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THE EFFECTS OF CURRENT REVERBERATION TIMES IN BRITISH LIVING ROOMS

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1. INTRODUCTION

The average reverberation in British living rooms has been considered to be 0.5 seconds since Parkin et al reported in the early 1960's [1] that "the reverberation time of furnished living rooms is usually about 0.5 sec at most frequencies within the range of interest" (100 to 3150 Hz). The value of 0.5 sec is used as the reference reverberation time for the normalising of field measurements of sound insulation. Over recent decades there have been substantial changes in domestic construction and furnishings which might be expected to produce changes in the reverberation times for furnished living rooms.

This paper reports the average reverberation time data for furnished living rooms obtained by the BRE in connection with research into the sound insulation of party walls, floors and of facades. This data is compared with other published data and the implications of the current reverberation times in living rooms are examined.

2. REVERBERATION TIMES FOR FURNISHED ROOMS

The average values for reverberation time obtained from three BRE studies are shown on Figure 1. The earliest is the 1960s BRE data obtained by Scholes and Parkin [2] from measurements in five living rooms. The 1970s BRE data represents the average values from measurements in 60 furnished living rooms which were part of the study on party wall insulation. The average reverberation times in 47 living rooms were obtained in connection with traffic noise measurements in semi-detached and terraced houses and are identified as 1983 BRE data. The other data on Figure 1 is that published by Gilford [3] and by Jackson and Levethall [4]. The former are based on measurements in I6 living rooms in the late 1950s and the latter on measurements in 50 living rooms in the early 1970s.

Perhaps the most striking aspect of the data on Figure 1 is that, with the exception of one set, all the reverberation times are less than 0.5 sec suggested as "usual" by Parkin in 1960. The reasons for the very long reverberation times for the Jackson and Leventhall data are not clear but may relate to the type of furnishings and to the particularly large room volumes for some of the sample.

It can also be seen from Figure 1 that there appears to be a tendency for the high frequency reverberation times to decrease over the decades. The main components in living rooms which provide the absorption, particularly at the middle and high frequencies are the carpets, curtains and lounge chairs. If the 1960 BRE reverberation time at 2000 Hz of 0.35 sec is considered to be representative

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of lightly furnished rooms the effect of changing the furnishings can be predicted by using the published data for the absorption coefficients in the Sabine equation for reverberation time. If thin carpet is replaced by pile carpet, straight curtains by folded curtains and padded chairs by upholstered chairs the reverberation time for a typical room would be predicted to reduce to 0.26 sec which compares well with the average value from the 1983 BRE study of 0.29 sec. These furnishings have little absorption in the low frequencies, so little change would be predicted in this area as can be observed on Figure 1.

It is important to remember that the data on Figure 1 are only the average values and within each sample group there was some spread of the data. For the 1983 BRE data the standard deviation varied from 0.08 sec at the low frequencies to 0.04 sec at the high frequencies. The average reverberation time for each room was obtained from a minimum of three measurements. The 1970 BRE data, which was obtained from a similar sized sample, showed a similar spread for the average reverberation times.

3. THE EFFECTS OF LOWER REVERBERATION TIMES

3.1 Room Constant

The room constant, R, provides another method for defining the acoustic characteristics of a room and is given by:

$$R = \frac{S \cdot \alpha}{1 - \alpha} \qquad (1)$$

where α is the average absorption coefficient for the room
S is the total surface area of the room, m^2

The room constant is used in the calculation of sound pressure level (SPL) from values of sound power level (PWL) by:

$$SPL = PWL + 10 \log \left(\frac{4}{R} + \frac{Q}{4\pi r^2} \right) \qquad (2)$$

where Q is the directivity factor for the sound source
r is the distance from the source, m

The distance from the source for which the direct field is no longer dominant is found when the two factors within the second term of the equation are equal. Using the average room dimensions from the 1983 BRE study, the distance of 0.55 m for which the direct field dominates when the reverberation time is 0.5 sec increases by 40% to 0.77 m when the reverberation time decreases to 0.3 sec. This is an important consideration for loudspeaker placement for good sound reproduction.

3.2 Normalisation Correction

The reverberation time is often used to obtain the normalised level difference in connection with sound insulation measurements in the field such as recommended in the British Standard BS 2750 [5]. This normalisation involves addition to the level difference of the correction 10 log RT/RT_0 where RT_0 is the reference value of 0.5 sec. When the reverberation time of the room is close to 0.5 sec this correction is quite small. However when the reverberation time is less than the reference value the correction can become significant. For the average reverberation times from the 1983 BRE sample the correction varies from -1.4 up to -3 dB. Thus in modern living rooms the effective noise reduction is often greater than indicated by the normalised level difference data for party walls or facades.

4. CONCLUSION

Current values of reverberation time in furnished living rooms are well below 0.5 seconds over the normal frequency range of interest. An examination of the effects of various furnishings supports the assumption that the reduction in reverberation time at the high frequencies over the recent decades arises from the changes in the type of furnishings found in living rooms. The range of values for reverberation times within the different samples highlights the importance of measuring the actual reverberation time in rooms whenever any measurements of sound insulation are being made.

A lower reverberation time in modern furnished rooms has the effect of increasing the distance for which the direct field from a sound source is dominant. The shorter reverberation time also has a significant effect on the normalising factor as applied to standardise level differences measured between two spaces.

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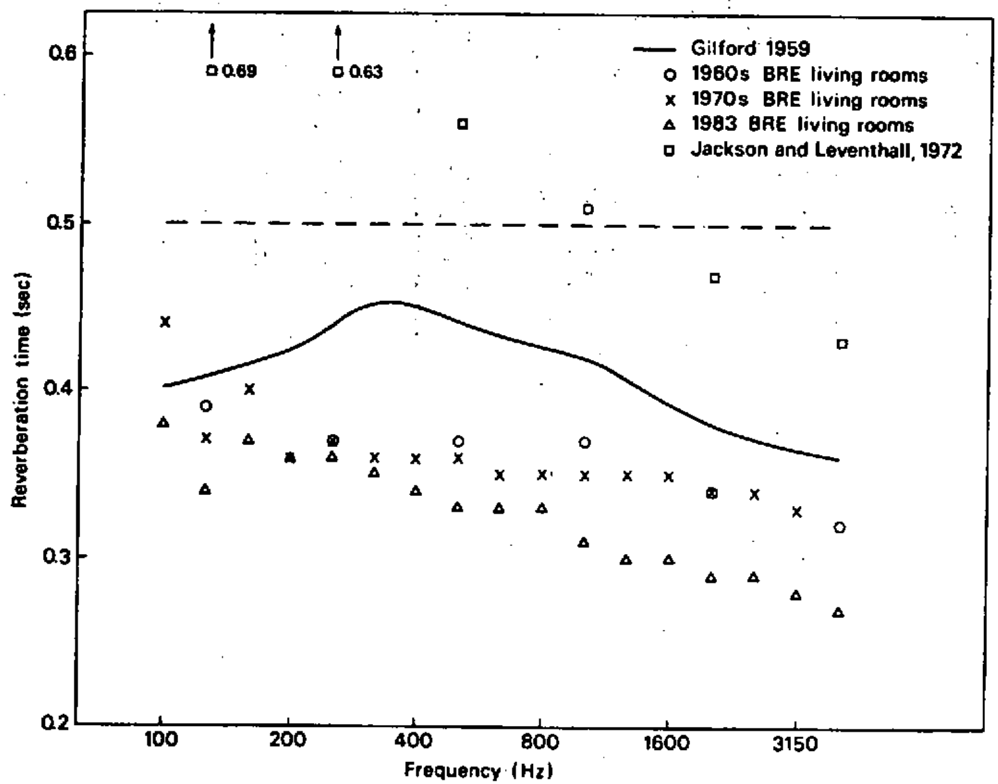

Figure 1 Reverberation times in furnished living rooms