Proceedings of The Institute of Acoustics

NEW INSTRUMENTATION FOR ACOUSTIC TRANSMISSION AND ABSORPTION TESTS.

by R.D. FORD and G. KERRY, ACOUSTICS DEPARTMENT, UNIVERSITY OF SALFORD.

Introduction

The acoustic testing facilities at Salford University consist of two adjacent reverberant rooms each massively constructed and isolated from the ground and the other room. There is a common opening between the rooms of size 2.4m x 3.6m which is used for SRI measurements. The smaller source room has a volume of 136 m^3 while the larger receiving room has a volume of 224 m^3 and a reverberation time ranging from 10s at 50 Hz to 1s at 10,000 Hz. With the opening blocked off the larger room can be used for absorption and sound power measurements. Additionally the roof of the larger room includes 9 m^2 of 160mm thick reinforced concrete, which can be used for impact insulation improvement measurements of floor coverings.

Ten years ago, measurements were labour-intensive, lengthy and liable to unnecessary error. The availability of a high quality $\frac{1}{3}$-octave frequency analyser with computer control and digital output opened the way for a system requiring the minimum of attention. One operator can now run the measurement programmes while doing other odd jobs around the laboratory and at the end of the test the results are printed on an A4 sheet ready to go into the report.

Requirements

The four commonest measurements to be undertaken are sound reduction index, absorption coefficient, impact insulation improvement and sound power. The general requirements for each of these tests are listed in table 1.

Table 1. Requirements for tests

	L/s selection and control	Mic selection	SPL measurement	RT measurement
SRI	✓	✓	✓	✓
Absorption coefficient	✓	✓		✓
III		✓	✓	
Sound power		✓	✓	✓

B & K microphones and followers are used, 5 in each room, but the power supplies together with the microphone and loudspeaker selectors were constructed within the University. Particular care was taken to obtain a very low noise floor. Each microphone has its own separate local sensitivity adjustment and then each set of microphones has a secondary adjustment for calibration with the frequency analyser.

The computer controls the frequency analyser, the loudspeaker selection and control and the microphone selection via the IEC/IEEE 488 interface. Aside from control and data transfer, the most stringent requirement is the ability to transfer a large amount of data very rapidly into computer storage. During measurement of reverberation time 48 complete spectra are transferred at intervals of 88 ms.

Measurement of steady levels

Measurements are made in one room at a time. The first microphone is selected and held while the analyser and the random noise generator (if appropriate) are adjusted manually. Although, in principle, automatic control could be incorporated some operator interaction is considered desirable. The computer then selects each microphone in turn, taking a linear average over 16s (32s for sound power). The 5 individual spectra, together with the average spectrum and the standard errors, are printed out as an intermediate check. The total time taken is about 4 to 5 minutes.

NEW INSTRUMENTATION FOR ACOUSTIC TRANSMISSION AND ABSORPTION TESTS.

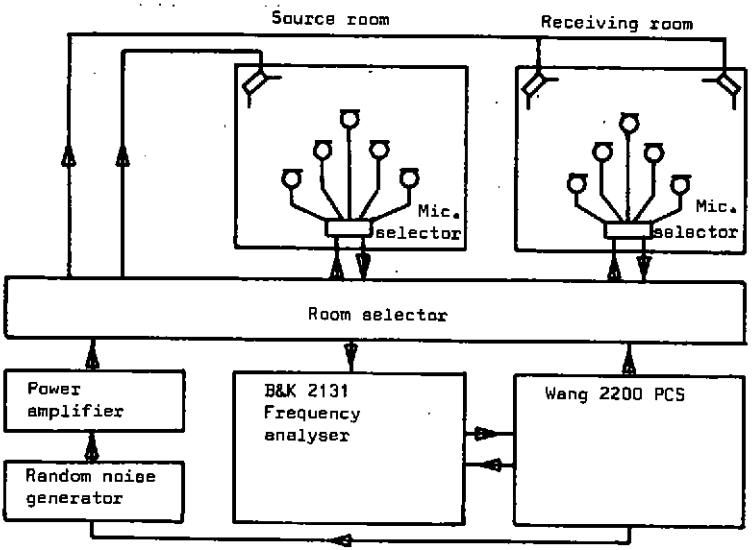

Figure 1. Equipment lay-out.

Measurement of reverberation times

The first microphone is selected and held while the analyser and the random noise generator are adjusted manually. Then the source is stopped and after approximately 0.3s sampling begins. 1/16s exponential averaging is used and 48 spectra are transferred at intervals of 88 ms. The date is then sorted and moved to another store. At frequencies up to 1600 Hz, 24 alternate spectra are retained, i.e. at intervals of 176 ms, while at 2000 Hz and above the first 24 spectra are retained. The procedure is repeated at the first microphone position to give 5 decays for SRI and power measurements or 10 decays for absorption. The subsequent decays are added into store to give cumulative decays for the microphone position. The reverberation time is then calculated for each frequency by the least square method. The decay is taken over 30 dB or to within 3 dB of the analyser base line, whichever is the lesser. The standard error of the slope is also calculated and, if this exceeds 5%, then the decay is automatically plotted out so that there is a visual safeguard against double decays. An example is shown in figure 2.
The process is repeated for the other 4 microphone positions and then average values of RT are printed out together with the standard errors. Measurement of RT's takes about 45 mins with 10 decays and 30 mins with 5 decays per microphone.

NEW INSTRUMENTATION FOR ACOUSTIC TRANSMISSION AND ABSORPTION TESTS.

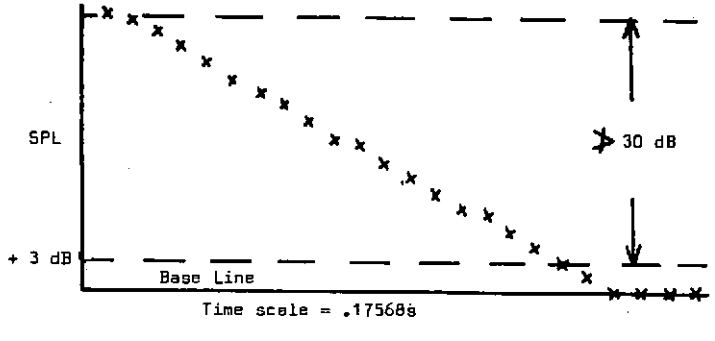

Figure 2. Typical decay plot.

Organisation of tests

Empty room RT's remain fairly constant although there is a small variation from day to day. Variation during the day is negligible and it is sufficient to measure once per day and store those results in the computer. So the first absorption test of the day requires measurement of RT's both without and with the sample, but subsequent tests only require RT's with the sample. Similarly the first SRI or sound power test of the day requires measurement of RT's and background noise levels followed by measurements of the source and receiving room levels but subsequent tests only require level measurements. The first impact insulation test of the day requires reference measurements of the tapping machine on the bare concrete floor together with background levels followed by measurements with the tapping machine on the sample. Subsequent tests only require measurements with the sample. Typical measurement times are shown in table 2.

Table 2. Typical measurement times

	First test	Subsequent tests
SRI	40 mins	10 mins
Absorption coefficients	90 mins	45 mins
III	45 mins	20 mins
Sound power	45 mins	15 mins

Conclusions

Measurement, although quick and easy, is now totally dependent on the computer, and a fault is likely to cause a delay of 48 hours or so. It is the erection and installation of samples which can be time-consuming, although minor changes can be assessed very quickly. We have carried out as many as eight tests in one day on panel absorbers with various types of infill and different lay-outs. The record, however, is 30 SRI measurements in 2 hours, using a modified programme, on a single sheet of laminated glass as its temperature was varied from 4 °C to 36 °C.

The big advantage of a computer controlled system over dedicated systems is its versatility. Standard programmes have been written to carry out the standard tests but they are all modular in nature and it is quite easy to modify a programme to carry out a test which is a little out of the ordinary.