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DIRECT SIMULATIONS OF ACOUSTIC RADIATION AROUND A TRAILING EDGE WITH AN UPSTREAM KINK SHAPE

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Abstract

Intense tonal sound often radiates from flows around a trailing edge with an upstream kink shape such as found in automotive body. To clarify the acoustic radiation mechanism, direct simulations of flow and sound fields are performed in accordance with wind tunnel experiments. The flow configurations and experimental setup are shown in Fig. 1. The origin of the coordinate system is located at the kink shape. The x_d and y_d axes are set in the direction along the line from the kink shape to the trailing edge and in the normal direction, respectively.

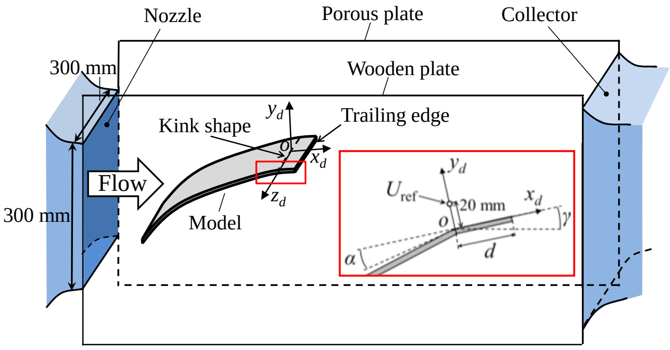

Figure 1 Experimental setup.

Table 2 Parameters

	d [m]	U_{ref} [m/s]	$M = U_{ref}/c$	Re_d	γ [°]
Comp.	0.03	30	0.087	6.0×10^5	0, 5, 10, 15
Exp.		26 ~ 36	0.076 ~ 0.105	5.2×10^5 ~ 7.2×10^5	

Table 1 shows the experimental and computational parameters. To clarify the effects of the kink shape on the sound, direct simulations and experimental were performed for 4 angles formed by the intersection of the line from the kink shape to the trailing edge and the horizontal line, γ = 0, 5, 10, 15°.
Figure 2 (a) shows the measured sound pressure spectra for γ = 0, 5, 10, 15°. It was clarified

that the tonal sound becomes most intense for γ = 5˚. Figure 2 (b) shows the effects of the freestream Mach number on the fundamental frequency. The ladder-type behavior was highlighted, and this behavior was also observed in flows around an airfoil in the past research[1]. This indicates that the acoustic-fluid interactions occur in the present configurations like in flows around an airfoil[2].

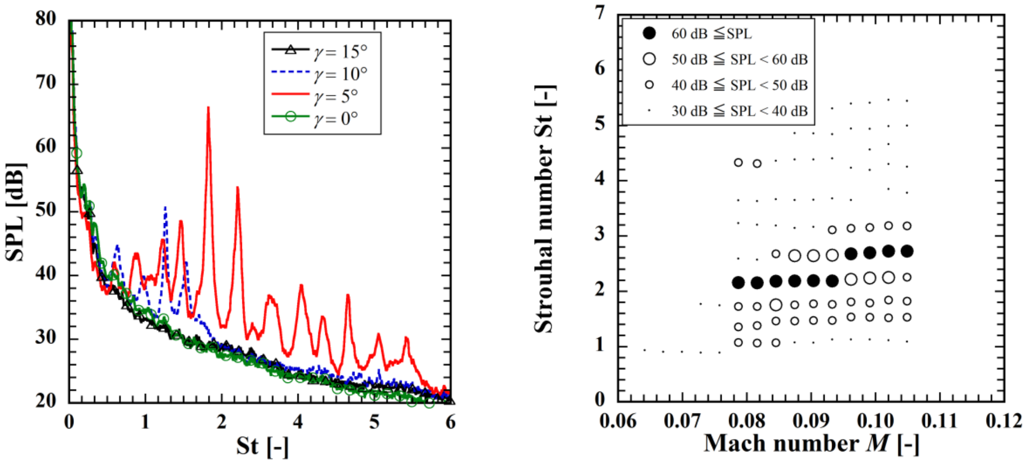

Figure 2 Measured sound pressure. (a) Sound pressure spectra (M = 0.087, ΔSt = 0.01). (b) Effects of Mach number on the fundamental frequency (γ = 5 ˚).

The direct simulations based on the compressible Navier-Stokes equations were performed. Figure 4 shows the measured and predicted sound pressure spectra for γ = 5˚. It has been confirmed that the frequency of the predicted tonal sound agrees with that measured that. Figure 4 (b) shows the contour of the predicted fluctuation pressure. It was clarified that the tonal sound radiates from the trailing edge. The detailed acoustic radiation mechanism and the effects of the kink shape are also discussed in the presentation.

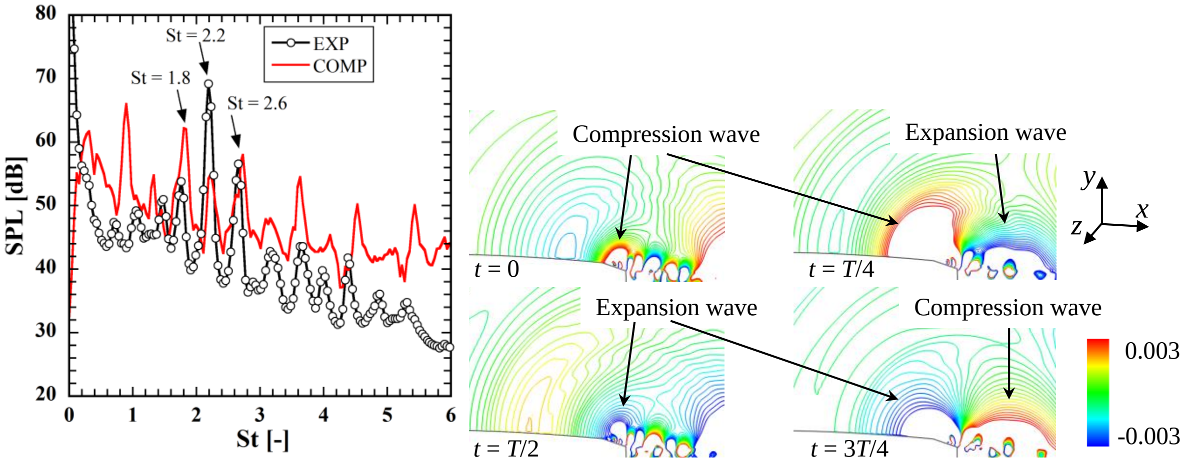

Figure 4 Acoustic fields (γ = 5 ˚, M = 0.087) (a) Sound pressure spectra (ΔSt = 0.04). (b) Contours of predicted fluctuation pressure.

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