

ACOUSTIC SIMULATION OF THE CENTRAL HALL IN PALAU GÜELL BY GAUDÍ

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Abstract

Introduction: Quadric surfaces are commonly used in buildings due to their geometric ability to distribute and focus sound waves. The Central Hall in Palau Güell — a UNESCO World Heritage Site — is topped by an ellipsoidal dome. Antoni Gaudí envisaged this room as a concert hall where the organ and the dome play a lead role. **Methods:** The two previously mentioned elements are the main subject of our paper, which serves two purposes: 1) determining the values of the acoustic parameters of the hall through onsite measurement and also through simulation, and 2) using the geometric parameters of the quadric surface, which best fits the dome, in order to check whether it is possible to improve the acoustics of the hall by placing a new emission source at the focus of the dome's ellipsoid. **Results and Discussion:** Contrary to the authors' expectations, due to the focal reflection properties of the quadric surface, some acoustic parameters on the listening plane do not improve significantly. Therefore, we conclude that Gaudí took the acoustical impact into account when designing this hall.

Keywords

Ellipsoidal dome, acoustics, Palau Güell, Antoni Gaudí.

Introduction

The Palau Güell (1885–1890) is amongst the first important projects by Antoni Gaudí (1852–1926), and the only new construction he was able to finish. The building was commissioned by the Barcelona businessman Eusebi Güell Bacigalupi, who gave the architect total freedom in design (González et al., 2013).

One of the most representative spaces in Palau Güell is the Central Hall (Fig. 1). Apart from being the space around which the entire residence was arranged, it was created and designed to hold music recitals. Being a music lover, Eusebi Güell suggested that Gaudí's project should include a room where he could listen to live music in the company of friends and artists of their time. As a matter of fact, several Wagner operas were presented in Barcelona during the construction of Palau Güell, resulting in a Wagnerian craze in which Eusebi Güell took an active part (Granell, 2002; Lahuerta, 1992). This stirred up his interest in incorporating music into the palace's design. In addition to using the Central Hall for music recitals — even with choirs and an organ — its design was also suitable for religious services, conferences, and public lectures.

According to González et al. (2013), the decision to provide the palace with an organ was taken very early and had a direct impact on the geometric design of the hall. More specifically, the Central Hall is topped by an ellipsoidal dome with many small holes and a central eye, which ensure daylighting.

The dome spans above a quadrangular area of approximately 60 m². The height to the central eye is 16.17 m. Throughout this height, the Central Hall musically and visually links three levels: a first level where the audience seats were arranged, a second level for the orchestra, and a third level for the choral ensembles. The organ pipes were installed between the third level and the dome. This hall has an approximate volume of 996.40 m³ and it features ceramic tilings, marble ornaments, glass enclosures, and oak wood flooring. Therefore, a priori, it is a very reverberant space (Figs. 1 and 2).

Antoni Gaudí envisaged this room as a concert hall where the organ and the dome play a lead role. These two elements are directly involved in our calculations. The following are the topics covered in our paper:

a) Despite the interior finishes and the proportions of space, it is commonly claimed that the Central Hall in Palau Güell has good acoustics. Nonetheless, we are not aware of any rigorous study, which quantifies the acoustic quality at the listening plane, where the audience sat. This paper provides a measure of the acoustic parameters.

b) We are not aware of any original documents by Gaudí explaining the reasons why he designed an ellipsoidal dome. Quadric surfaces are commonly used in theaters, stadiums, and public venues due to their geometric ability to distribute and focus sound (Kircheri, 1673; León-Rodríguez, 1998). Based on