1 INTRODUCTION

The reverberation-room method, which assumes a diffuse sound field, has long been used for various standardized room-acoustical measurements – i.e. absorption coefficient, source power level, transmission loss, etc. However, unsatisfactory opinions regarding the accuracy of the method, especially at low frequencies, have been reported over the years [1, 2]. This might be due to deviations from the assumed diffuse-field concept, which is very challenging to implement from an application point of view.

To investigate the problem, and find an optimal solution, a number of reverberation rooms of different sizes and shapes have been studied; their capacity to approximate a diffuse sound field is analyzed by means of descriptors like a statistically-based cut-off-frequency definition, spatial uniformity of the reverberant sound field (SPL), prediction accuracy of reverberation times (RT), etc. Results obtained with the help of a numerical finite-element-based modal approach are discussed; in particular, the effect of different room sizes and shapes on the measurement accuracy are explained. Based on these findings, recommendations are proposed regarding the sizes and shapes of reverberation rooms that will give better sound field diffuseness and, hence, better prediction accuracy.

2 THE REVERBERATION ROOMS

Four different shapes of reverberation rooms, all equipped with a number of diffusing panels hanging from the ceilings, were considered, to determine the degree of field diffuseness and, hence, the prediction accuracy. The reverberation rooms considered were: Room #1 – rectangular-shaped with the shortest vertical dimension; Room #2 – rectangular-shaped with the longest vertical dimension; Room #3 – oblique-shaped with the longest vertical dimension; and Room #4 – oblique-shaped with the shortest vertical dimension. For each of the room shapes, three volumes of 150 m³, 125 m³ and 82 m³ were considered.

Predictions were performed with 2 sources and 5 receivers in seven third-octave bands ranging from 63 to 250 Hz. Positioning of the sources and receivers was performed based on the standards’ prescriptions [3]. A finite impedance value is applied at boundaries to include damping.

3 RESULTS

3.1 Room #1: Rectangular-Shaped with Shortest Vertical Dimension

Predictions done in Room #1 (see Table 1) reveal that the required minimum number of modes of 20, which is the basis for the statistically-based cut-off-frequency definition [4], occurs from the 125-Hz third-octave band for all three room volumes. That means that prediction can be done from this frequency band. However, the standard deviation, which is a measure of the spatial uniformity of the reverberant sound field, yields values smaller than the ISO-prescribed limit of 1.5 dB [3] from the 160-Hz third-octave band for the 150 m³ and 125 m³ room volumes. In particular, for the 150 m³ volume, the band-averaged standard deviation and the RT-prediction accuracy are relatively better than for the two other room volumes.

3.2 Room #2: Rectangular-Shaped with Longest Vertical Dimension

For Room #2, predictions are presented in Table 2. It is clear that the required number of modes 20 occurs from the 125-Hz band. The SPL deviations are also smaller than 1.5 dB from the 160-Hz band. However,
the RT-prediction accuracy is not as good as that obtained in Room #1.

### 3.3 Room #3: Oblique-Shaped with Longest Vertical Dimension

For Room #3, predictions are presented in Table 3. Like Room #2, the required minimum number of modes of 20 occurs from the 125-Hz band, both for the 150 m³ and 125 m³ room volumes. SPL deviations smaller than 1.5 dB occur from the 160-Hz band, and the RT-prediction accuracy is also better for these two volumes than for the 82 m³ volume.

### 3.4 Room #4: Oblique-Shaped with Shortest Vertical Dimension

For Room #4, the results Room #3 are also true for Room #4, as presented in Table 4. However, the band-averaged SPL deviations, as well as the RT-prediction errors, are smaller in Room #4 than for Room #3.

### 4 DISCUSSION

Considering all the predictions discussed in section 3, it is evident that the number of modes of 20 required to start prediction occurs from the 125-Hz third-octave band for all of the reverberation-room shapes and volumes. It is also noticeable that the 150 m³ room gives better prediction accuracy than the two other room volumes for different room shapes. Comparing results for different reverberation-room shapes make it clear that the oblique-shaped room with the shortest vertical dimension (Room #4) gives better prediction accuracy than the other room shapes for different room volumes.

### 5 CONCLUSION

Based on the above findings, it can be concluded that prediction from the 160-Hz third-octave band, using the 150 m³ oblique-shaped reverberation room with the shortest vertical dimension, will give better RT-prediction accuracy and smaller SPL spatial variation than the other reverberation rooms of different volumes and shapes.

### REFERENCES


