
An Experimental Study of Acoustical Parameters in Churches

A. Magrini

Dipartimento di Ingegneria Idraulica e Ambientale, Università di Pavia, Via Ferrata 1, 27100 Pavia, Italy

P. Ricciardi

Dipartimento di Termoeconomica e Condizionamento Ambientale, Università di Genova,

Via all'Opera Pia 15A, 16145 Genova, Italy

(Received 3 October 2000; revised 16 July 2002; accepted 19 July 2002)

This paper reports the acoustical parameters measured in ten churches in the city of Genoa, Italy. Churches are often selected for use as auditorium, theatres, concert halls, and other non-liturgical uses without any technical knowledge about their acoustical properties. Wiser selections could be made if the decisions were informed by knowledge of their acoustical parameters. This paper presents the results of a wide investigation on the various acoustical parameters such as clarity index, definition index, centre time and various reverberation times (e.g. EDT, RT20, RT30), which can give more reliable information on the acoustical response of an enclosed environment. This problem has already been studied by some authors, but mostly for the case of church restoration, connected with the changes in uses for auditorium functions. The selected churches (XI-XVI sec.), are mainly located in the historic centre of Genoa, and are all characterised by a longitudinal plans having two aisles and by cubic volumes ranging from 1500 to 20.000 m³. A wide experimental study has been carried out with the impulse response analysis measurement system in each church. A comparison with data available in the literature (reverberation time, RT, and clarity index, C80) regarding churches and also theatres is presented; measurements of RT and C80 show a dependency on the ratio of the volume to the floor seating area (V/S). The variation field of RT, C80 and D50 related to frequency are reported. Further on, a mathematical correlation between C80 and RT is proposed.

1. INTRODUCTION

In recent times the development of more sophisticated measurement techniques has allowed for the evaluation of various acoustical parameters such as C50, C80 (clarity index), D50 (definition index), TS (centre time) and various reverberation times (e.g. EDT, RT20, RT30). These parameters can give more reliable information on the acoustical responses of enclosed environments. These methods have been mainly applied to the design or acoustical correction of theatres and auditoriums. Literature regarding these types of buildings is extensive, while only a few papers have been published about the conversion of churches into auditorium originally designed for other purposes.

A typical example where the acoustical characteristics have been disregarded is represented by religious buildings. These structures have not been designed and constructed for auditorium uses. The shape and the materials of the original projects and the following restorations were based on architectural criteria, taking into account not only space distribution necessities but also the historical evolution of architectural styles and liturgical services and ceremonies. Nevertheless churches often harbour music performances. So there is a need for an investigation of the acoustical parameters of these buildings.

This work is a part of an experimental study and consists of measurements made in the more historic churches located in the city of Genoa, in an unoccupied state, in order to identify either the type of music could be played in each church or the eventual requirement of a space correction.

2. MEASURED CHURCHES

In this paper the results of the measurements in ten churches are presented. The selected churches each have a longitudinal plan with two aisles either with or without lateral chapels, and are mainly located in the historic centre of the city of Genoa.

The date of the design of S. Lorenzo, the Cathedral of the city of Genoa is very difficult to state, since its construction progressed over several centuries: the first nucleus was built in 1118, in the XIII century the building was transformed from Romanesque to Gothic style and in the XVI century the façade was modified. Figure 1(a) shows plan and section of S. Lorenzo.

S.S. Annunziata was erected in 1228 by Franciscan friars and completely reconstructed in 1616, when its Gothic structure was completely substituted with a Baroque one. Figure 1(b) shows plan and section of S.S. Annunziata.

S.M. delle Vigne was firstly mentioned in 981, but it was completely modified in the late XVI century, and a century later all the interior decoration was completed in the Baroque Style. Figure 1(c) shows plan and section of S.M. delle Vigne.

S.M. di Castello was founded before 1130 by "magistri antelami" and even though it was modified in various centuries up till the XX century, the Romanesque style is prevalent. Figure 1(d) shows plan and section of S.M. di Castello.

N.S. Consolazione was founded in 1684 and its construction was achieved in 1693. It is all, including the façade in Baroque style. Figure 1(e) shows plan and section of N.S. Consolazione.