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THE PRACTICAL PROBLEMS OF SOUND INSULATION TESTS

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1. INTRODUCTION

The Building Research Establishment has, over a number of years, established a substantial database of information on the sound insulation provided by a large number of different building constructions. In order to update this information, two contracts were awarded to Wimpey Environmental in June 1995. The first (EMC 95/32 [1]) was to measure the sound insulation of certain separating walls in recently built dwellings. The second (EMC 95/33 [2]) was to provide a small number of "one-off" site visits for sound insulation tests of separating walls and floors. Consequently, over the past year, Wimpey Environmental has tested over 100 individual walls and floors in nearly 30 sets of sound insulation tests. Not surprisingly, many practical problems were encountered during this work programme. This paper presents an overview of the project, highlights some of these problems and suggests some possible solutions.

2. WORK PROGRAMME

The work programme for the two contracts was as follows:

EMC 95/32 Sound Insulation of Separating Walls in New Build Dwellings

Locate suitable dwellings for sound insulation tests. Sites should be distributed throughout England and Wales. Constructions sought are to be examples of Wall Types 1B, 1D, 2B and 2D (as given in Approved Document E, 1992 [3]). Ensure that a range of housebuilders are included in the test programme.

Obtain full detail plans of the building construction as approved by the Local Authority or Approved Inspector. Confirm that critical site details are in accordance with these plans. In particular, take reasonable steps to confirm the manufacturer, type and density of masonry used in separating and flanking walls. Provide details of any significant deviations from approved plans.

Carry out sound insulation tests in completed but unfurnished dwellings. Room doors and windows shall be closed. Doors to any fitted backless cupboards shall be open. At each site a set of 4 examples of one type of wall construction shall be tested. Measurements shall be carried out between 4 pairs of rooms in at least 2 pairs of dwellings. In total, 5 sets of 4 examples of each of Wall Types 1B, 1D, 2B and 2D are required, ie. 20 sets of 4 examples of the specified Wall Types.

EMC 95/33 Sound Insulation Testing – Call Off Contract

Outline details of the site, contact names, addresses and other relevant information will be provided.

Arrange sound insulation tests including access arrangements. Obtain full detail plans of the building construction. Confirm that site details are in accordance with these plans and provide details of any significant deviations from the plans.

Carry out sound insulation tests. Dwellings may be furnished or unfurnished, occupied or unoccupied. Up to 10 sets of tests are required.

Sound Insulation Tests

Separating walls – Tests shall be carried out to determine the standardised level differences (D_{nT}) in accordance with BS 2750 : Part 4 : 1980 [4]. Measurements must be made using one-third octave bands and over the frequency range 50 Hz to 3150 Hz.

Separating floors – Tests shall be carried out to determine the standardised level differences (D_{nT}) in accordance with BS 2750 : Part 4 : 1980 and to determine the standardised impact sound pressure levels (L'_{nT}) in accordance with BS 2750 : Part 7 : 1980 [5]. Measurements must be made using one-third octave bands and over the frequency range 50 Hz to 3150 Hz.

Wherever possible, for each measurement:

a. the room size shall be a minimum of $25m^3$;
b. the common separating area for walls shall be a minimum of $7m^2$;
c. do not use pairs consisting of a room and some other space;
d. take only one set of measurements between each pair of rooms.

When measuring airborne sound transmission between a pair of rooms of different size, the sound source should be in the larger room. Impact sound transmission should be measured without carpets.

At each site, and as appropriate, calculate:

a. for airborne sound insulation, the weighted standardised level difference ($D_{nT,w}$) in accordance with BS 5821 : Part 1 : 1984 [6];

b. for impact sound transmission, the weighted standardised impact sound pressure level ($L'_{nT,w}$) in accordance with BS 5821 : Part 2 : 1984 [7].

3. INSTRUMENTATION

One of the first problems was how to measure the sound insulation. Over 100 individual measurements were required over the frequency range 50 Hz to 3150 Hz. Wimpey Environmental's existing sound insulation instrumentation consisted of a Brüel and Kjær Type 4418 Building Acoustics Analyser which can measure in one-third octave bands over the standard frequency range 100 Hz to 3150 Hz in series. Each measurement lasts about 5 minutes, and it was estimated that each set of measurements would therefore take about 8 hours to complete.

Fortunately, recent advances in digital signal processing have resulted in affordable real-time frequency analysers. A CEL-593 Sound Level Analyser was chosen to enable measurements in one-third octave bands over the frequency range 50 Hz to 3150 Hz in parallel. Each measurement takes 15 seconds giving a total measurement time of 20 minutes per set. An additional advantage was the corresponding decrease in the size and weight of the instrument.

However, the change from serial to parallel filters presented a new problem: how to ensure enough energy in each third-octave band to raise the source noise sufficiently above the background. This problem was solved by using a high power amplifier and speaker with a third-octave band graphic equaliser to enable the energy distribution of the source noise to be adjusted to compensate for the background noise.

4. ORGANISATION

The single most difficult part of the project was the organisation. Wimpey Environmental was required to "locate suitable dwellings", "obtain full detail plans" and "confirm manufacturer, type and density of masonry". In practice, these three requirements proved to be particularly difficult to achieve.

"Locate Suitable Dwellings"

A general letter was sent to 464 local housing associations asking them if they were building any of the required wall types and whether they would be prepared to participate in the project. Only 23 replies (5%) were received with 12 negative and 11 positive responses, from which 13 possible sites (7 x 1B, 2 x 1D, 2 x 2B and 2 x 2D) were identified. However, many of these turned out to be unsuitable.

A personal letter was subsequently sent to the 23 largest housing associations. This time, 20 replies (87%) were received with 8 negative and 12 positive responses, from which 19 possible sites (8 x 1B, 3 x 1D, 5 x 2B and 3 x 2D) were identified. Again, many of these turned out to be unsuitable.

Finally, a personal letter was sent to the 51 largest builders, and 17 replies (33%) were received with 11 negative and 6 positive responses. Surprisingly, all of the 6 positive replies from the builders claimed to use wall type 2D. Once again, many of these turned out to be unsuitable.

The main reasons that sites turned out to be unsuitable were as follows:

a. They were already completed, sold and occupied;
b. They had not been built yet;
c. They turned out to be a different wall type;
d. The housing association/builder was not prepared to help.

Type 1 walls were less difficult to locate, but type 2 walls (and in particular type 2D) were much more difficult.

"Obtain Full Detail Plans"

Once suitable sites had been identified, obtaining the appropriate plans was the next problem. Because many of the sites were owned by housing associations, there were often three parties involved including the builder and the architect, and the housing association was sometimes unsure who was responsible for the plans. In general, the architect was usually found to be the best contact.

"Confirm Manufacturer, Type and Density of Masonry"

The most reliable method of confirming the building materials was to view the site during construction. Failing this, the same problem with obtaining the plans was encountered. In this case, the site foreman was usually found to be the best contact.

Other organisational difficulties included complying with health and safety policies and ensuring that access arrangements were carried out.

5. IMPLEMENTATION

The actual implementation of the sound insulation tests resulted in a curious mixture of on-site problems. Many of these were to be expected, but some were surprisingly obscure.

"Access Arrangements"

Once on site, the single greatest problem with the call off contract was gaining access to the properties. Unrestricted entry was required to at least two occupied dwellings and frequently four or more. In practice, in order to minimise inconvenience, the tests had to be carried out within a day, with little scope for repeat visits.

Access to the new build properties presented rather different problems, ranging from carrying all of the equipment ¼ mile from the nearest parking place to procuring carpet slippers to ensure that houses ready for hand-over remained clean. It is also worth noting that buildings under construction rarely have operable lifts. Other difficulties included ensuring compliance with health and safety policies and locating the correct front door keys.

"Completed but Unfurnished Dwellings"

In occupied dwellings it was necessary to rely on the cooperation of the occupants to empty the test rooms as far as possible. However, even in new build dwellings, the test conditions varied enormously, ranging from a basic shell to a fully carpeted show home. On a few occasions, doors and windows were either missing or badly fitted, and a spare door handle was found to be a useful accessory. At the other extreme, one builder would not allow testing until the final coat of paint had been applied just in case it affected the results.

"4 Pairs of Rooms in at least 2 Pairs of Dwellings"

Even if suitable wall types, availability and access had all been established, tests were not always guaranteed. The restrictions on minimum room volumes and shared party wall areas largely restricted testing to lounges and main bedrooms. In addition, the source room was required to be the larger of the two rooms and this required checking on-site. Handed pairs, where the room layouts were reversed, resolved this situation, but were often built with the stairs adjacent to the party wall. At one development of eighty houses, only two were actually suitable for testing. Wherever possible, therefore, plans were carefully checked before going on site.

"Impact Sound Transmission without Carpets"

In practice, it was not always possible to completely empty the contents of furnished rooms in occupied dwellings, and compromises on measurement positions sometimes had to be made. Several houses with white vinyl floor tiles were also tested where a sheet of A3 paper was found to be invaluable to avoid marking the floor.

Mains Power

Because sound insulation tests are generally carried out in buildings, mains power is almost always available, and is therefore often taken for granted. However, this was not the case for many of the new build dwellings. Properties near to completion occasionally had mains power connected, although not always switched on, but those still under construction did not. In this case, it was sometimes possible to run a short extension cable from the nearest mains supply if a residual current breaker was used. Alternatively, it was often necessary to step down from 240 volts to 110 volts. Battery power was not really a suitable alternative for the high power amplifier and speaker, and the last resort was therefore a portable generator.

External Noise Sources

The range of unwanted external noise sources was vast. Some of the more obvious examples for building sites were pneumatic drills, disc cutters and compacters. However, ordinary drilling, hammering and sawing were equally disruptive. The noise of radios, footsteps and slamming doors also contributed to the problem. In order to minimise these intermittent noise sources, testing was therefore confined to quiet periods such as lunch, tea and coffee breaks where possible. A more general unwanted external noise source was road traffic. This was a particular problem at low frequencies, and the use of the third-octave band graphic equaliser was found to be invaluable, allowing the source noise to be 'tuned' to match the background noise.

Sudden Drops in Sound Transmission

One of the most alarming problems encountered was a sudden or unanticipated drop in sound transmission. Several possible causes were identified:

a. incorrect instrument settings;
b. equipment failure;
c. significant variation in wall construction;
d. the door to the source room had opened.

Miscellaneous

Finally, there were two other rather engaging problems encountered during the contracts. The first was being held up by people who were genuinely interested in what was being done. The second was a particular site where the performance of the walls was so good that even with a quiet background and the implementation of all of the above practical measures, it was still difficult to generate enough source noise to measure the sound transmission.

6. SUMMARY

Over the past year, Wimpey Environmental has tested over 100 individual walls and floors in nearly 30 sets of sound insulation tests for the Building Research Establishment. The right combination of instrumentation, organisation and implementation enabled the project to be completed both effectively and economically. The results of the tests have been added to the BRE database of information on the sound insulation provided by a large number of different wall constructions.

7. REFERENCES

[1] EMC 95/32 *Sound insulation of separating walls in new build dwellings*, Building Research Establishment, 1995.

[2] EMC 95/33 *Sound insulation testing - call off contract*, Building Research Establishment, 1995.

[3] Approved Document E, 1992 *Resistance to the passage of sound*, The Building Regulations 1991, Department of the Environment and The Welsh Office.

[4] BS 2750 : *Measurement of sound insulation in buildings and of building elements* : Part 4 : 1980 *Field measurement of airborne sound insulation between rooms.*

[5] BS 2750 : *Measurement of sound insulation in buildings and of building elements* : Part 7 : 1980 *Field measurement of impact sound insulation of floors.*

[6] BS 5821 : *Methods for rating the sound insulation in building elements* : Part 1 : 1984 *Method for rating the airborne sound insulation in buildings and interior building elements.*

[7] BS 5821 : *Methods for rating the sound insulation in building elements* : Part 2 : 1984 *Method for rating the impact sound insulation.*

140-5

180 ~~TBS~~ expected room – allows in

measurements

Field indicator F

$F = 9 + \log\left(\frac{ST}{0.16V}\right)$ determines if more abs needed

Empirical data ~~HSE~~. 125 Hz → 2 kHz

Expect published F > 7.5

U/F > 8.5

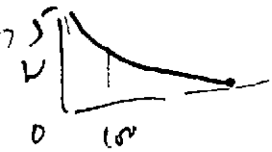
Eurodec ~ T ~ 0.35 F ~ 6.2 dB

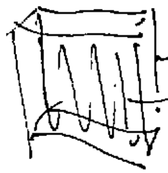
So generally OK.

but w/f room needs extra abs

Committee for SRI ([illegible]) or SRI ([illegible] method)

Waterhouse $W = \log\left[1 + \frac{ST\lambda}{8V}\right]$





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