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MODELLING OF AN AERODYNAMIC NOISE PROPAGATION BY MEANS OF AN IN-HOUSE CAA CODE

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The compressible Navier-Stokes equations can numerically predict the aerodynamic as well as acoustic flow field simultaneously. The solution of the Navier-Stokes equations using DNS or LES methods for capturing both the aerodynamic and acoustic fluctuations is still very time consuming. Since there is a large disparity of the length and time scales between the aerodynamic and acoustic variables the DES and LES methods are usually used for the source domain, it means there, were the aerodynamic disturbances generate noise. For the rest of computational domain, where the acoustic waves propagate the other methods can be used, e.g. the non-linearized Euler equations for fluctuating (acoustic) variables (Dykas et al.2008, 2010). Usually, in the propagation region it is assumed that the flow field does not generate any sound. However, the form of the non-linearized Euler equations applied in the in-house acoustic postprocessor allows for such possibility. For the computational domain called often as an acoustic source region, where flow disturbances generate noise, for better modeling acoustic excitation the LES method was implemented into the compressible in-house CFD code. This CFD code is dedicated for modeling the flow with inlet Mach number higher than 0.2.

The in-house CFD/CAA codes have been used for computation of the a cavity flow noise applications, where both broadband and tonal noise is emitted. This type of flow is commonly found aviation, turbomachinery, power engineering and of course in environmental flows. In the presented results the aerodynamic and acoustic fields were considered as 2D. This paper focuses mainly on the qualitative assessment of the applied techniques and description of the appeared problems.

The phenomenon of flow induced noise radiation in cavities has been studied experimentally (Ahuja and Mendoza, 1964 or Weyna, 2005) by many researchers from many years. The validation of the in-house acoustic postprocessor against Prof. Weyna experiments was preliminary carried out (Dykas et al., 2010).

Figure 1 shows a schematic overview of the phenomena undergoing during the cavity flow. The pressure wave travelling inside the cavity induces the shear layer oscillation, what is mainly responsible for the acoustic waves propagation. In Fig.1 the cavity depth and length used for calculation was presented also (according to experiment of Ahuja and Mendoza, 1964).

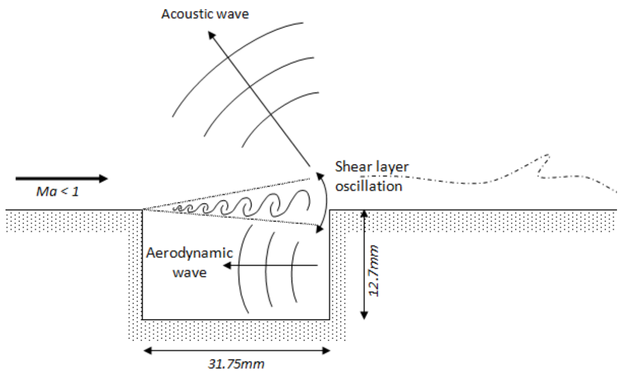

Fig 1: Schematic overview of the flow over the cavity.

Figure 2 shows the acoustic pressure field obtained from LES calculations. Acoustic waves are mainly generated by the oscillation of the shear layer above cavity and propagated rather upstream.

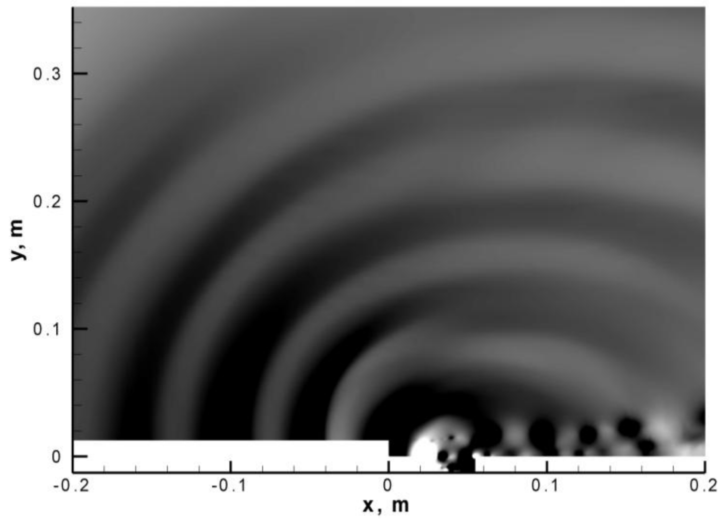

Fig.2. Snapshot of the acoustic pressure field from in-house LES computations

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