Acoustical Behavior Of Churches: Mudejar-Gothic Churches

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Abstract: Christian churches have traditionally been considered to have very good acoustical behavior. This unfounded belief has led to important errors in church rehabilitation works, especially when the church is to be used subsequently as an auditorium or theater; this is the case of many churches in Spain. Our research group has worked in acoustical analysis for more than ten years. We have participated in many cases of church rehabilitation and have had the opportunity to achieve surprisingly good acoustical behavior in several. We deal with a very common type in southern Spain: Gothic-Mudejar churches, which have a small volume, a triple-nave layout, and wooden ceilings.

INTRODUCTION

The acoustical behavior of Roman Catholic churches has been the object of different studies by several authors, including the authors of this paper (1,2). In reality, the special volumetric and formal characteristics of these places of worship lend them a particular acoustical behavior which, with few exceptions, can be rated as inadequate. The Andalusian Mudejar-Gothic churches are among these exceptions.

When Christians recovered southern Spain from the Arabs in the thirteenth century, they built churches over the mosques for symbolic reasons: they wanted to represent the new power. To do so, they brought masters from the north who knew the rules of Gothic architecture. However, a large number of churches had to be built in a short time, and the available workers were mainly Mudejars (subjugated Moors), who were familiar with other constructive techniques, such as wooden roofs and brick walls. This gave rise to the Mudejar-Gothic style, with churches whose most representative points (presbytery and portals) are built of stone, following the Gothic style, while the body of the church has brick walls and three naves with a coffered ceiling (figure 1).

This is the style of most of the parish churches in Seville (Spain), and it is the style we will deal with in this study. We have chosen ten churches, a sampling which we consider sufficiently representative.

ACOUSTICAL BEHAVIOR

We carried out a very detailed acoustical analysis on each building, including on-site tests to determine the following:

a) Reverberation time at different frequencies on the octave band
b) Distribution of sound pressure levels in a stationary state
c) RASTI index at several points, with and without electroacoustical support
d) NR indexes to evaluate background noise.

The sound distribution study allowed us to deduce a model similar to Barron's model (3) to describe the reverberated field, which we published recently, (4). From the analysis of the reverberation times at different frequencies in the ten churches (figure 1), we can conclude that their acoustical conditions are reasonably good, even when there is no audience. These conditions are close to optimum for music at medium and high frequencies, although the values are rather low for bass because of the presence of a large amount of bass-absorbing material (wood). When the church is full, reverberation times are near optimum for speech.

Only three of the ten churches studied differ from the above evaluation: the St. Marina, St. Julian, and St. Mark Churches. All three have recently undergone renovation and restoration work and have lost much of their ornamentation. Also, the St. Marina and St. Julian churches are characterized by their large size in relation with the other churches

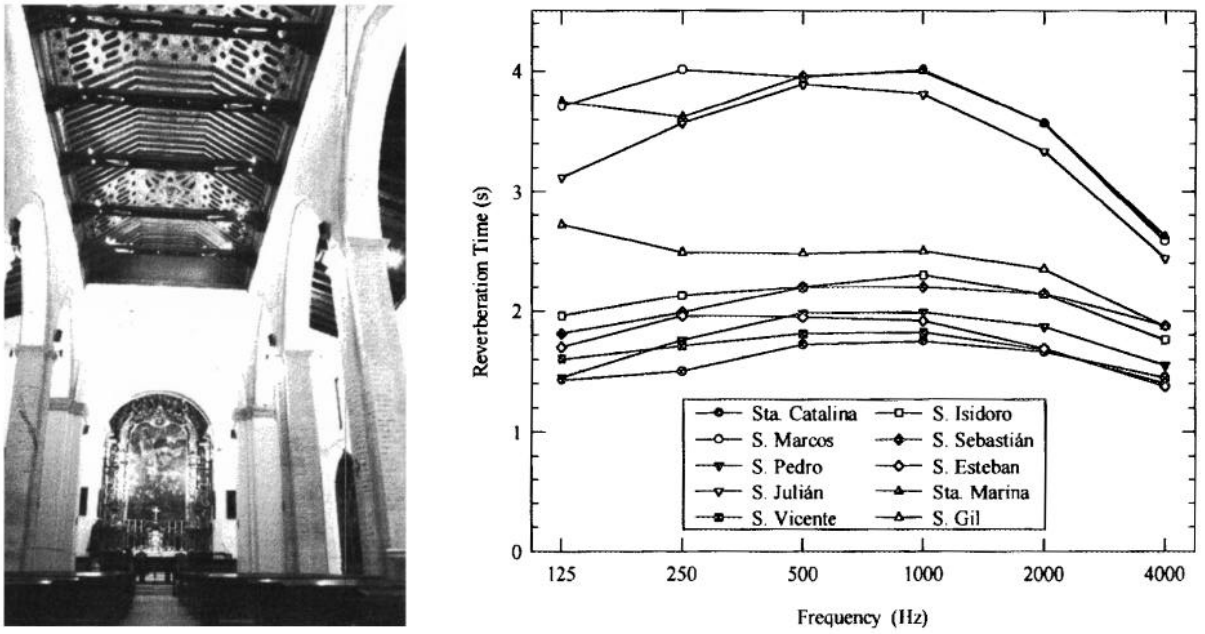

FIGURE 1. Inside of the Mudejar-Gothic St. Isidore Church and reverberation times measured in the ten churches

studied. St. Mark's church is smaller, but its main nave is presently covered with ceramic pieces because the original wood was damaged by termites. Finally, it is important to mention that none of these three churches have side chapels.

The RASTI index measurements gave average values of between 0.35 and 0.48 without electroacoustical support, which would classify their intelligibility as "poor," although it must be noted that the tests were run when the churches had no audience. The existence of a public-address system raised the average RASTI values to between 0.45 and 0.57.

The background noise levels in the churches produce NR indexes of between 33 and 44 due to traffic noise because all of them, except one, are located in the historic center of the city, near narrow, heavily-traveled streets. The presence of a heavy wooden inner door at the main entrance in the St. Gil and St. Vicent Churches is the principal cause of the lower values shown for this index.

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