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Modeling interior noise due to fluctuating surface pressures from exterior flows

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Interior noise resulting from exterior flow over a structure is an important issue. The prediction of interior “windnoise” requires to model (i) broadband spatial and spectral statistics of the exterior fluctuating surface pressures (FSP) and (ii) how these FSP are transmitted through / radiated from the structure to the interior (broadband). Usage of unsteady compressible flow CFD simulation to characterize exterior FSP for broadband interior noise problems is relatively new; the accurate prediction of both the convective and acoustic wavenumber content of the flow can therefore be challenging. A numerical investigation of the flow characteristics downstream of a simplified side-mirror is presented here. A complex windnoise source is then described in terms of the superposition of two simple analytical sources derived from wavenumber analysis using CFD data. An example is presented in which the FSP are applied to a side glass with prediction of interior noise by SEA method.

Keywords: windnoise, CFD, aero-acoustics, fluctuating surface pressure, SEA, Turbulent Boundary Layer

1 Introduction

Interior noise generated by unsteady exterior flows is often referred as windnoise. In this paper, an analysis of fluctuating surface pressure downstream of a simplified side mirror. It is often found that the glass acts as a spatial filter and preferentially transmits certain wavenumbers in the fluctuating surface pressure.

An exterior fluctuating fluid surface pressure must thus be characterized not only by its magnitude but also its wavenumber content. A CFD model of FSP can be used for the prediction of its characteristics. If a compressible CFD simulation is performed, various signal processing techniques can be used to characterize the wavenumber content of the fluctuating surface pressures as discussed below.

2 Flow past simplified mirror

An unsteady CFD analysis was performed for flow past the simplified side mirror described in as illustrated in Figure 1 with examples of the unsteady flow due to a free-stream velocity of 50 m/s (computed using the commercial code PAM Flow). The resulting pressure time history data was imported into VA One software and converted to the frequency domain as illustrated in Figure 2 for with the auto-spectra magnitude at 100Hz and 1000Hz.

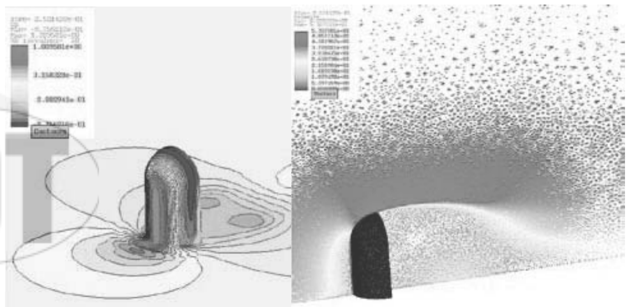

Figure 1: Visualization of flow predicted by CFD.

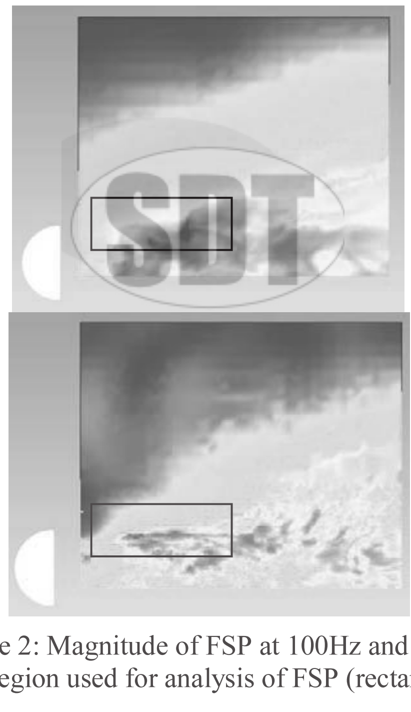

Figure 2: Magnitude of FSP at 100Hz and 1kHz and region used for analysis of FSP (rectangle).