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NEW EUROPEAN STANDARDS FOR MEASURING AND RATING SOUND INSULATION

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1. INTRODUCTION

Different countries have different national standards for describing the performance of products. For example, a window manufacturer in one country may rate the sound insulation of his windows in terms of R_w, while a competitor in another country may use dB(A) against traffic noise. At best this is confusing for the customer, and at worst it can present a barrier to trade because a product designed for optimum performance on one rating system may not appear so good on another system. The EC Construction Products Directive is to be implemented in 1992 to expedite the single European market. It is designed to remove technical barriers to trade by developing a rational system of harmonised European standards to replace the diversity of national standards.

For construction products the detailed topics requiring harmonised Standards have been defined in Interpretative Documents (IDs), which were drafted by representatives from Member States. Each of the six IDs covers a different aspect of health or safety connected with buildings, and one deals with "Protection against Noise". The European Commission is now in the process of issuing "Mandates" to CEN, the European Committee for Standardisation, to develop the necessary Standards. It is a policy of CEN to adopt existing International Standards whenever possible, and sometimes the Working Groups of CEN and ISO co-operate to produce Standards that are acceptable to the membership of both organisations.

In the case of acoustics it will be necessary to harmonise a large number of Standards, but among the first will be measuring and rating methods for sound insulation. Many countries already use ISO 140 and ISO 717 which in the UK are dual numbered as BS 2750 [1] and BS 5821 [2]. These ISO Standards have therefore provided the starting point for the new European Standards. The revision is not yet complete, and when it is the UK will be able to comment through BSI. The purpose of this paper is to outline the main changes that the Working Groups have proposed to date.

2. ISO 140 (BS 2750) MEASUREMENT OF SOUND INSULATION IN BUILDINGS AND OF BUILDING ELEMENTS

This Standard is currently in nine parts, although Part 10 on measuring the sound insulation of small elements such as ventilators, will soon be added.

Most parts of the Standard were published in 1978 and the CEN work has coincided with a revision by ISO. However, Part 2: "Statement of precision requirements", and Part 9: "Method for laboratory measurement of room-to-room airborne sound insulation of a suspended ceiling with a plenum above it", are more recent and are likely to be adopted by CEN with only minor modifications. Consequently this paper will deal only with Part 1, and Parts 3 to 8.

2.1 ISO 140/1: Requirements for laboratory test facilities with suppressed flanking transmission.
When testing high performance constructions in this type of laboratory it is difficult to be sure that the insulation value measured is determined by the test element and not the flanking construction of the laboratory. The flanking limit of the laboratory depends on the type of partition being tested, so ideally, a complete test would include lining the wall to improve its performance, and then a re-test to show if the measured value increased; if it did not it would indicate that the flanking limit of the laboratory had been reached. Obviously, it is not practical to do this additional work every time, so the new Standard requires that it is done once for each of the main types of partition tested, and representative partition constructions are described. The appropriate R'_{max} value obtained in this way must be quoted in the test report if the flanking limit of the chamber has been exceeded at any frequency.

Another important change is that the niche depths on either side of the partition should be in the ratio of 2:1, not 1:1 as in the current Standard. This is to improve reproducibility of measurements. For the same reason more detail has been given on how panes of glass should be mounted in the aperture.

2.2 ISO 140/3: Laboratory measurements of airborne sound insulation of building elements.
The frequency range has been extended to cover 100 Hz to 5000 Hz; it has not been extended below 100 Hz because of the difficulty in making reliable measurements. However, because complaints often concern insulation below 100 Hz, advice has been given on how to improve measurement accuracy down to 50 Hz, and if this proves to be adequate low frequency measurements may be made mandatory in later revisions.

Experiments have shown that the position of the loudspeaker has an influence on the results, especially when small elements like windows are tested. Ideally, a large number of loudspeaker positions should be used, but for practical reasons the Standard only stipulates at least two positions. However, these positions have to be established by conducting sound insulation tests on one partition, but using a large number of loudspeaker positions, and then following a procedure to identify positions that yield results close to the mean obtained from all the positions. These positions are to be used in future tests.

It has also been found important to ensure that microphones not in the direct field of the loudspeaker. If an omnidirectional loudspeaker is used it is sufficient to use the separating distances specified in the current version of the Standard. Consequently the new Standard includes a simplified test for directivity, and if a loudspeaker fails this test it is necessary to establish that the microphones are not in its near field. This is done by moving each microphone further away from it and checking that the measured level does not decrease significantly with distance.

The current Standard allows results to be presented graphically using one of three scaling options. This makes comparing graphs difficult if different scales have been chosen. To overcome this problem the new standard stipulates only one scale (5 mm per 1/3 octave, 20 mm per 10 dB).

2.3 ISO 140/4: Field measurements of airborne sound insulation between rooms. In principle a field measurement is the same as a laboratory measurement, but the Standard recognises the practical difficulties encountered in the field. The frequency range 100 Hz to 3150 Hz in 1/3 octaves has been retained with the option of 125 Hz to 2000 Hz in octaves. The Standard recommends using the wider range specified for laboratory measurements, but does not make it mandatory because of the difficulty of reducing extraneous noise.

As with laboratory measurements, it is important to use multiple loudspeaker positions and to ensure that the microphones are not in the near field. However, for practical reasons the procedures have been simplified, although it is stipulated that two loudspeaker positions should be used.

2.4 ISO 140/5: Field measurements of airborne sound insulation of facade elements and facades.
Extensive changes have been proposed for this Standard and it will be easier to outline the proposals, rather than describe the changes. Three field tests are described, two of them for testing facade elements, and the third for testing whole facades. The first two methods yield results that are comparable with laboratory tests made according to Part 3, while the third method is only to measure the insulation provided by the facade, and the results cannot be related to laboratory measurements on particular elements.

Method 1 uses a loudspeaker as sound source, with the loudspeaker, preferably on the ground, directed at 45° to the normal at the facade element. Measurements are made inside the room in the usual way (eg five microphone positions or moving-arm microphone) and the external level is measured using microphones fixed to the outer surface of the test element.

Method 2 uses existing road traffic noise as the source but there are very stringent conditions on the position and orientation of the road (eg it must be at least 25 m away from the facade) so this method will be of limited use. The measurement procedure is the same as for the first method.

Method 3 also uses existing traffic noise but with only minor restrictions. The internal noise level is again measured in the usual way, but the external level is measured at one position, two metres away from the facade. This method therefore takes account of the screening effect of balconies etc and so it gives a measure of the insulation achieved by the whole facade of a room, not just the windows.

The proposed Standard includes two important new Annexes. One Annex describes two methods to measure insulation using aircraft noise as source. The first method is to measure the insulation of building elements for comparison with laboratory measurements, and the second is to measure the insulation of larger areas. These methods may be supplemented by methods using railway noise. The other Annex describes a method for testing an element by measuring the transmitted intensity, with the loudspeaker either inside or outside the building. This method will be particularly useful when it is necessary to test a window that performs nearly as well as the rest of the facade, and the traditional methods are unable to differentiate between transmission through the window and transmission through the rest of the facade.

2.5 ISO 140/6: Laboratory measurements of impact sound insulation of floors. Measurements are to be made in 1/3 octave bands in the frequency range 100 Hz to 5000 Hz, and guidance is given for making measurements at lower frequencies.
The main change to this part is the addition of instructions on how to deal with soft coverings which have time dependent characteristics (probably because of local heating by the hammers in the tapping machine). The procedure is to run the tapping machine for five minutes before making the measurements "in a well defined period". The proposal also includes more rigorous tests of the performance of the tapping machine.

2.6 ISO 140/7: Field measurements of impact sound insulation of floors. The proposal for this Part is not as well developed as the Parts already described. Measurements are to be made in either 1/3 octave bands in the frequency range 100 Hz to 3150 Hz or octave bands in the range 125 Hz to 2000 Hz.

2.7 ISO 140/8: Laboratory measurement of the reduction of transmitted impact noise by a floor covering on a standard floor.
Little work has been done on this Part; it is likely that any changes will be similar to those already described for Part 6.

3. ISO 717 (BS 5821) RATING OF INSULATION IN BUILDINGS AND OF BUILDING ELEMENTS

The single number rating assigned to a product such as a window is very important because it is used by potential customers to compare products from different manufacturers. Two main methods are in use by Member States: the curve shifting method described in ISO 717 (used in the UK as BS 5821); and the "A" weighted level difference, usually using road traffic noise as the source spectrum. As manufacturers in different countries can optimise their products to suit their national rating method there has been lengthy discussion on how to draft a Standard acceptable to all countries. A compromise has now been reached which involves both methods, and it is described below.

ISO 717 is currently in three parts: Part 1 deals with rating the insulation of interior elements against airborne sound; Part 2 deals with rating insulation against impact sound; Part 3 deals with rating the insulation of exterior elements against airborne sound. In fact Parts 1 and 3 are very similar and so we propose to combine them.

3.1 ISO 717/1: Airborne sound insulation.
For sound insulation against internal noises such as speech and music, the ISO ratings of R_w and $D_{nT,w}$ have become familiar and correlate quite well with subjective judgements. However, for insulation against external noise the position is not so clear. The ISO method implicitly assumes that the source spectrum is pink noise, and many people think that it underestimates the importance of good insulation at low frequencies where, for example, traffic noise has considerable energy. The dB(A) level difference approach overcomes this problem, but in principle a rating is required for each type of noise likely to be encountered. This could lead to different ratings for road, rail and air traffic, industrial noise, etc, and in the extreme, different ratings could be calculated for urban traffic, motorway traffic, diesel trains, electric trains, jet aircraft, propeller aircraft, children playing, dogs barking, --- etc.

The compromise proposal has been designed to make use of the best features of both methods. One of the familiar ISO ratings will be calculated (eg R_w) and also the dB(A) level difference against pink noise and traffic noise. The difference between R_w and each of these other two ratings must be calculated and the values will be called "adaptation terms", symbol C and C_{tr} respectively.
The performance of a product will be stated as follows:

$$R_w(C;C_{tr}) = 41(0;+5) \text{ dB}$$

This means the R_w is 41 dB, the $dB(A)_{pink}$ is 41 dB(A), and the $dB(A)_{traffic}$ is 46 dB(A).

The requirement for a product should be stated either in terms of the R_w alone or R_w plus the appropriate adaptation term:

$$R_w = 41 \text{ dB, or } R_w+C_{tr} = 46 \text{ dB}$$

A Table in the Standard will list common noises and say which of the two adaptation terms should have a high value to provide protection against that particular noise. Products required to provide protection against sounds with predominately low frequency energy will require a large C_{tr}, while protection against high frequency noise will be indicated by the C value.

3.2 ISO 717/2 Impact sound insulation
The current method is widely regarded as being lenient for timber floors, but too stringent for solid concrete floors. It is likely that the new Part 2 will use the familiar ISO ratings (eg $L_{n,w}$), with adaptation values to facilitate conversion to dB(A) levels to overcome the deficiencies mentioned above.

3.3 Measurements in octave bands
The current ISO 717 only provides rating methods for measurements made in 1/3 octave bands. This was done for two reasons: (a) to avoid the confusing 5 dB difference between ratings of impact measurements made in 1/3 octave and octave bands; (b) because octave bands do not match the familiar 100 Hz to 3150 Hz 1/3 octave frequency range, so either the 1/3 octave range would have to be changed or the two methods would use slightly different frequency ranges with the possibility of a systematic difference in results.

For reasons of harmonisation it has now become necessary to provide rating methods for field measurements made in 1/3 octave and octave bands. Analysis of field data has shown that the difference in frequency range does not normally make an appreciable difference, so it is likely that we will propose 100 Hz to 3150 Hz for 1/3 octave band measurements and 125 Hz to 2000 Hz for octaves, and accept that there will be a small difference between the two methods.

4. CONCLUSIONS

The European single market has increased the importance of reliable test and rating methods for products to ensure that they compete on a level playing-field. The result of this is that Standards are becoming more rigorous as sources of uncertainty are identified and controlled. In some cases the cost of tests will increase, but it is possible that this will be off-set by advances in instrumentation that reduce the time required to make measurements.

5. REFERENCES

[1] BS 2750: 1980, Methods of measurement of sound insulation in buildings and of building elements.
[2] BS 5821: 1984, British Standard Methods for rating the sound insulation in buildings and of building elements.