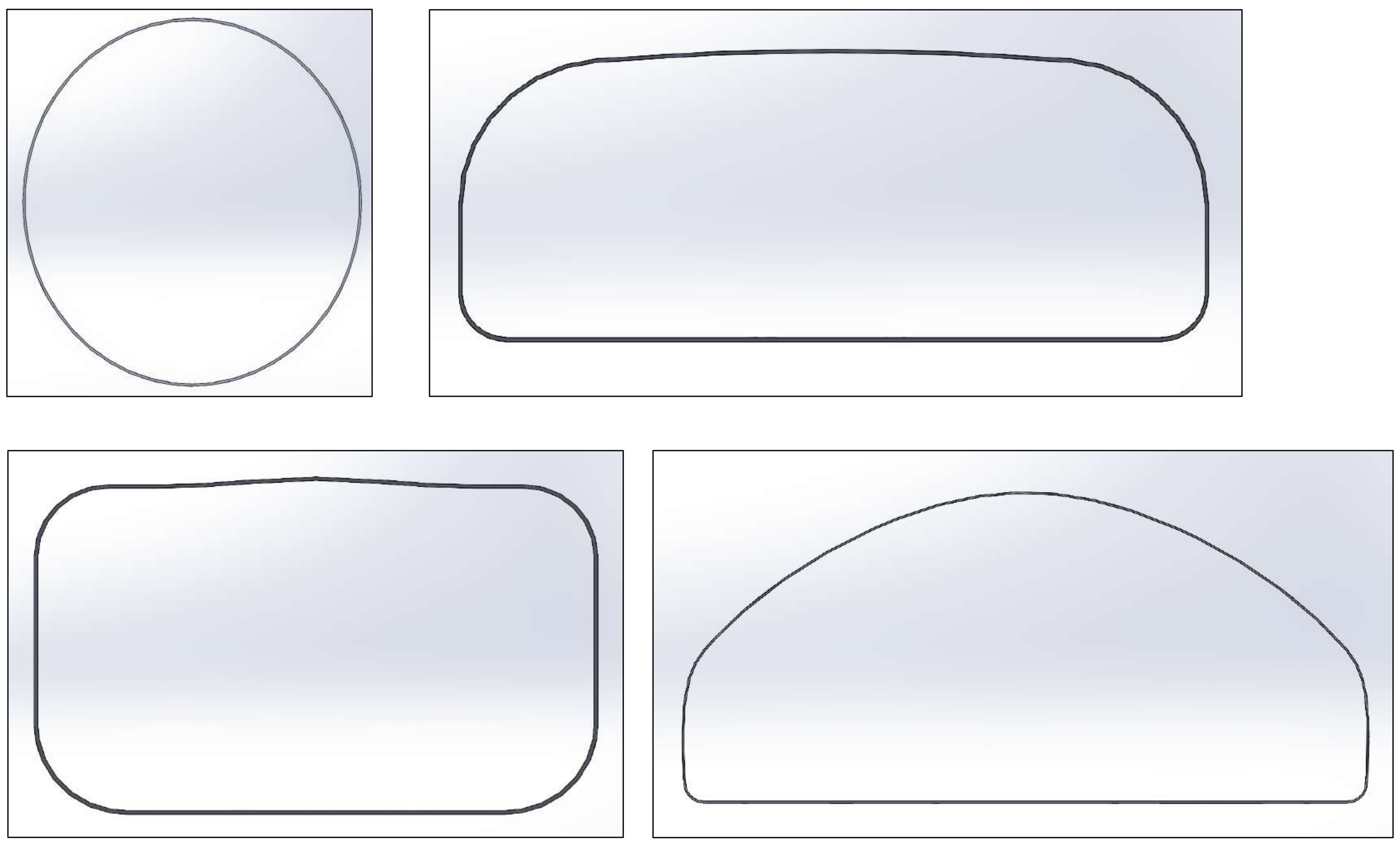
RF Antenna Radome Profile Optimization for Wind Load

Project Description:
The current Radome profiles that are manufactured by JMA Wireless experience high wind loads that impose substantial structural loading on the towers they are attached to. The initial task of our team is to use the wind tunnel we have at Syracuse University to perform wind load testing on the current Radome models used by JMA. We are to then obtain optimal CFD simulation parameters that match our experimental data and use those parameters to develop new scalable Radome profiles that yield a reduced wind load for wind observed at 150 km/h. In developing our prototypes, our team will adhere to design considerations that ensure we will not be compromising either the protection capabilities of the Radome model or the manufacturability constraints pertaining to the large-scale production of the new prototype(s).

Background:
A Radome is a protective enclosure, typically a large dome or shell, that shelters antennas from the elements and physical damage while allowing electromagnetic signals to pass through. Large wind loads can impose high amounts of stress on the Radome, which can lead to both structural damage and electromagnetic signal traffic interference. Wind load testing is commonly used to ensure the reliability of a Radome profile.

Example of Communications Tower with Multiple Radomes

Examples of Radome Cross-Sectional Profiles for Testing:

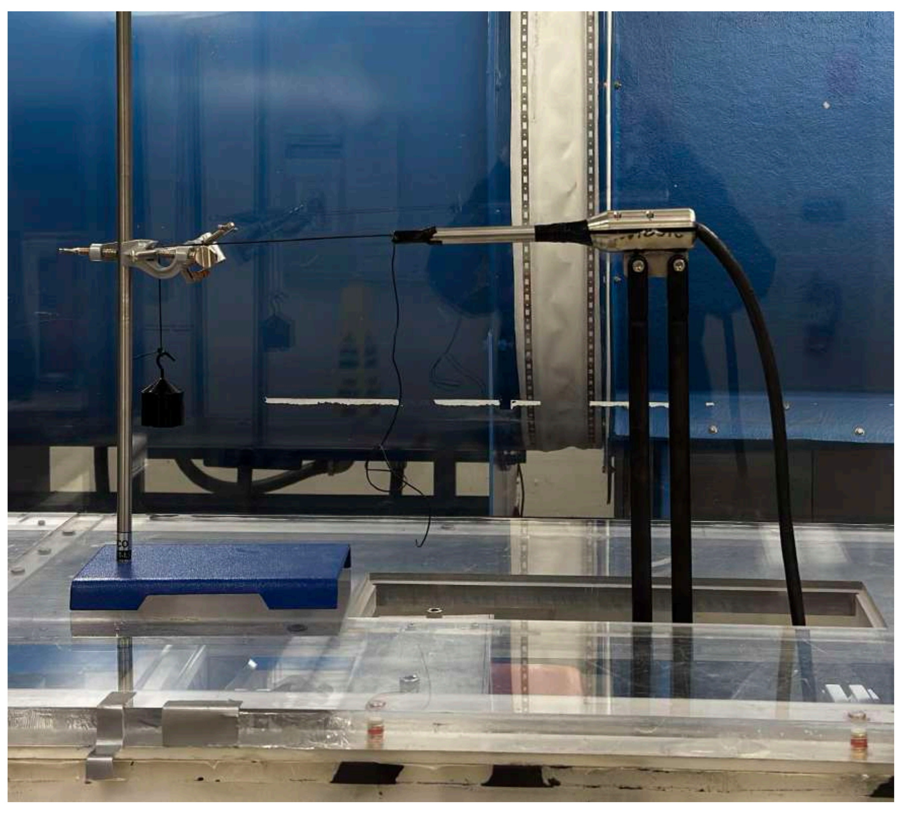


Key Concept: Reynold's Number Scaling

$$Re_D = \frac{\rho V D}{\mu}$$

We will perform wind load testing on 1:1 as well as smaller scale Radome models provided by JMA to verify the results obtained by their CFD model. To keep the Reynold's number consistent, we will scale up the tunnel wind velocity by the same factor as what was used to scale down the model size/diameter. The drag coefficients obtained at various wind velocities for a 1:1 scale model will be compared with their counterparts for the scaled down models we test to verify that the shape of their drag curves match. Successfully verifying this concept would enable us to only need to test one smaller scale size, for which the wind load results can be rescaled to represent those of a 1:1 model.

Wind Load Testing (using the Wind Tunnel):



The Sting & Mounting Solution
The Sting (left image) is a device with the capability to record the overall drag force imposed on our test models in the Wind Tunnel. The yellow attachment (right image) represents our 3D printed solution for mounting our models to The Sting.

Gathering Test Data
For our wind load tests, the wind will hit the face of our test model that is opposite to the face that will be mounted to The Sting, which will impose an axial force on The Sting. This axial force can be interpreted as the drag force on the model, and its corresponding value is output to a MATLAB script, which we will use to collect our data.

Syracuse University Wind Tunnel

Example of 3D Printed Radome Test Model

Deliverables:
- 3D print various scaled JMA Radome profiles for wind load testing
- Verify the wind load generated by existing JMA Radome cross-sections through testing using the Syracuse University Wind Tunnel
- Determine optimal CFD simulation parameters based on experimental wind load test results
- Develop new Radome profile(s) designed to experience a goal of 10% reduced wind load (or drag force)
- Have new designs comply with optimized simulation parameters

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