Simulation of Atmospheric Boundary Layer in a Wind Tunnel with a Contracted Inlet using Cowdrey Method

Nishigandha Kelkar, Undergraduate Researcher | Dhuree Seth, Doctoral Student (GRA) | Dr. J. Gordon Leishman, Faculty Advisor

Why Simulate ABL?

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<th>ENGINEERING DIVISION</th>
<th>APPLICATION</th>
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<tr>
<td>STRUCTURAL</td>
<td>• Local and overall fluctuating pressures on cladding</td>
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<td>• Wind forces on structures</td>
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<td>• Manner in which these structures affect the winds</td>
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<td>ENVIRONMENTAL</td>
<td>• Studies of diffusion from chimney stacks</td>
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<td>WIND ENGINEERING</td>
<td>• Estimate the wind loads acting on the ship</td>
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<td>• To further impact its performance</td>
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<td>• Obtain a safe operating envelope</td>
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ABL Simulation Techniques

• Rods with a Leading Trip
  • Law of the wall for smooth surfaces not obtained.
  • Flow did not have sufficient mixing to produce thick boundary layer.

• Grids
  • Very distorted velocity profile.
  • Aerodynamic drag too high.
  • Blockage effect was observed.

• Elliptical Wedge Generators
  • Complex method.
  • Flow with exaggerated wake was observed downstream.

Cowdrey Rod Method (1967)

• Technique generates ABL using horizontal circular rods placed parallel to the wind tunnel floor.
• Major advantage: Theoretical basis to obtain a desired power law profile.

Results

Wind Tunnel Contraction

Cowdrey Grid Comparisons: Increasing K1 values

Fig 1: This picture gives a perspective of how Bernoulli’s theorem was incorporated with Cowdrey method for calculation of rod dimensions and placement.

Fig 2: This graph shows that as the K1 value increases, the number of rods required at the inlet of the cross-section increases, for diameter of rod as 1 inch.

Fig 3: This picture shows the vertical spacing of the rod placement in the wind tunnel for diameter of road as 1 inch.

Cowdrey Rod Method (1967) Conclusions

• With increasing the K1 values, more number of rods were required while the spacing between axes of consecutive rods decreased.
• Also, the total number of rods required increased with decreasing the diameter of the rods.
• These observations were used to deduce the optimal placement of rods in the wind tunnel.

Conclusions

References