SOUND-FIELD DIFFUSENESS IN OBLIQUE-SHAPED REVERBERATION ROOMS WITH DIFFERENT TEST CONFIGURATIONS

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1 INTRODUCTION

The accuracy of the reverberation-room methods, especially at low frequencies, has a long controversial history, which can be attributed to insufficient sound-field diffuseness [1, 2]. To find a solution to the problem, numerous studies have been carried out over the years. One of the recent studies [3] suggested that an oblique-shaped reverberation room having an ISO-prescribed volume of 150 m^3 [4] with the regular dimensional orientation (shortest vertical dimension) and a test configuration prescribed by standards would provide better sound-field diffuseness and, hence, better measurement accuracy than other reverberation rooms of different shapes and volumes. Based on this finding, the same study was extended to other test configurations, and their effect on sound-field diffuseness is addressed in this paper. A number of parameters like curvature (κ) of temporal energy-decay curves, spatial uniformity of the reverberant sound field (SPL), prediction accuracy of reverberation times (RT), prediction accuracy of absorption coefficients, etc. have been used as descriptors to quantify the degree of sound-field diffuseness. Results obtained with the help of a numerical finite-element-based modal approach are discussed. Finally, an optimal test configuration is recommended that would provide better field diffuseness.

2 THE REVERBERATION ROOMS

For a given oblique-shaped reverberation room of volume 150 m^3 with regular dimensional orientation, six different test configurations were considered here. The configurations considered are: Room #1 – with no diffusers (empty) (Fig. 1a); Room #2 – with diffusers (Fig. 1b); Room #3 – with absorbent corner treatments (Fig. 1c); Room #4 – with both diffusers and absorbent corner treatments (Fig. 1d); Room #5 – with Quadratic Residue Diffusers (QRD) (Fig. 1e); and Room #6 – with both diffusers and QRD (Fig. 1f). Predictions were performed with 1 source and 5 receivers in nine third-octave bands ranging from 50 to 315 Hz. Positioning of the sources and receivers was performed based on the standard's prescriptions [4].

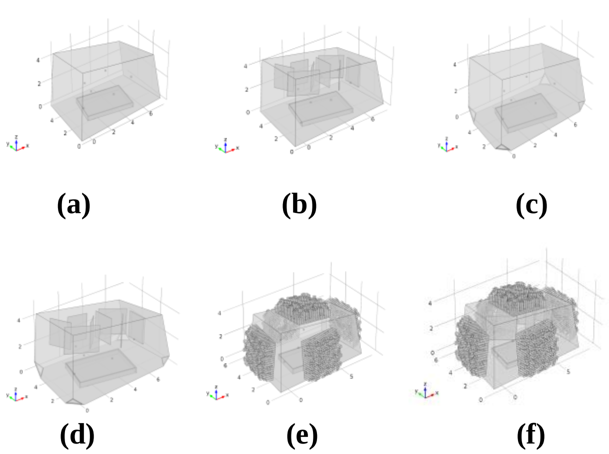

Figure 1: Different test configurations.

3 RESULTS

The curvatures of the temporal-decay curves in third-octave bands for the different test configurations are presented in Figure 2. It is noticeable that the curvatures are smaller than 10 for the room equipped with diffusers and absorbent corner treatments (Room #4) from the 125-Hz third-octave band. The curvatures are a bit higher for the rooms equipped with QRDs.

The SPL deviations predicted in third-octave bands for the different test configurations are presented in Figure 3. It is obvious that the deviations are smaller than the ISO-prescribed limit of 1.5 dB from the 160-Hz third-octave band for all of the test configurations except those equipped with QRDs. Overall, it is also noticeable that Room #4 (with diffusers and absorbent corner treatments) yields a smaller deviation from the 125-Hz band than the other test configurations.

The RT-prediction errors in third-octaves for the different test configurations are presented in Figure 4. It is obvious that the errors are smaller than 10% from the 125-Hz third-octave band for Room #4. However, the same is not true for the rooms equipped with QRDs; rather they show greater errors than the other test configurations.

The predicted absorption coefficients of a sample absorber in third-octave bands for the different test configurations are presented in Figure 5. It is noticeable that the predicted values from the 100-Hz band are closer to the

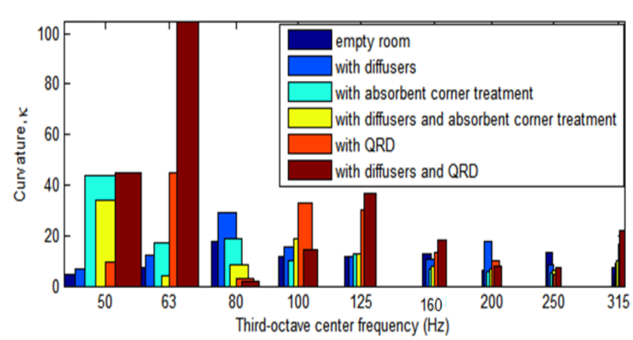

Figure 2: Curvatures of temporal-decay curves in third-octave bands for different test configurations.

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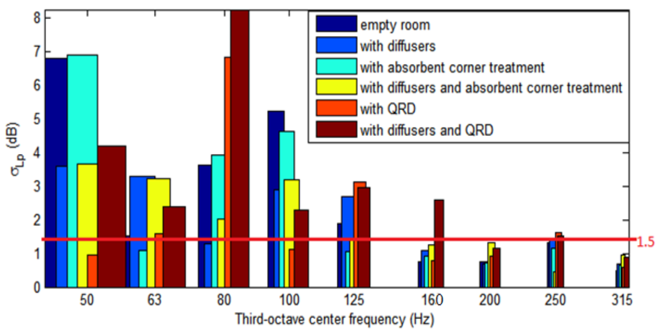

Figure 3: SPL deviations in third-octave bands for different test configurations.

expected value of 0.76 for the room with absorbent corner treatments (Room #3) and the room with both diffusers and absorbent corner treatments (Room #4). Surprisingly, the rooms with QRDs also give good accuracies in some frequency bands, which is not clear and cannot be explained.

4 DISCUSSION

Based on the results discussed above in terms of different descriptors, it is clear that reverberation rooms equipped with either diffusers or absorbent corner treatments, or both, yield better field diffuseness than other test configurations. It was also noticed that the prediction accuracy of the absorption coefficients of the sample absorber is better for the room equipped with both diffusers and absorbent corner treatments than for the other test configurations. Overall, it was noticed that the rooms with QRDs yield less accurate results; this can be attributed to the increased surface absorption, which results from a significant increase in surface area (due to the installation of the QRDs).

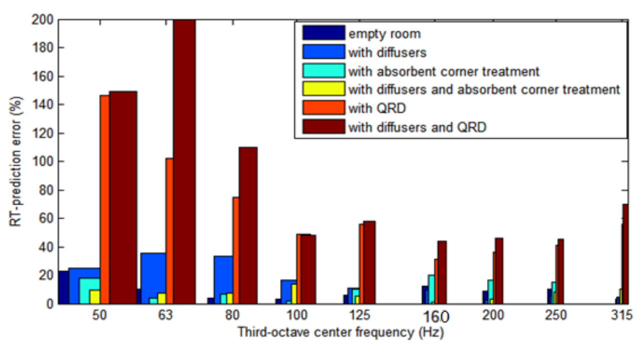

Figure 4: RT-prediction errors in third-octave bands for different test configurations.

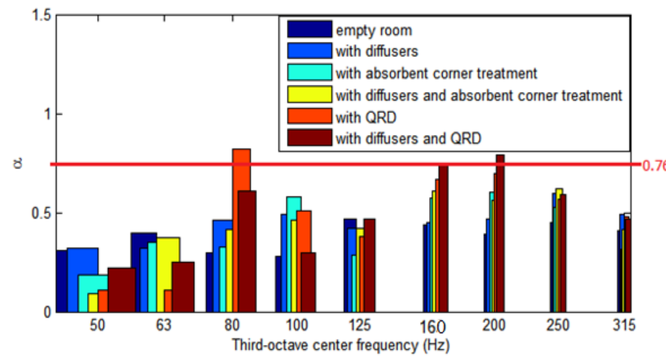

Figure 5: Sample absorber absorption coefficients in third-octave bands for different test configurations.

5 CONCLUSION

Overall, it can be concluded that an oblique-shaped reverberation room of volume 150 m^3 with regular dimensional orientation and equipped with diffusers and absorbent corner treatments would provide better diffuseness compared to other test configurations.

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