

STRUCTURAL, WIND AND CONTROL ENGINEERING WITH DR ALICE ALIPOUR AND DR JARED HOBECK

TALKING POINTS

KNOWLEDGE

1. What are structural engineers, wind engineers and control engineers?
2. What is a building's façade?

COMPREHENSION

3. What are the main differences between Alice's specialties and Jared's specialties? How do they complement one another?
4. Why are the effects of wind a significant and growing issue for buildings?

APPLICATION

5. How do you think the different types of engineers involved in a project like this interact to ensure they are working as an effective whole?
6. After a major hurricane, palm trees are often the only trees left standing. What structural characteristics do you think help them to survive?

ANALYSIS

7. Why do you think the effect of wind on the whole building has not typically been a major consideration when designing façades?

SYNTHESIS

8. What variables would you include within a computer model to assess how well building attributes such as Smorphacades are working in different wind conditions?

EVALUATION

9. Scale models and computer models, while useful, are not a complete substitute for real life. How do you think engineers can guarantee how buildings will behave in real life before building them?
10. Aside from wind, what other environmental variables do you think need considering when designing a building's façade? Do you think the Smorphacade should account for these?

ACTIVITIES YOU CAN DO AT HOME OR IN THE CLASSROOM

STRUCTURAL ENGINEERING

1. Using only 20 toothpicks and 10 marshmallows, build a free-standing structure that is as tall and as big as possible, and that can support an object. Try different versions. What strategies are you using to make your structure taller and more stable? Now read the information in the following link below, or research the internet, and use this information to build an even stronger structure: letstalkscience.ca/educational-resources/hands-on-activities/how-tall-can-you-build-a-marshmallow-structure-will

What would happen if you used a hair drier or fan on your structure? How about placing your structure in a wind tunnel (see instructions under Wind Engineering)?

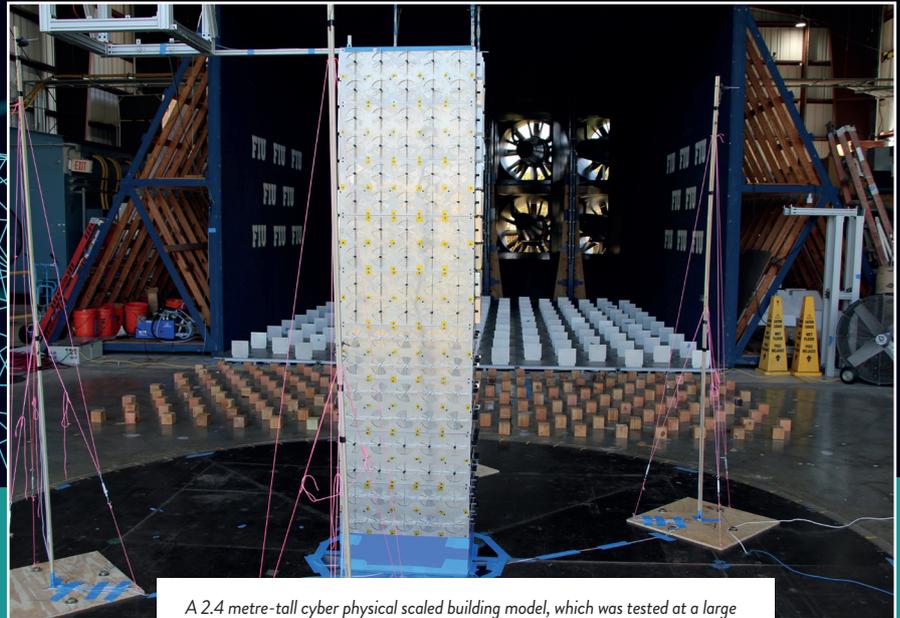
Watch this interesting video by AcabeenOrg about wind loads on structures: www.youtube.com/watch?v=mBtoR6DJlE. Using this video for inspiration, draw the flow of air as you see it happening.

Now try using different materials such as bamboo, spaghetti, tape or glue. Apply the same strategies you used in building a structure out of marshmallows and toothpicks. Do they work? Why/ why not? Think about how you would build a structure that can withstand wind (from the hairdrier, fan or in a wind tunnel) using the least amount of materials (engineers have to consider costs when they design and build structures).

Engineering is driven by curiosity. Ask yourselves questions, try out different strategies, make notes and, above all, have fun!



A model of a tall building with Smorphacade in a wind tunnel



A 2.4 metre-tall cyber physical scaled building model, which was tested at a large NSF-sponsored tunnel facility called the Wall of Wind

2. Teach Engineering has created a lesson that challenges you to find the best beam strength to beam weight ratio. This hands-on activity is a great way to learn about the trade-offs engineers make when designing a structure: www.teachengineering.org/activities/view/cub_mechanics_lesson07_activity1

WIND ENGINEERING

Build your own wind tunnel! There are lots of links to websites that show you how to build your own wind tunnel. Here are two:

1. The Accelerated Bridge Construction team at the University Transportation Centre has come up with an instruction sheet, with images, that shows you how to build a small low-speed wind tunnel. The aim is to help you understand flow types (laminar vs. turbulent, flow patterns around different objects, the conservation of mass and energy (Bernoulli's equation), aerodynamic lift and drag, and how wind interactions affect our daily lives: abc-utc.fiu.edu/wp-content/uploads/sites/52/2016/08/4-Wind-Tunnel.pdf
2. Flying Start Challenge has outlined an activity that enables you to design and build a wind tunnel using materials that can be found at home. Through this activity, you will be creating technical drawings, building a wind tunnel, testing it and performing experiments to investigate the effect air flow has on different objects: www.flyingstartchallenge.co.uk/wp-content/uploads/2021/02/PRESENTATION-Build-Your-Own-Wind-Tunnel-Activity-Pack.pdf

CONTROL ENGINEERING (AND COMPUTATIONAL AND MATHEMATICAL MODELLING)

Control engineers combine their skills in engineering and mathematics to ensure systems work efficiently and predictably.

Computer simulation is the process of mathematical modelling, performed on a computer, which is designed to predict the behaviour, or outcome, of a real-world or physical system – like wind.

1. Plus magazine has some wonderful examples of mathematical modelling: plus.maths.org/content/teacher-package-mathematical-modelling

2. This is an interesting article about the Eiffel Tower in Paris, France, which was designed mathematically to withstand the forces of wind at a time when computational modelling did not exist: plus.maths.org/content/shaped-wind

3. In this activity, you can use a hurricane tracking map to measure the distance from a specific latitude and longitude location of the eye of a hurricane to a city. The aim is to introduce you to an engineering design process, by analysing computer code, obtaining data, determining incorrect model assumptions and suggesting ways to improve the simulator: www.teachengineering.org/activities/view/uoh_hurricane_activity1

MORE RESOURCES

- Alice's group holds a number of outreach activities, including the recruitment of high school students and mentoring opportunities. Find out more here: alicealipour.com
- Jared directs the Multifunctional Structures Laboratory at Kansas State University. Its website provides details on the various interesting research projects Jared's team is looking into. www.msl-lab.com/research.html

You can also access the website via this QR code.



- This video from The B1M explores how tall buildings interact with wind: www.youtube.com/watch?v=tHMPR7f1pf4
- Head to Alice and Jared's Futurum webpage for a PowerPoint, which summarises all the key points in their article: futurumcareers.com/morph-with-the-wind-shape-changing-buildings