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Design and Construction of a Silent Wind Tunnel for Aeroacoustic Research

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Abstract

The anechoic chamber of "hepia - Genève" was modified with the purpouse to host a removable wind tunnel for aeroacoustic research. This paper describes in detail the design and construction of this small scale, low Mach number, silent wind tunnel. Special attention is given to a detailed description of the technical challanges faced.

1 Introduction

Due to the growing interest in aeroacoustics from the side of *"hepia - Genève"* (Haute école du Paysage d'Ingénierie et d'Architecture de Genève - hereafter *hepia*), its pre-existing anechoic chamber was modified in order to host a wind tunnel which can be used for aeroacoustic research. The anechoic chamber, still having to be used for classical acoustic measurements, could not host a permanent facility. A choice has been made to design and construct a removable wind tunnel inside the anechoic chamber.

2 Scope of the work

This paper presents the design and the construction of a small-scale, low Mach number and silent wind tunnel for aeroacoustic research. The presented work was realized in the anechoic chamber of *hepia*. The technical challenge of this project rises due to the fact that any new installation in the anechoic chamber should not prevent its further use for purely acoustical measurements. This led to the choice of a silent wind tunnel that does not introduce relevant structural modifications to the anechoic chamber and that can be easily removable.

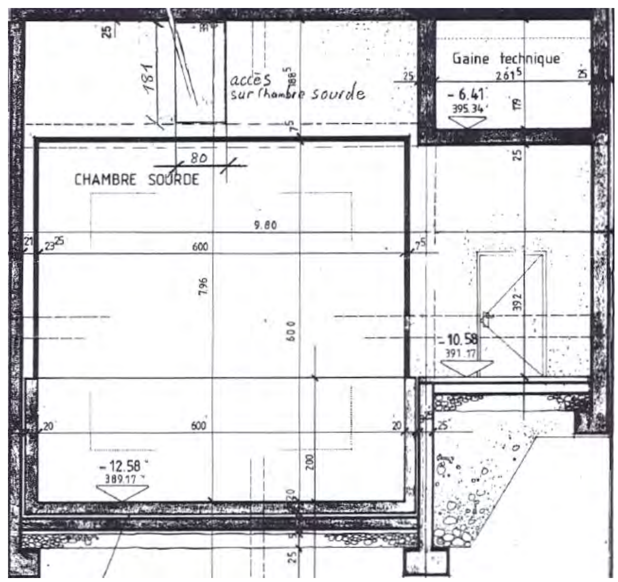

Figure 1: Schematic drawing of the hepia anechoich chamber.

The silent wind tunnel test section is an open test section where flow is provided by an horizontal square jet. The open jet test section is particularly suitable for acoustic testing because the surrounding plenum chamber can be equipped with acoustc linings [2]. In fact, the test section is positioned inside the anechoic chamber, so that aeroacoustic experiments can be performed with a very low background noise

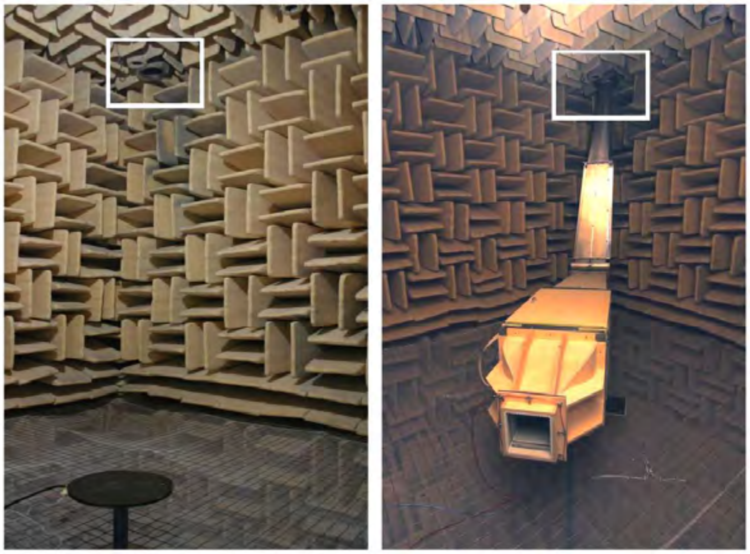

Figure 2: Internal pictures of the *hepia* anechoic chamber. The left figure shows the empty chamber. The right figure shows the wind tunnel setup inside it. The figures highlight the aperture used for the ventilation of the room.

level.

3 The *hepia* anechoic chamber

The *hepia* anechoic chamber, presented in Fig. 1, is a 6 m side cubic chamber lined with sound absorbing wedges (prisms 860 mm long) on the walls, ceiling and floor. The chamber is mounted inside a room that is located underground, to minimize the noise transmitted from the surroundings to the anechoic chamber. Several omega-shaped springs suspend the chamber with respect to the room where it is housed and prevent acoustic-vibrational coupling of the two structures. Above the ceiling of the anechoic chamber, an empty space exists, providing room for technical inspections and for housing a ventilation system. This system is used to blow air from outside into the test chamber, with the purpose of reducing the moisture level in the acoustic facility. The ventilation system discharge (highlighted by the white square in the left picture of Fig. 2) is a 200 mm circular aperture placed near the upper corner of the chamber opposite to the chamber door.

In order to obtain a low background noise the test section of the silent wind tunnel is housed inside the anechoic chamber. To keep this low noise level during the aeroacoustic experiments, the wind tunnel was designed such that it does not introduce additional noise (silent wind tunnel). To achieve such an objective, the fan of the wind tunnel was housed outside of the chamber, in the empty space above the ceiling of the anechoic chamber.

The main issue to be addressed in the wind tunnel design and construction was the identification of a flow entry within the anechoic chamber without massive, expensive and destructive actions on the structure of the room. As shown in Fig. 2, the flow entry was decided to be the already existing aperture previously used for ventilation purposes. Since this hole is placed on the opposite top corner of the room entrance, the layout of the room suggested the possibility of using the open door as air outlet during the aeroacoustic experiments. Fig. 3 shows the configuration of the silent wind tunnel.

4 Aerodynamic design

The design goal of the wind tunnel is to perform aeroacoustic measurements at low Mach numbers. For this purpose, the target maximum flow velocity in the test section was set to 20 m/s.

According to the geometrical dimensions of