CFD and Stress Analysis of a Movable Deflection Wall in a Coastal Airport Environment

Objective: Determine the stresses and deflections in a movable deflection wall under operational and extreme wind loading conditions.

Introduction: The wall finite element analysis model was developed based on geometry provided by the client. The finite element (FE) model was built using mainly 4-node plate elements. Bolted connections were modeled using beam and rigid elements. The FE model does not incorporate the bolt preload or friction between bolted components.

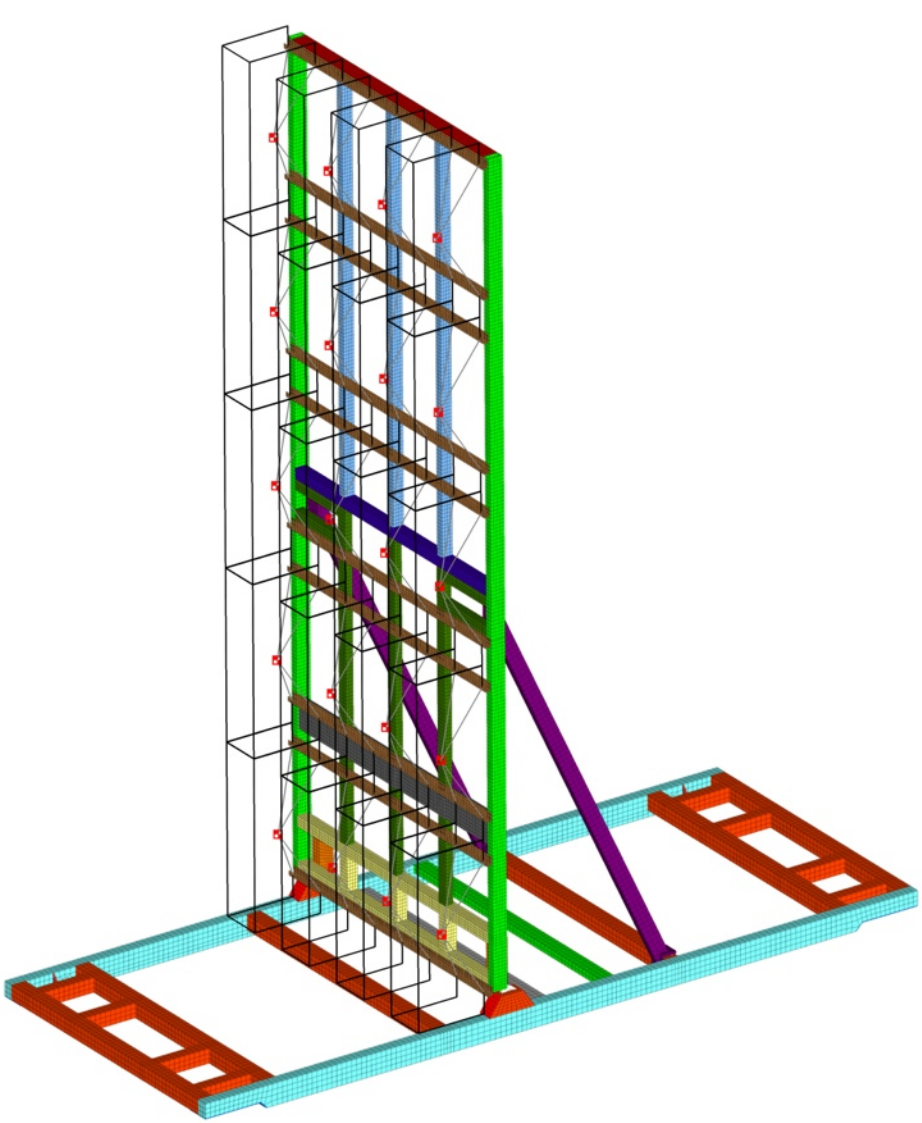
The wall was constrained by pinning the structure at the mounting feet.

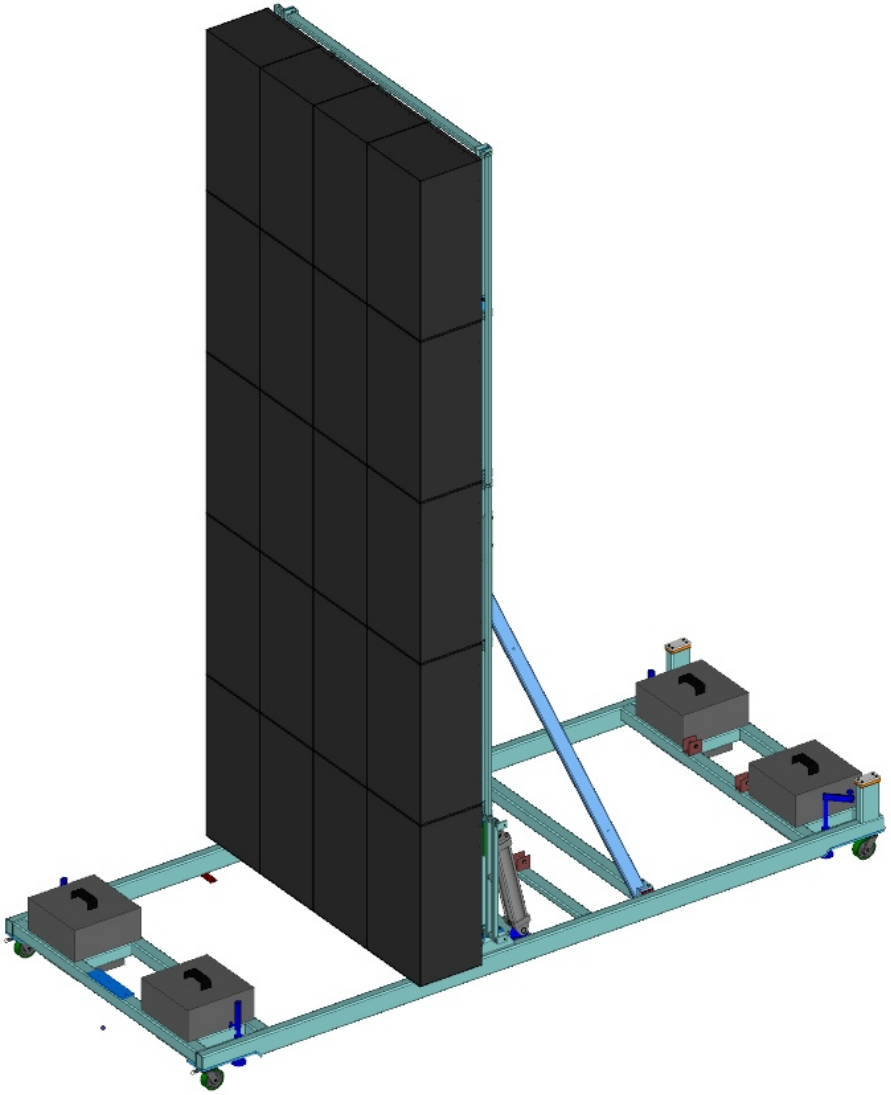
The wind loads were calculated using ASCE 7-02, Minimum Design Loads for Building and Other Structures. A Computational Fluid Dynamics (CFD) Analysis was also performed to ensure that the loads calculated ASCE 7-02 were conservative, but not so conservative that the structure would be overbuilt.

The steel design material is ASTM A500 Grade A Structural Steel Tubing with a nominal yield stress of 39,400 psi and an ultimate tensile strength of 45,000 psi. The aluminum design material is 6061 T-651 Aluminum with a nominal yield stress of 40,000 psi and an ultimate tensile strength of 45,000 psi.

The model was built using Femap v10.2 and analyzed using NX Nastran v7.1. The CFD analysis was performed using Autodesk CFD Simulation.

CFD Wind Force Calculation for Structural Analysis of Movable Wall





The absorption wall FEA plate model is displayed on the left with the CAD model on the right.

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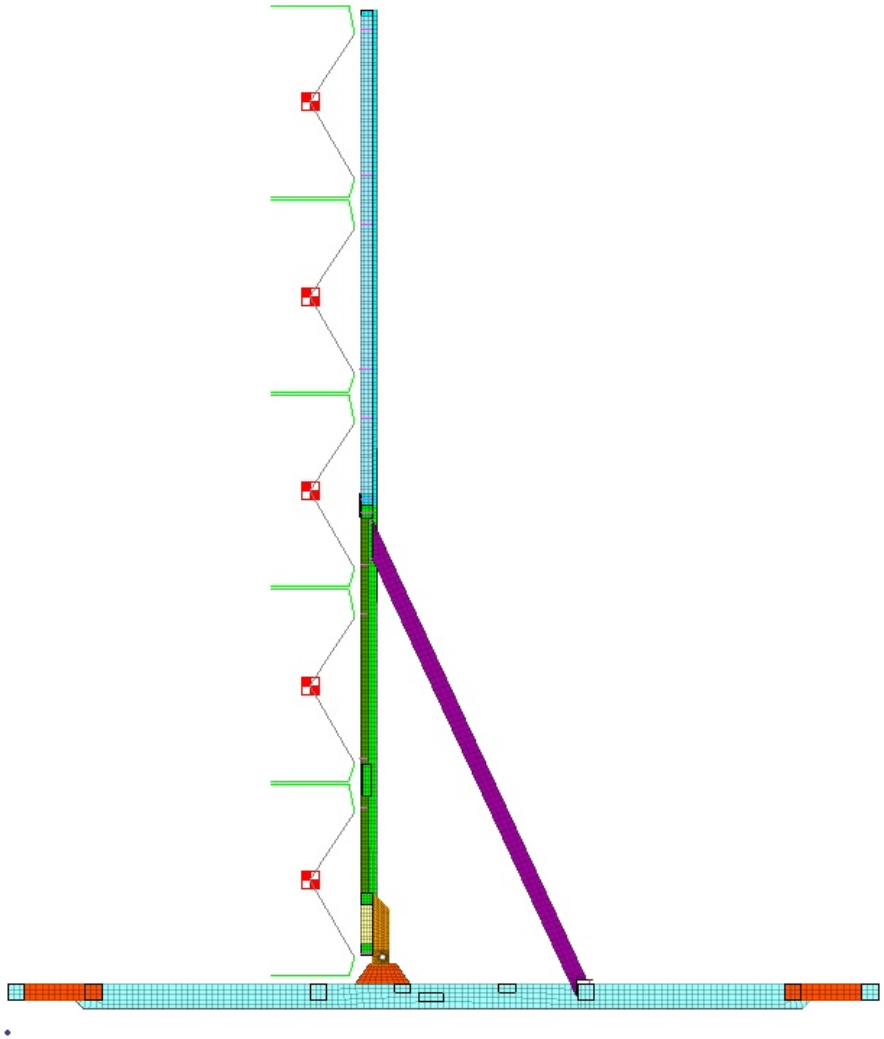

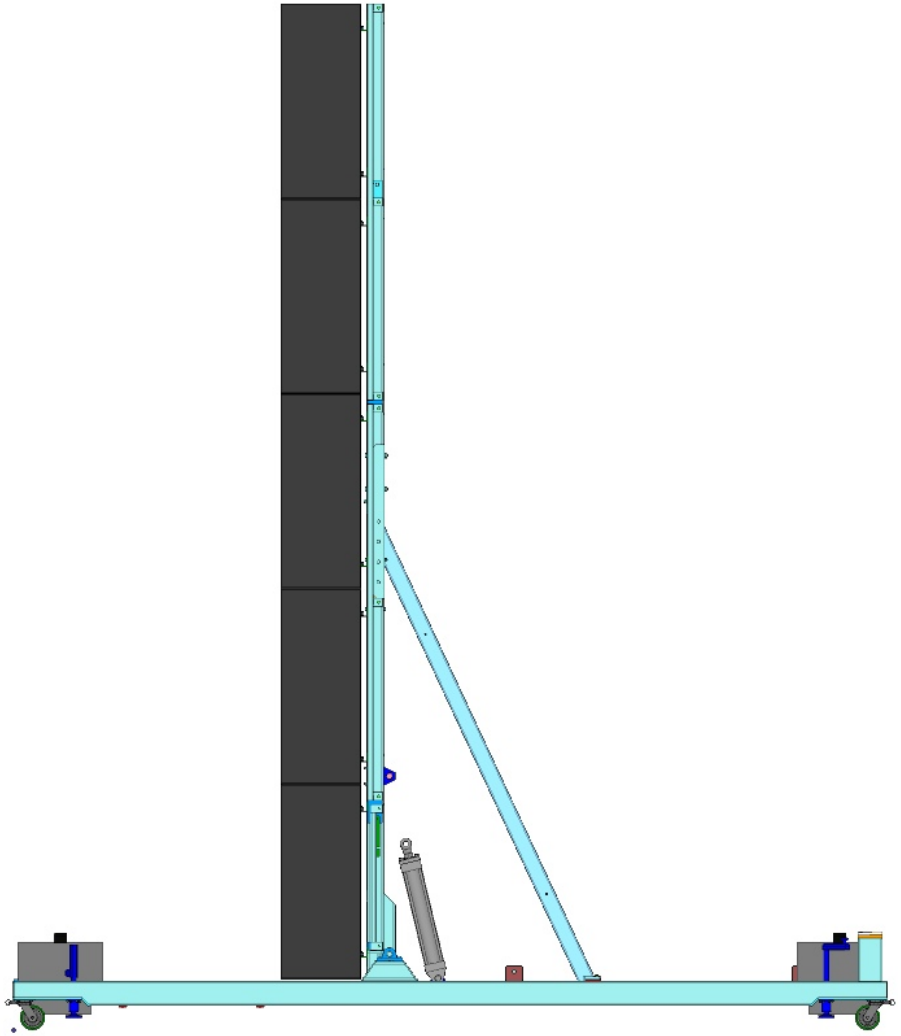

Blocks are idealized with mass elements and attached to the frame with RBE3 (force interpolation) elements.
With this modeling technique, the weight of the blocks is transmitted to the frame without adding unwanted stiffness.

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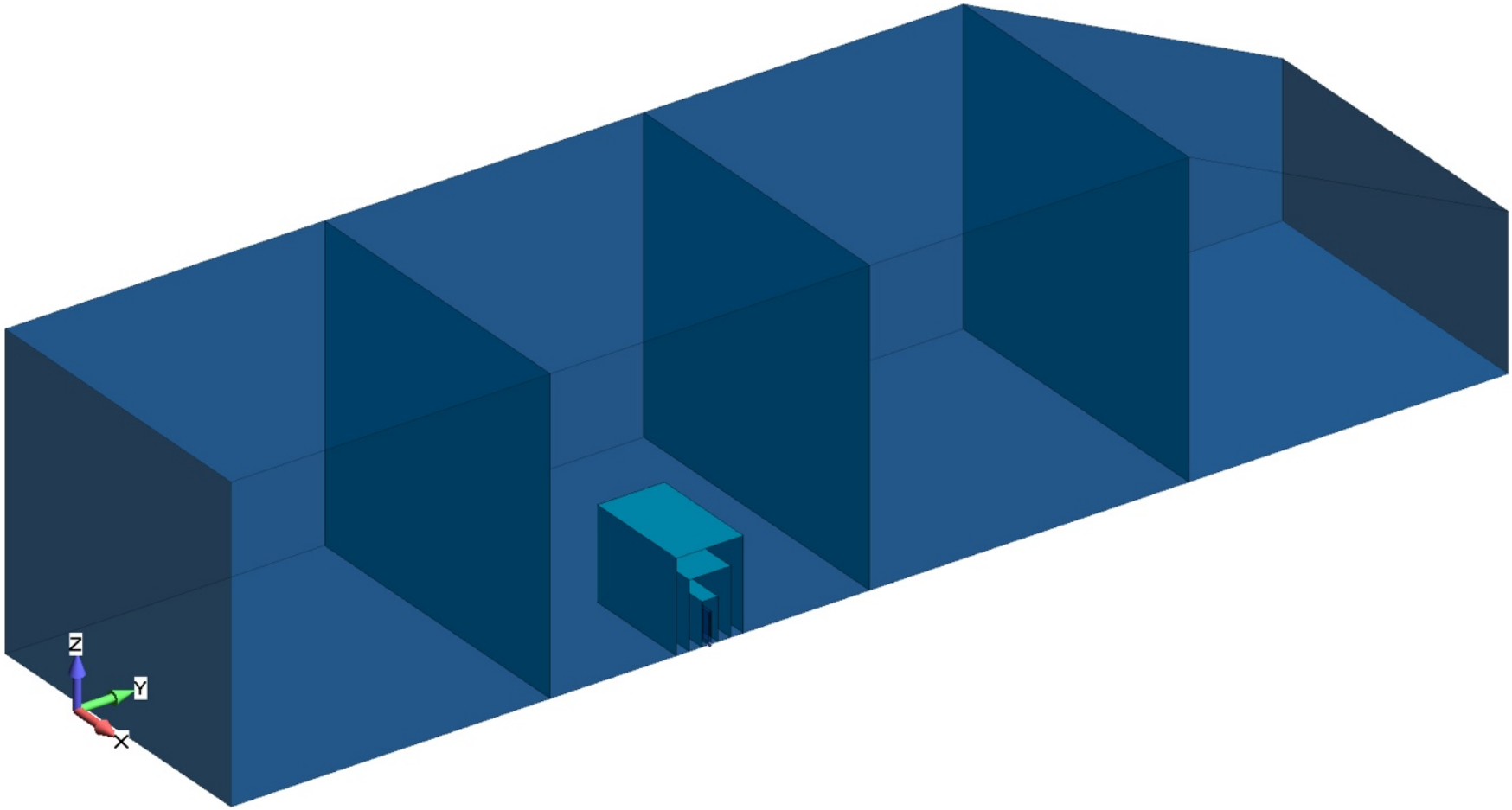

CFD wind tunnel used to determine wind forces against the wall. The model is half-symmetric.

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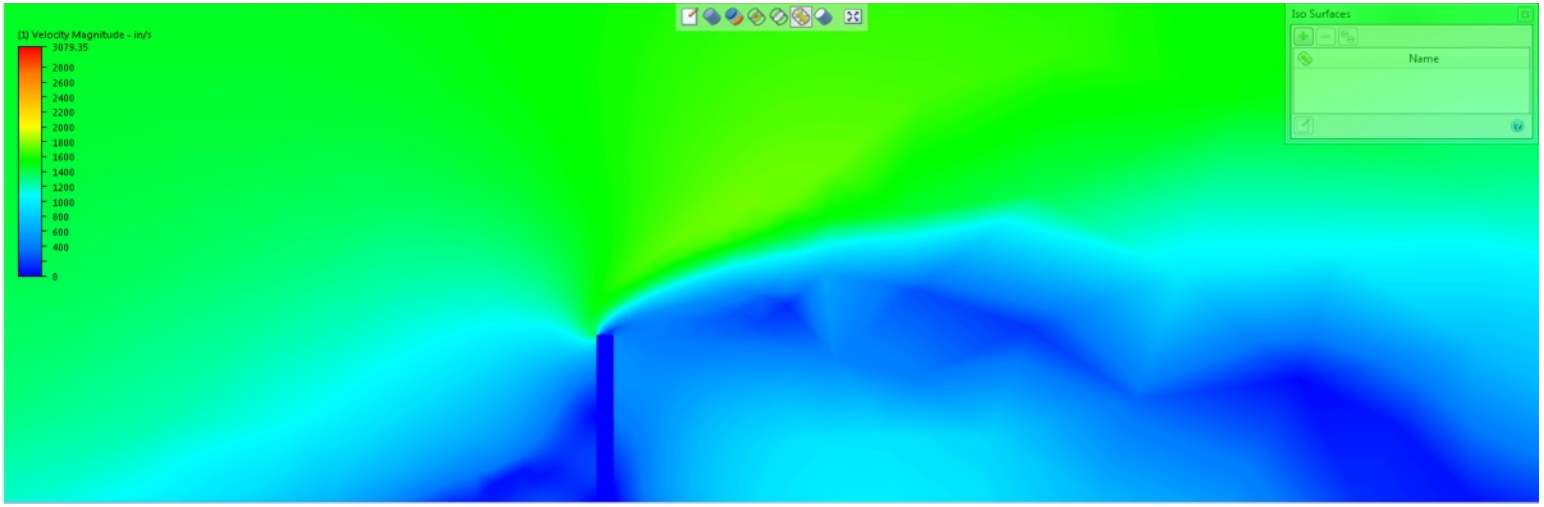

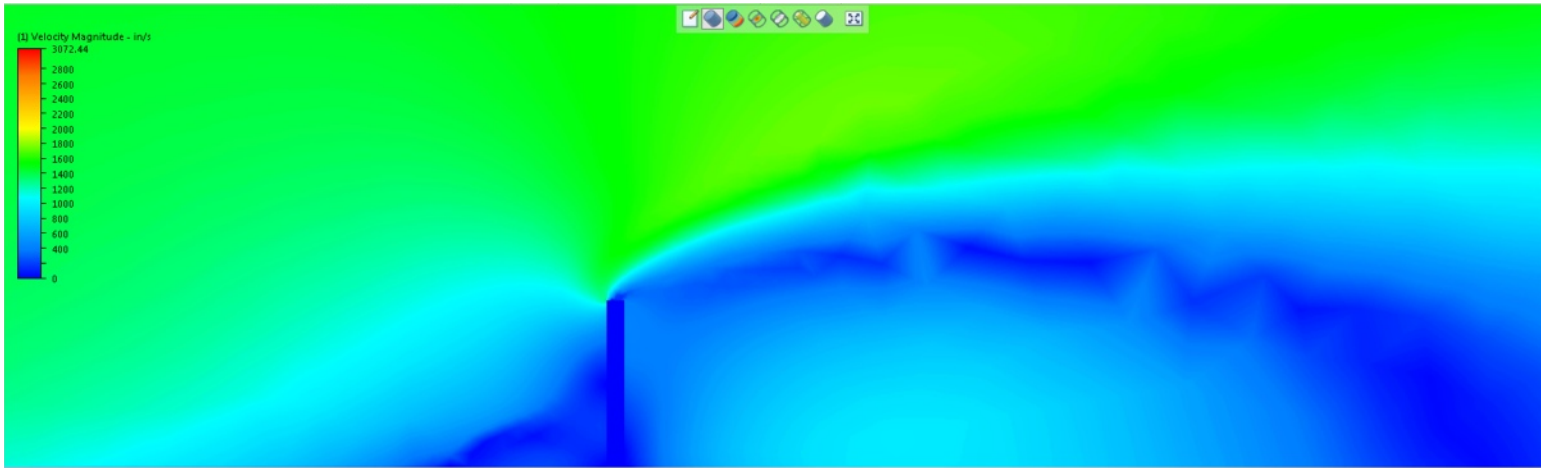

The velocity magnitude is contoured over the course and medium mesh in the upper and lower images respectively.

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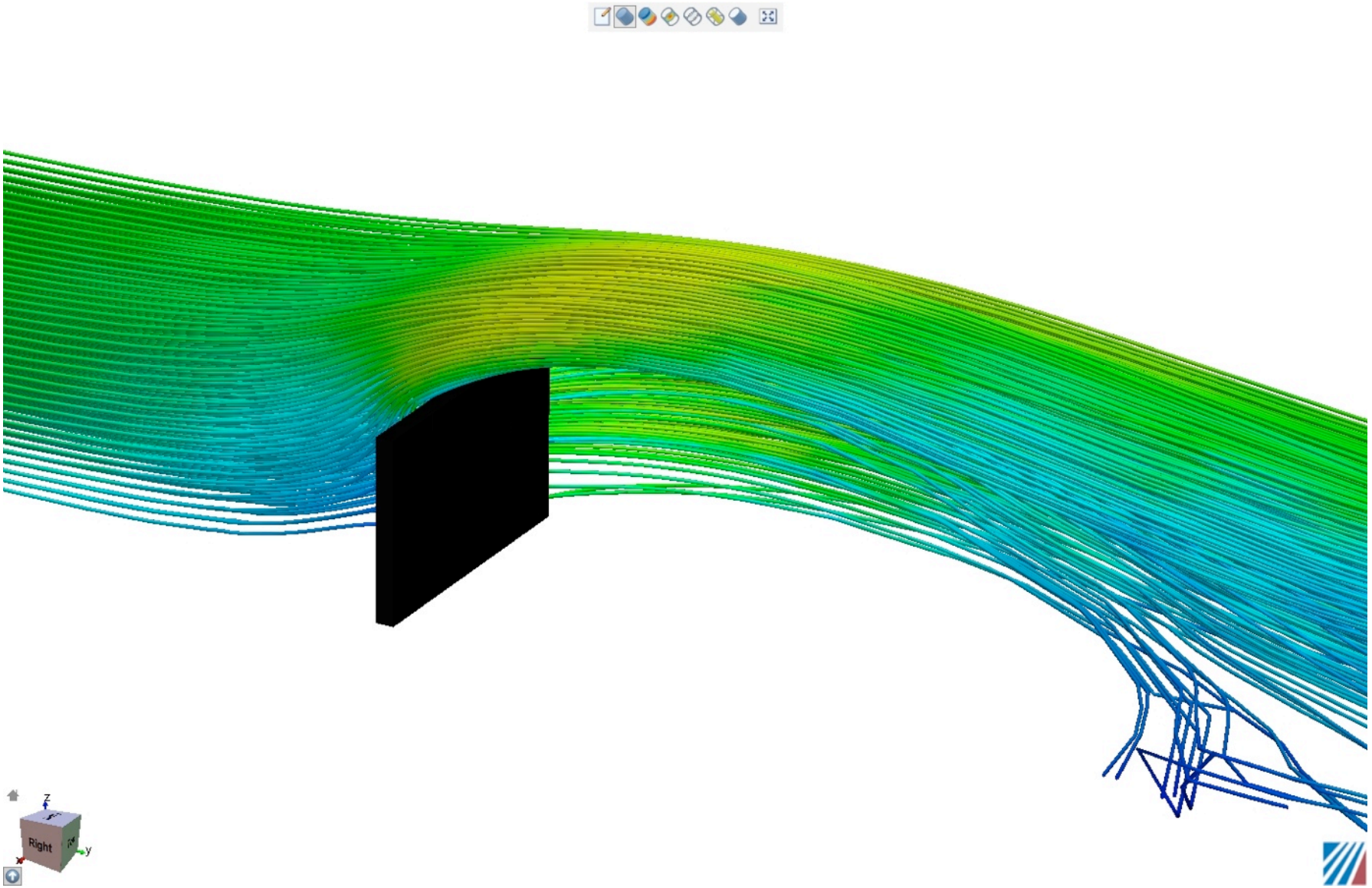

The CFD model was used to determine a quantitative force distribution across the wall under varying wind speeds. Results show good agreement with ASCE 7-02 and demonstrated that the handbook values were excessively conservative.

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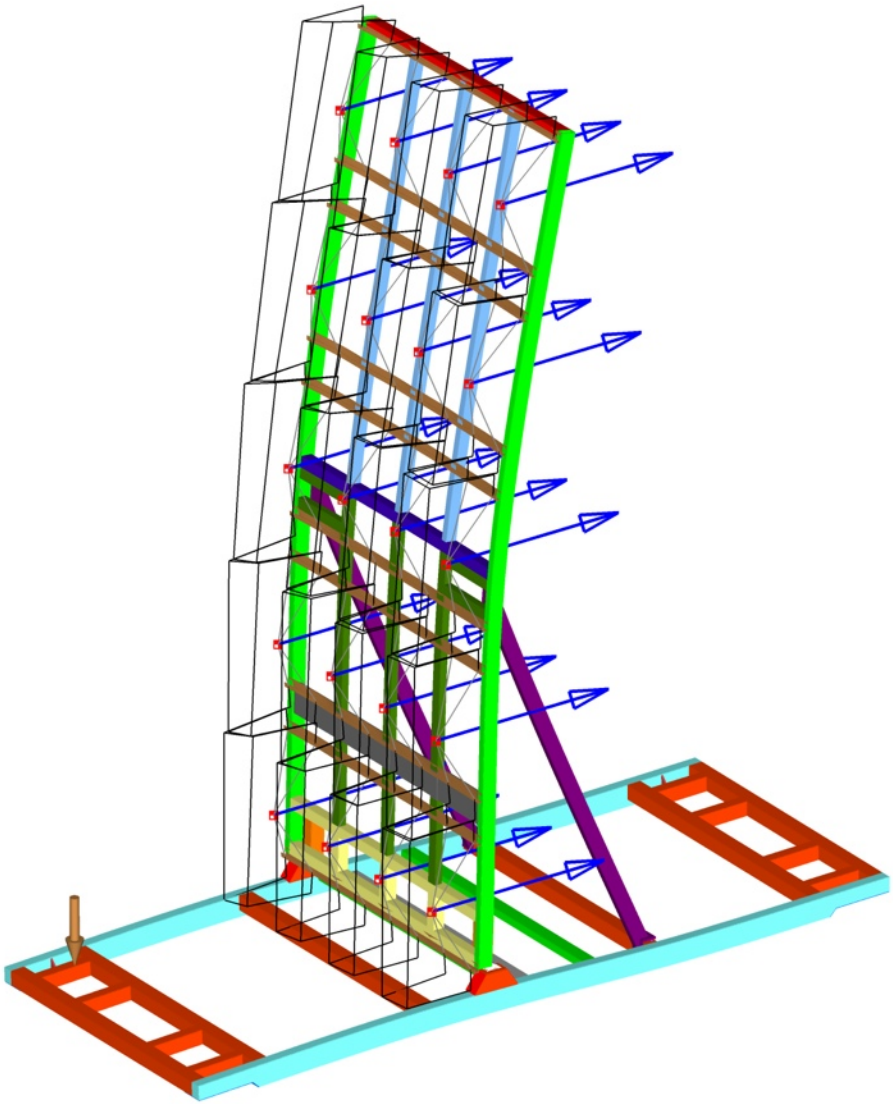

The CFD loads were applied to the FE model and a nonlinear analysis was performed to determine the margin-of-safety of the wall under the most extreme wind loading conditions.