Simulation of Atmospheric Boundary Layer in a Wind Tunnel with a Contracted Inlet using Cowdrey Method
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Why Simulate ABL?

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

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**

  ![Wind Tunnel Contraction](image)

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

- **Cowdrey Grid Comparisons: Increasing K1 values**

  ![Cowdrey Grid Comparisons](image)

  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.

- **Plot of y vs l for various K1 when d=2 inches at inlet of test section**

  ![Plot of y vs l for various K1](image)

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

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.

References