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SJSU Undergraduate Research Grants

Design of the Straightening Section of a Supersonic Wind Tunnel

Kiana Luongo and Dr. Fabrizio Vergine

Department of Aerospace Engineering
at San Jose State University

Abstract

A flow straightener is a critical component in a wind tunnel, usually placed between the plenum chamber and the nozzle to cancel any transverse momentum component of the incoming flow and reduce the intensity of turbulence to achieve a research-grade flow quality in the test section. Turbulence reduction is especially critical for high-speed wind tunnels where the inherent high-Reynolds numbers can promote even higher turbulence levels that may not be representative of typical flight conditions. A screen with honeycomb shaped cells is the devices of choice to accomplish the task.

Due to its relatively small size, a honeycomb cell breaks up as many large turbulent eddies as possible while the length of the channel will help straightening the flow. An improper design could result in non ideal and unpredictable test conditions.

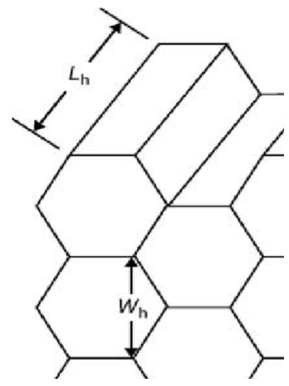
Final Dimensions

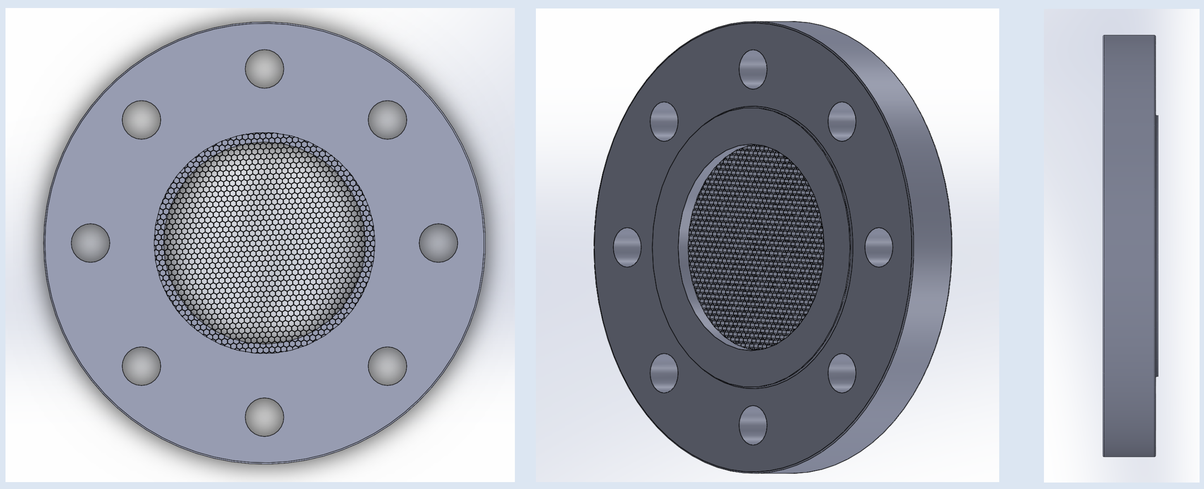
Straightener: Honeycomb
Cell Type: Honeycomb
Length: 1 in , L/D = 8
Thickness: 0.008 in
OD: 4.56 in
Cell #: 1261 , Cell size: $\frac{1}{8}$
Closed surface area: 2.29 in^2

Containment: Flange
High-Pressure Steel unthreaded Pipe Flange
Bolt size: ¾ in

Project Findings

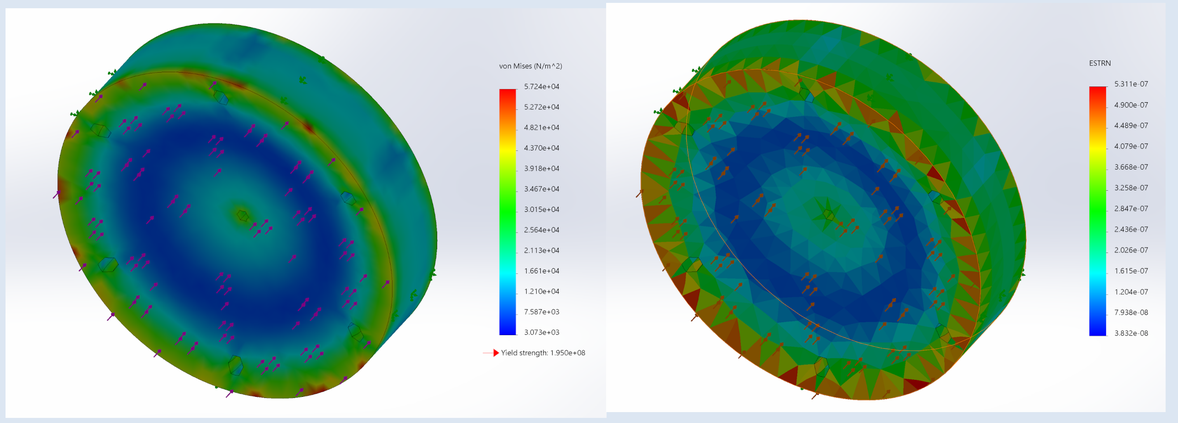
- Ideal cell size to length ratio: 6-8
- Minimum cell # 150 cells per OD



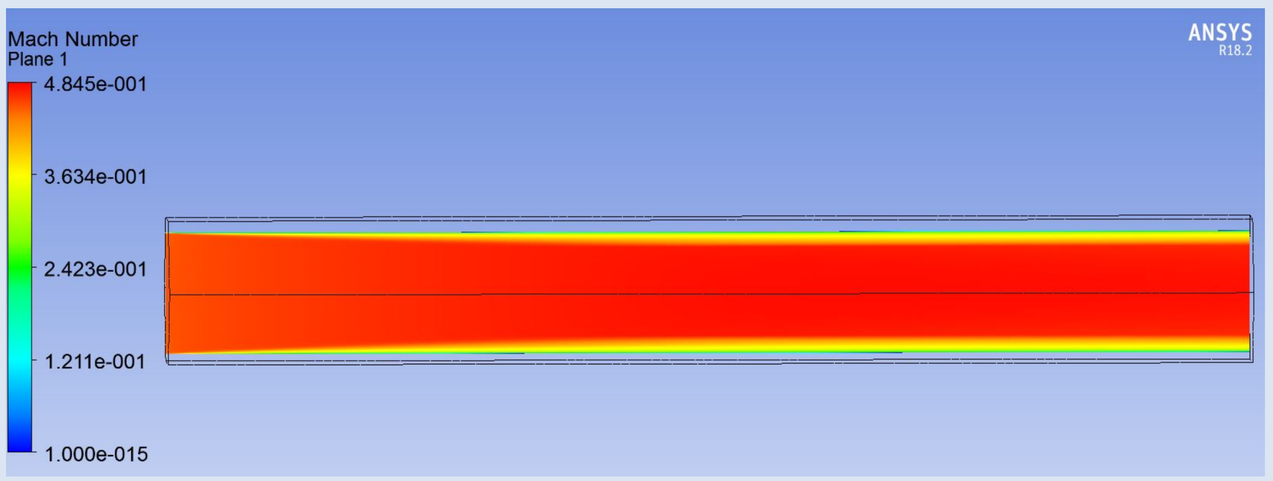


3-View CAD Assembly

Intergraded Assembly



Stress vs. Strain



Mach number distribution along a honeycomb cell for a given wind tunnel working condition.
Credit: Alexis Thoeny, Naval Postgraduate School, Monterey, CA

Research Questions

How to design a honeycomb straightener without interfering with critical aerodynamic processes

- What is the purpose of a flow straightener and why is it critical to the performance of a wind tunnel
- What are the appropriate flow straightening measures for a supersonic wind tunnel with a given area and Mach number
- What size and length of a honeycomb cells?
- What are the forces/stresses acting upon the flow straightener and what is the resulting flow/pressure after?
- Will this straightener interfere with the throat of the wind tunnel?

Citations

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