Travel Trailer Shell and Aerodynamics

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Overview

- Project Background
- Objectives & Functionality
- Engineering Design
  - Aerodynamics Approach
  - Aerodynamics
  - Frame Design

Project Background

- Project scope split between two separate groups
  - Shell and Aerodynamics
  - Utilities
- Design and construct a travel trailer for replacement of his current cargo trailer
  - Cost, Fuel Economy, Interior Livability
  - Ultimately delayed: used as a guide for future design considerations

Objectives & Functionality

- Cost: $5,000
- Fuel Economy
  - Aerodynamic Improvements: 20% drag reduction
  - Lightweight Trailer Design: 3,500 lbs total wet weight
- Interior Livability
  - Specific dimensions laid out by client

Aerodynamics Approach

- Research of scholarly texts, journals, and articles
  - Land borne vehicle aerodynamics
- Implement research into possible aerodynamic design solutions
- Utilize an iterative design approach with fluid flow modeling

Aerodynamics

- Proposed Solution

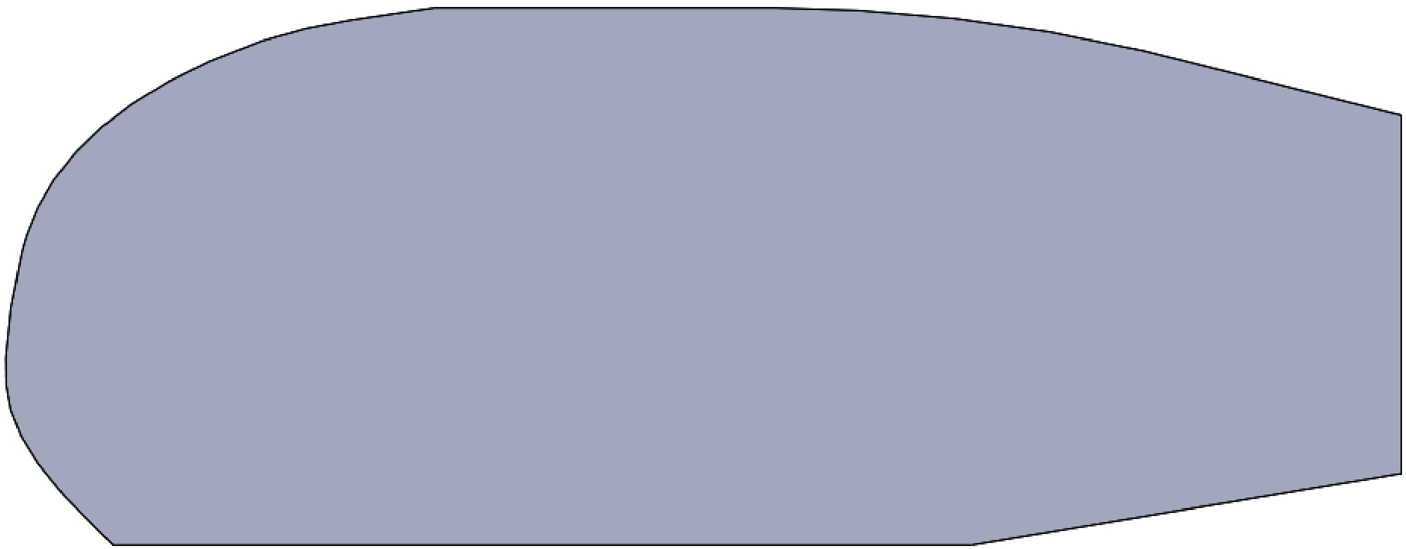

Figure 1. *Travel trailer design concept (side view)*

Aerodynamics

- Streamlined Bodies

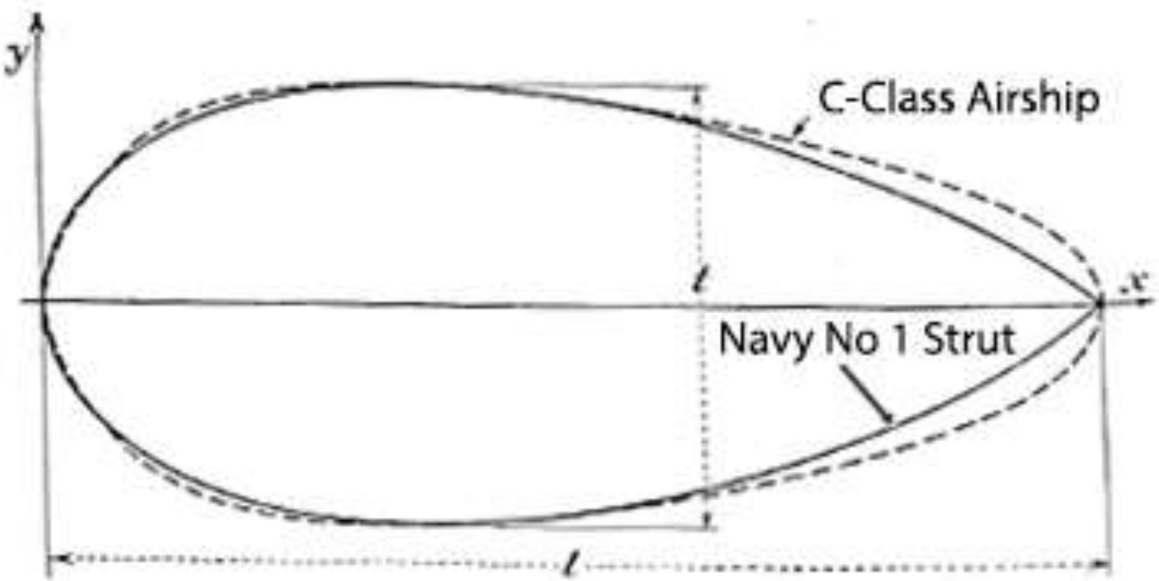

Figure 2. Von Mises, Richard. *Typical streamlined cross sections.* N.d. *Theory of Flight.* New York – London: McGraw-Hill Book Company, Inc., 1945. 102.

Aerodynamics

- Rear-End Modifications
  - Slant angle has a large effect on C_D
  - Minimum value occurring at α = 10-15^o
  - Maximum value occurring at α = 30^o

Figure 3. *Definition of alpha*

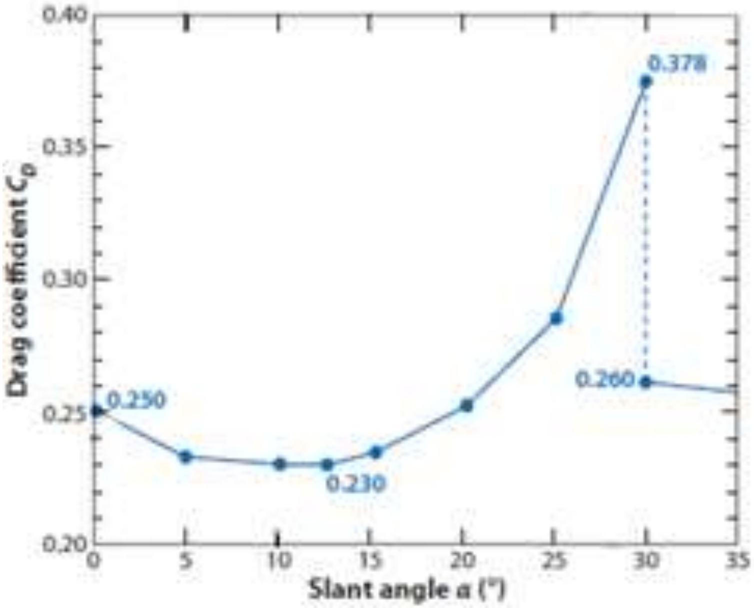

Figure 4. *Optimal slant angle design adapted from* Choi et al. Annual Review of Fluid. *Aerodynamics of Heavy Vehicles*. 444.

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Aerodynamics

- Optimal Gap Design
  - *l/d = 0* act as a singular body
  - *l/d* up to *1.5* resistance is decreasing
  - *l/d > 1.5* resistance approaches that of two bodies acting independently

Figure 5. *Flow characteristics for bodies in tandem (side view) adapted from* Morokin, M.V. N.d. Aerodynamic drag mechanisms of bluff bodies and road vehicles. *General discussion and outlook for the future.* New York – London: Plenum Press, 1978. 259-260.

Aerodynamics

- Iterative design approach using fluid flow modeling

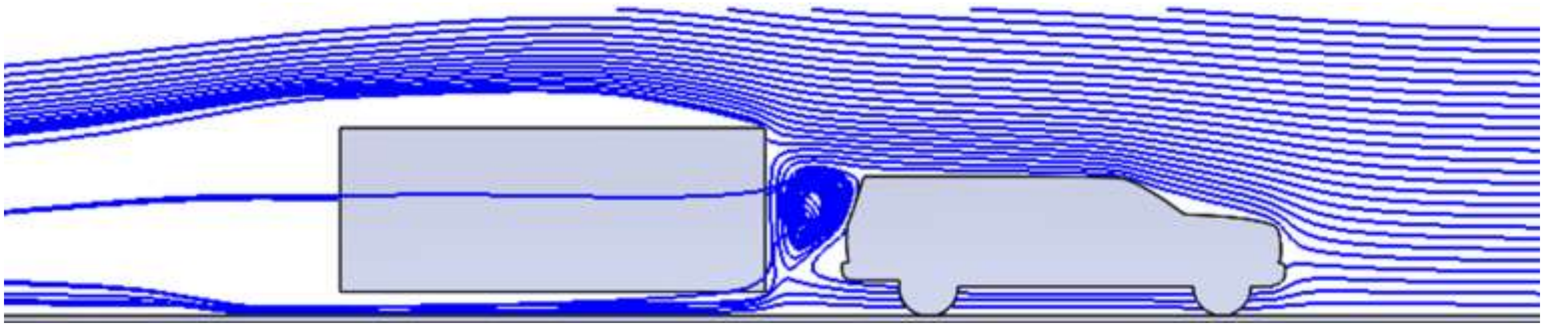

Figure 6. *Baseline model for aerodynamic testing*

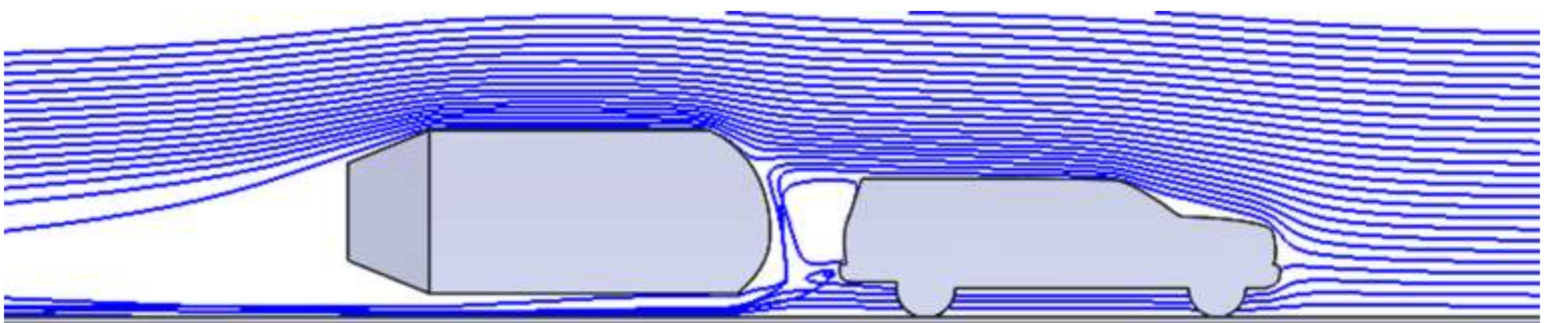

Figure 7. *Model with short rear-end dual boat tail*

Aerodynamics

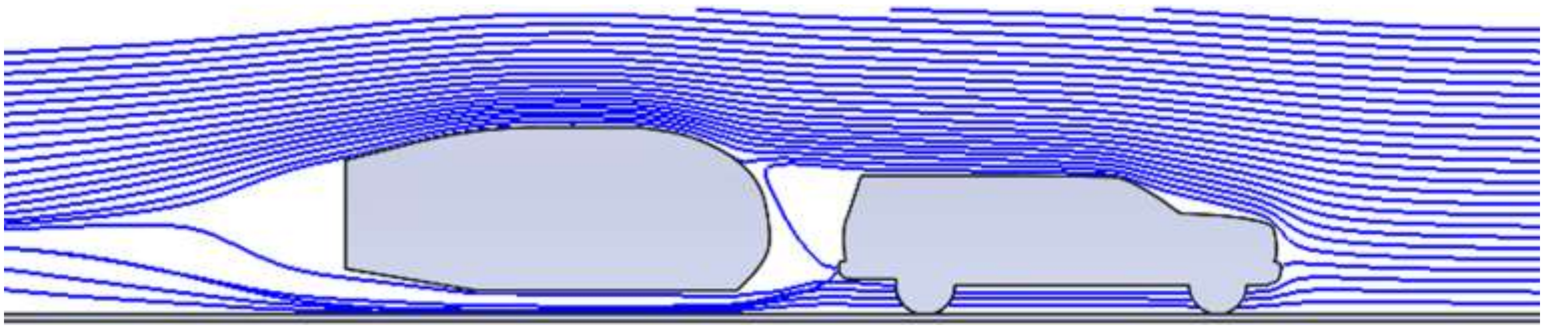

Figure 8. *Proposed travel trailer design*

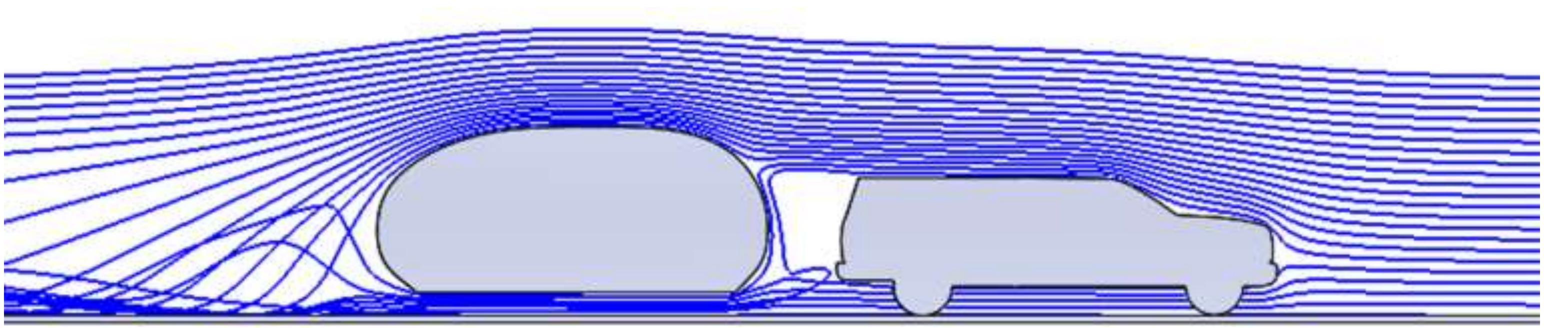

Figure 9. *Client's redesign for aesthetics*

Aerodynamics

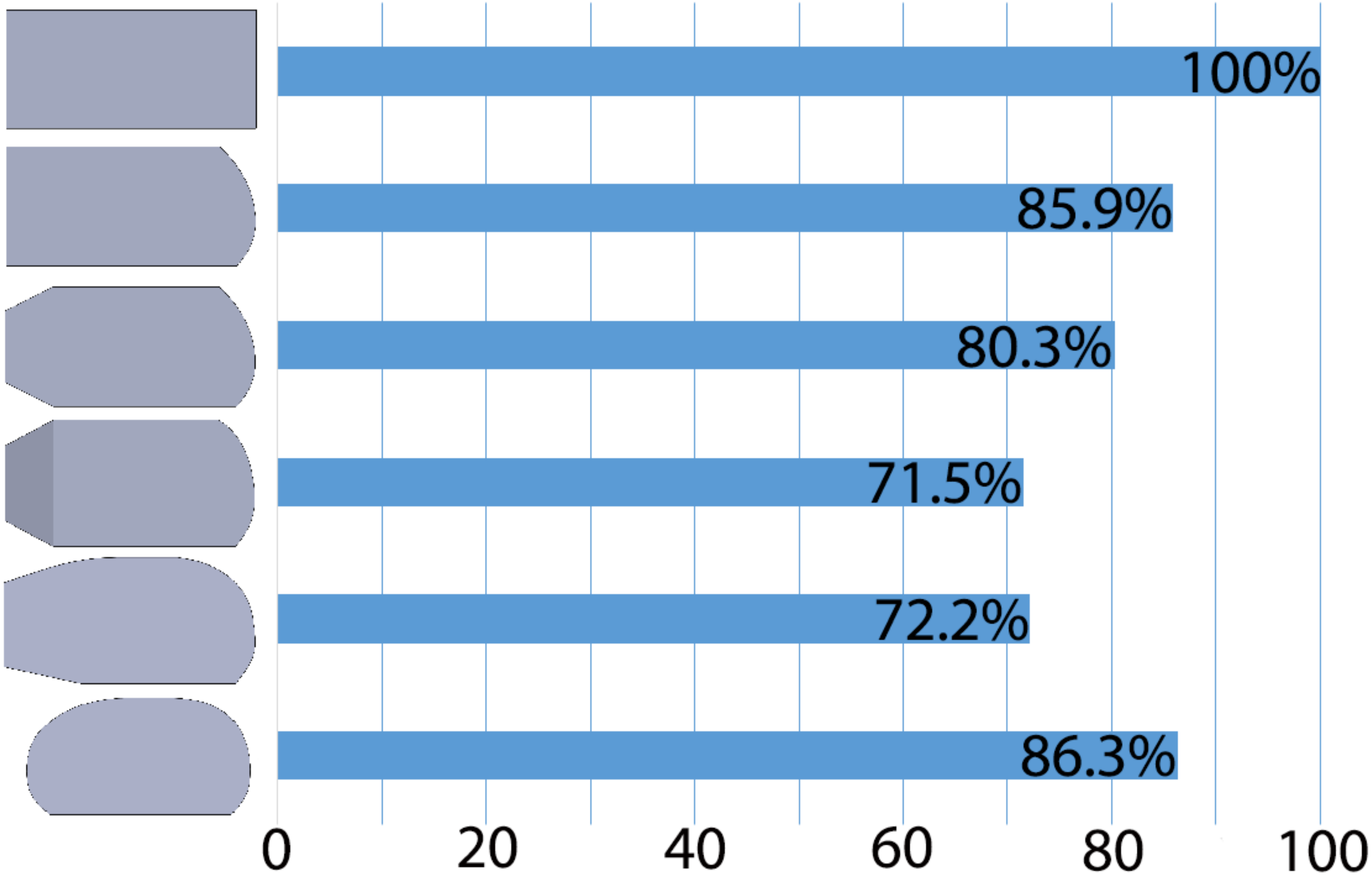

Figure 10. *Aerodynamic improvements for various iterations*

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Frame Design

- Shock Analysis
  - Interested in magnitude of maximum force
  - The maximum force was found to be approximately 5500 lb_f
  - The maximum deflection was found to be approximately 2.5 in.

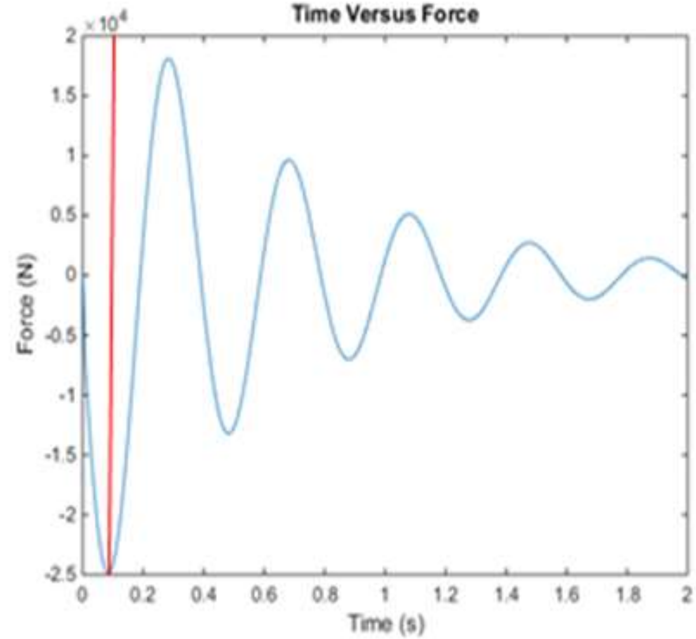

Figure 11. *Time versus force*

Frame Design

- Initial Design Concept
  - Rectangular Tubing
    - 5 x 2 x 1/4” for use at the base of the travel trailer
    - 3 x 1.5 x 1/8” for use everywhere else
    - Profiles picked at discretion of the client

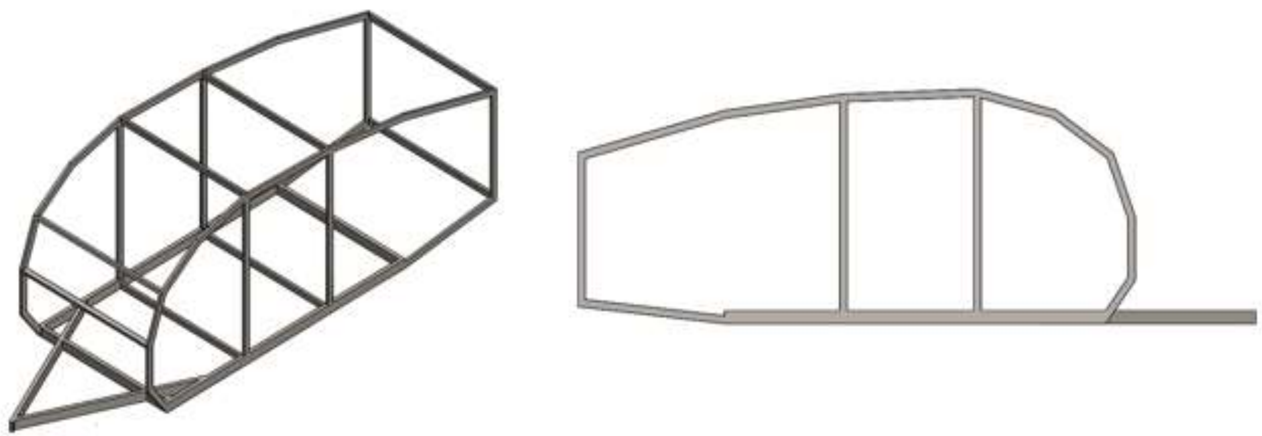

Figure 12. *Minimally comprised steel frame*

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Frame Design

- FEM Results
  - Abaqus CAE
  - Three loading scenarios
    - Headwind
    - Cross wind
    - Snow load
  - Determine feasibility of initial frame design

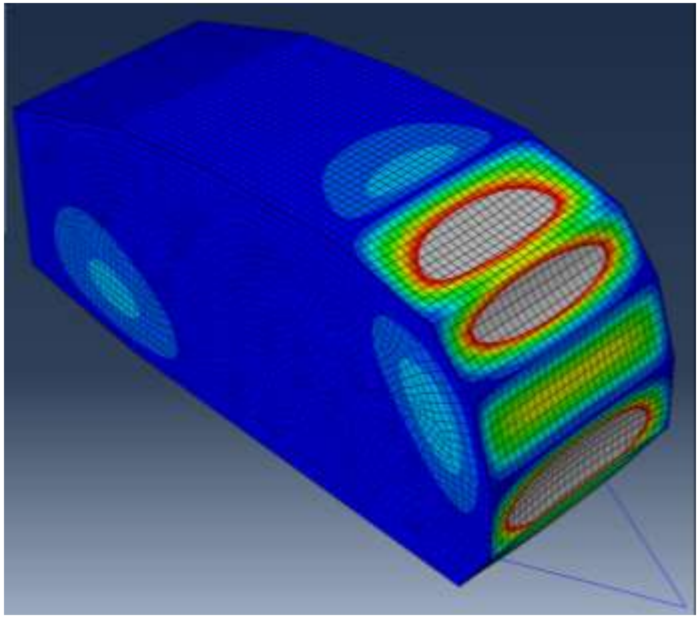

Figure 13. *Deflections due to headwind loading*

Frame Design

- Final Frame Concept
  - 2 x 4 x 1/4” rectangular tubing for the tongue
  - 4 x 7.25 C-Channel for all remaining members
  - Remaining members to be comprised of wood

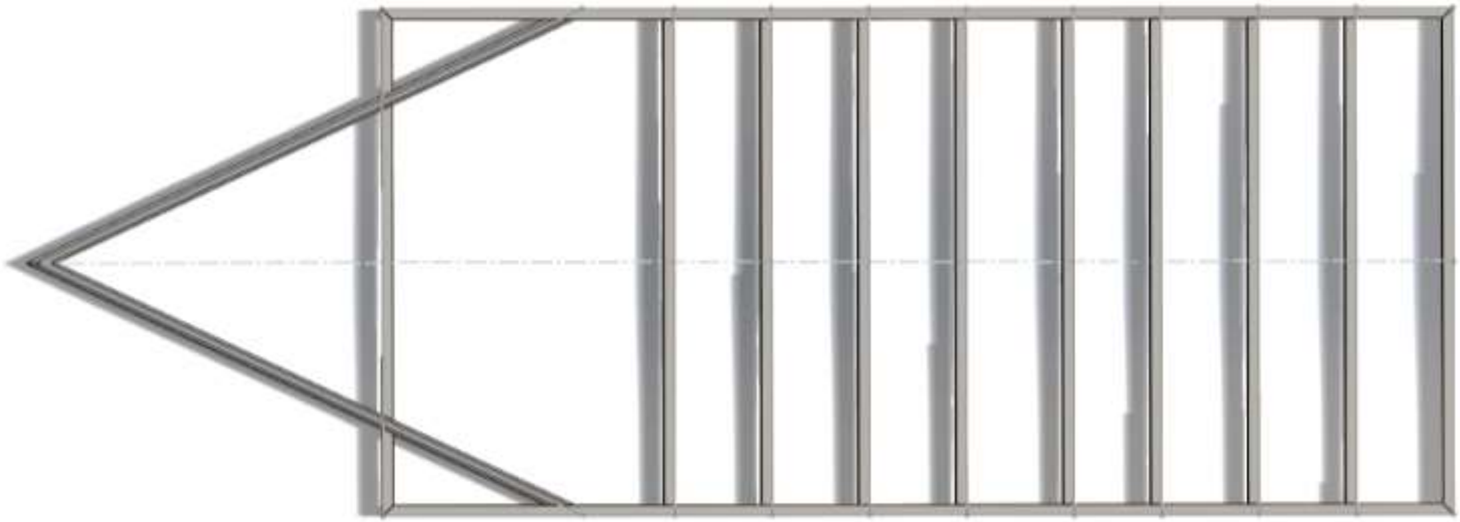

Figure 14. *Final frame concept (top view)*

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Questions?