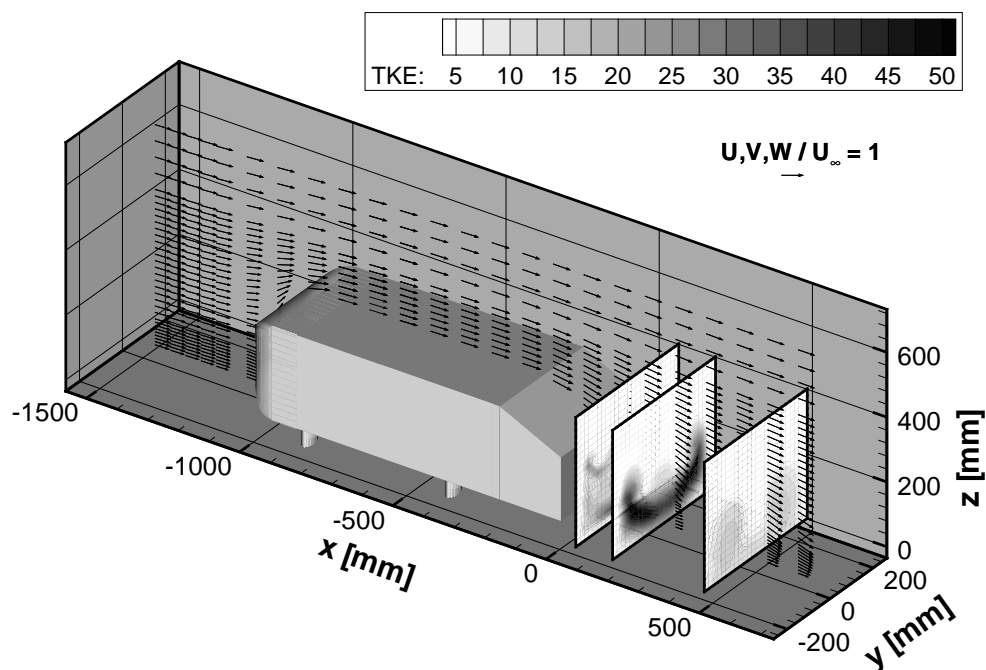


# CASE 9.4: flow around a simplified car body (Ahmed body)



Overview of velocity distributions and TKE around the  $25^{\circ}$  slant Ahmed body

#### Case 9.4. Flow around simplified car body (Ahmed Body).

Measurements of Lienhart, Stoots and Becker (2001) have been performed within EU project MOVA (Models for Vehicle Aerodynamics 1998-2001). The authors kindly provided their measurements for this Workshop. All data has been prepared for the download from Workshop's WebPages (the file-names are Ahmed\_25\_LDA.xls and Ahmed\_35\_LDA.xls).

#### Flow Description

The experiments were performed in the LSTM low-speed wind-tunnel. Cross-section of the tunnel is  $1.87 \times 1.4 \text{ m}^2$ . Figures 1-3 illustrate the investigated Ahmed Body.

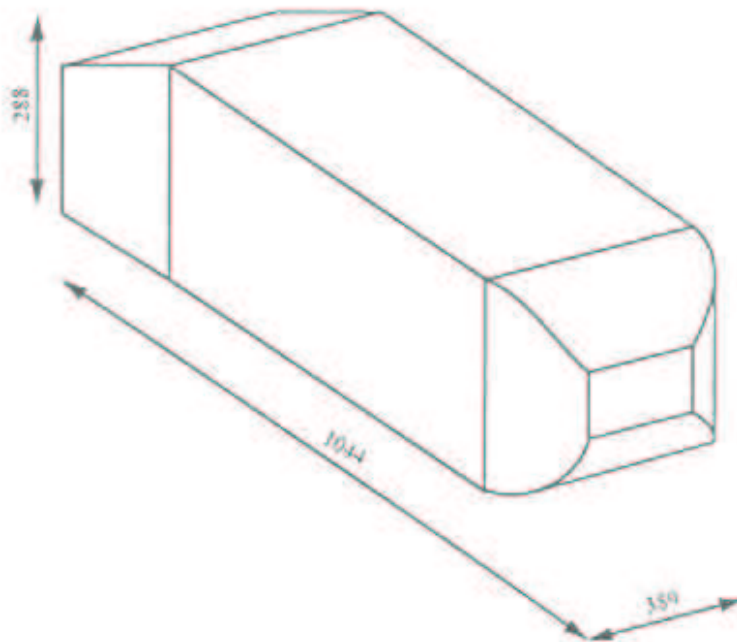


Figure 1. Dimensions of Ahmed Body

Stilts' diameter is 30 mm. Two slant angles of  $25^\circ$  and  $35^\circ$  are considered. The front part of Ahmed Body is given with all details in the file Ahmedgeo.hst, which can be downloaded. In the case that the surface or grid can be loaded directly within the solver, please send your request to [basara@avl.com](mailto:basara@avl.com). Available are all commonly applied file-formats used in standard commercial CFD codes.

## 8. Illustrations

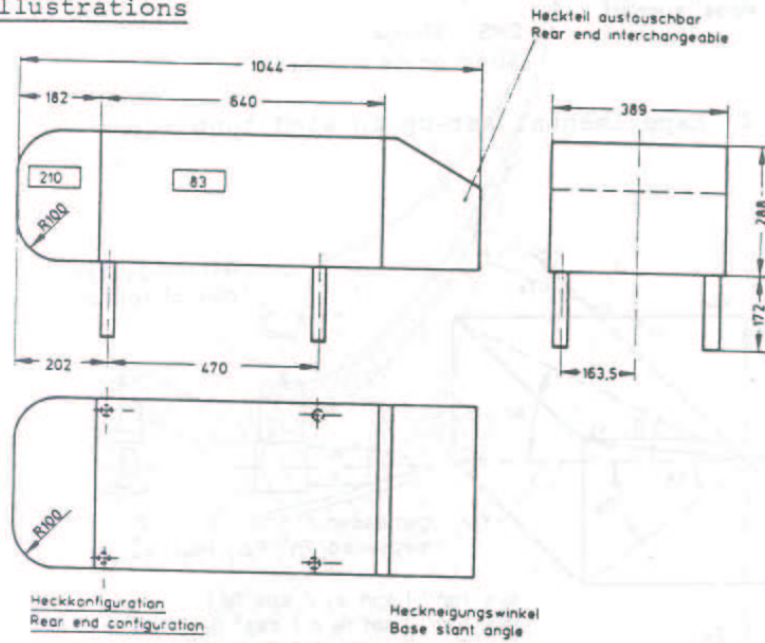


Figure 2. Ahmed Body as shown in Ahmed et al. (1984).

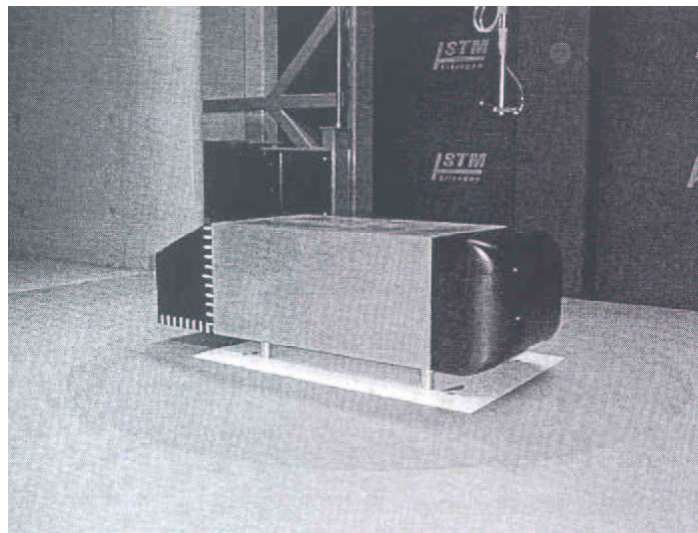


Figure 3. Original wind tunnel model (Ahmed Body) used in MOVA

## Flow parameters

Air with a kinematic viscosity of  $\nu = 1.5 \times 10^{-5} \text{ m}^2 / \text{s}$ . Bulk velocity is 40m/s.

## Available data

The center of the coordinate system is placed at the end of Ahmed Body ( $x=0$  end of the model,  $y=0$  symmetry plane,  $z=0$  ground plane). Measurements at the following positions (first, second and third order moments) are available:

25° :

$x=\text{const.}$  (symmetry plane)

-1.442, -1.262, -1.162, -1.062, -0.962, -0.862, -0.562, -0.362, -0.262, -0.162,  
-0.112, -0.062, -0.012, 0.038, 0.088, 0.138, 0.188, 0.238, 0.288, 0.338,  
0.438, 0.538, 0.638

$x=\text{const.}$  (y-z planes)

-0.178, -0.138, -0.088, -0.038, 0., 0.080, 0.200, 0.500

$y=\text{const.}$  (x-z planes)

-0.195, 0., 0.180, 0.0195

35°:

$x=\text{const.}$  (symmetry plane)

-1.463, -1.263, -1.163, -1.063, -0.963, -0.863, -0.563, -0.363, -0.263, -0.163,  
-0.113, -0.063, -0.013, 0.037, 0.087, 0.137, 0.187, 0.237, 0.287, 0.337,  
0.437, 0.537, 0.637

$x=\text{const.}$  (y-z planes)

-0.088, -0.0, 0.080, 0.200, 0.500

$y=\text{const.}$  (x-z planes)

0., 0.100, 0.0185

Detailed boundary layer measurements have been provided at the same positions for 25° and 35°:

$x=\text{const.}$

-0.243, -0.223, -0.203, -0.183, -0.163, -0.143, -0.123, -0.103, -0.083, -0.063,  
-0.043, -0.023, -0.003

Pressure distribution at the symmetry plane is also available.

## Instruction for calculations

Calculation domain should start at least half of the body length in front and approximately five body lengths behind Ahmed Body. Other dimensions are defined by the channel's height and width.

Inlet profiles for velocity and turbulence kinetic energy are given in Excel format and should be taken from the first measured position  $x = -1.463$  m. Measured inlet viscosity ratio is approximately 10 and this value should be used to recalculate a dissipation rate. Calculations are not sensitive on small variations of this ratio.

All walls should be treated as fixed walls.

In the case that transient calculations are performed, a full body should be calculated. Otherwise, a symmetry boundary condition can be employed through the middle central plane.

Zero streamwise gradients may be assumed for the flow variables at the outlet.

## Presentation of results

Profiles of Cartesian velocity components and turbulence kinetic energy should be plotted and compared with experimental data at  $x$  along the symmetry plane (tabulated data should be sent to organisers):

$X = -0.243, -0.223, -0.203, -0.183, -0.163, -0.143, -0.123, -0.103, -0.083, -0.063, -0.043, -0.023, -0.003$  m

Velocity vectors and turbulence kinetic energy should be plotted in  $y$ - $z$  planes at

$X = -0.038, 0.080, 0.200$  m

Surface streamlines should be plotted as shown in following Figures.

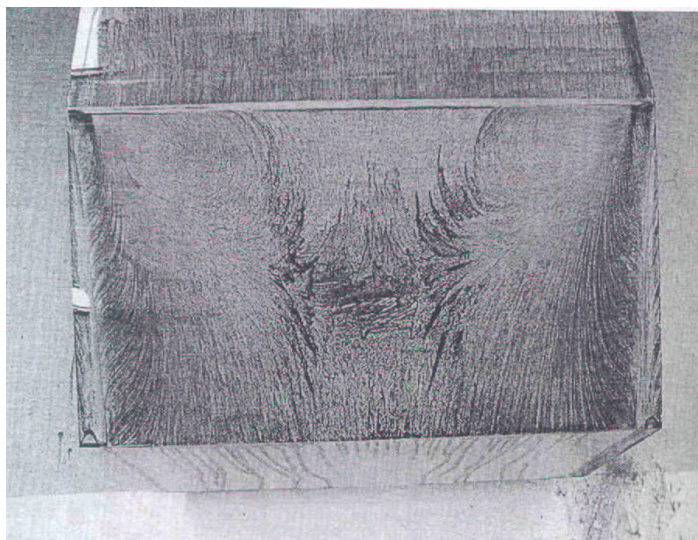


Figure 4: Flow visualisation of surface streamlines (25°), EU report APTF P/99-3.

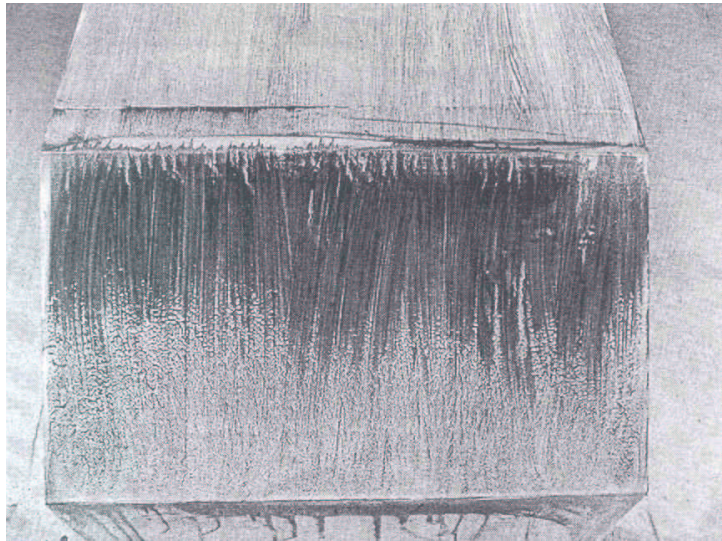


Figure 5: Flow visualisation of surface streamlines (35°), EU report APTF P/99-3.

## REFERENCES

**Becker, Lienhart, Stoots:** Flow and Turbulence Structures in the Wake of a Simplified Car Model (Ahmed Model), *DGLR Fach Symp. der AG STAB*, Stuttgart University, 15.-17. November 2000

**Ahmed, Ramm, Faltin:** Some salient features of the time-averaged ground vehicle wake, *SAE Paper 840300*, 1984

**B. Basara:** Numerical simulation of turbulent wakes around a vehicle, *FEDSM 99-7324*, 1999

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