. Draw attention to the idea that the materials and geometry of a house can predict the effect that strong winds may have on their stability.
- **Before the activity**
 - Go to the Wall of Wind for a brief tour and explanation of the facility.
 - Give a brief physics lesson that explains what a wind load is. Explain how the Wall of Wind helps calculate wind loads and why they are important when building a structure. Mention the three main force directions that make up wind loads acting on a building: Along wind, across wind and torsional (twisting). Make clear that buildings are at risk of damage from each of these directions.
- **During the activity**

- Have students build their own model homes, given the materials provided. Then, have the students test their models and observe the effects of unique designs using the handheld fans. Students are encouraged to alter their designs and conduct multiple tests to better understand which geometries cause which wind loads. Students will be given a worksheet to write down the loads they observe from the fan on their models and to keep track of the different changes they have made to their house.
- Creativity is encouraged in their designs, giving students the opportunity to think creatively with their wind mitigation solutions. Edible materials were chosen with the intention that students could enjoy some of the marshmallows, chocolate, and graham crackers at the end of the activity.
- **After the activity**
 - The students will participate in a small competition to see whose model best fares against progressively stronger wind loads from the fan.

Assesment- how will you know that students have mastered the objectives? The kids will have a chance to demonstrate their knowledge with their very own model under various wind loading forms. After which should explain why and what is happening to their model. Faculty will explain and show what the students did correctly, or incorrectly. Prizes will be awarded to participants with the best model.

Wrap-up- how will you wrap-up the learning/activity to ensure retention? After mini-model activity is completed, the students can return to the wall of wind to witness a test run in front of the fans. This will allow them to make connections between their experience and real testing. Additionally, the staff will arrange for the students to be able to stand in front of the fans at low speed, allowing them to feel the power of wind at just 30mph.