

# Vortex breakdown in the near-wake of 25° Ahmed body

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The Ahmed body is an academic test-case meant to reproduce a wide range of the flow features encountered in automotive aerodynamics. In the present study, we focus on the 25 deg. slanted rear end, which is known to produce a fully three-dimensional, unsteady state consisting of a separation bubble over the slanted surface with highly energetic streamwise vortices issuing from the slant side edges, as observed experimentally by Lienhart et al<sup>2</sup>. The present work relies on high resolution Automated Stereo-PIV to clarify the structure and dynamics of the longitudinal vortices at high Reynolds number ( $Re = 2.8 \times 10^6$  based on the length of the geometry). A collection of 40 planes along the rear slant and 40 additional planes in the wake with a spatial resolution of  $dx = 5$  mm,  $dy = 1.5$  mm and  $dz = 1.5$  mm was used to reconstruct the fully three-dimensional (3D) time averaged mean flow. In addition, static pressure was acquired in the vortex core along the streamwise direction by the use of a pitot tube inclined following the vortex path deduced from 3D velocity field. The vortex core undergoes a sharp decay of streamwise velocity in the near wake ( $1 < x < 2$ , see Figure 1(a)) which suggests possible occurrence of vortex breakdown. Confirmation comes from the sign switch of the azimuthal vorticity in the longitudinal plane intersecting the vortex core. An abrupt change occurs 0.4 times the projected length of slanted window downstream of the square back, as marked by the vertical dashed line in Figure 1(b), and can be seen as the result of the divergence of axial vortex lines brought by an adverse pressure gradient, according to the work of Brown and Lopez<sup>1</sup>. The location of the sign switch seems strongly correlated to the modification of streamwise velocity as seen from Figure 1(c): initially in a uniform state, a low speed region appears followed by a conical shape of similar aspect than the experimental data obtained by Sarpakaya<sup>3</sup> in slightly diverging cylindrical tube at high Reynolds number.

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<sup>1</sup> Brown and Lopez, *J. Fluid Mech.* **221**(1), 553-576 (2009)

<sup>2</sup> Lienhart et al., *New Results in Numerical and Experimental Fluid Mechanics III*, 323-330 (2002)

<sup>3</sup> Sarpakaya, *Phys. Fluids* **7**(10), 2301-2303 (1995)

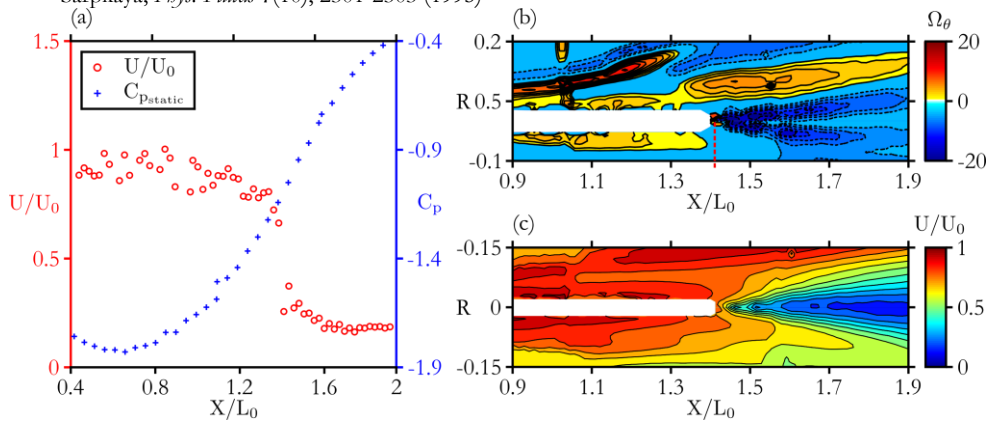


Figure 1: (a) Evolution of streamwise velocity and static pressure in the vortex core along the streamwise direction. (b) Contours of time-averaged azimuthal vorticity in the longitudinal plane intersecting the vortex core axis. (c) Contours of time-averaged streamwise velocity in the longitudinal plane intersecting the vortex core axis.