THE IMPLICATIONS OF ISO 717 SPECTRUM ADAPTATION TERMS FOR RESIDENTIAL DWELLINGS

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I. INTRODUCTION

In 2001 new proposals(') were issued for public consultation regarding changes to the English and Welsh Building Regulations Part E "resistance to the passage of sound" and guidance document Approved Document E. Several major changes were proposed in these documents such as new levels of sound insulation for internal walls and floors, incorporation of hotels and hostels and pre-completion testing (PCT). One of the niost iniportant changes was the proposal to introduce ISO 717 [(2)] spectrum adaptation terms, C_{tr} for airborne sound insulation of separating walls and floors and C_I for impact sound transmission for separating floors. The new proposals outlined that changing to the new measurement criteria and sound insulation levels, the current sound insulation performance would be improved by +3dB for walls and +4dB for floors.

To evaluate the impact of introducing such *proposals* to the Scottish Building Regulations Part H [(3)] "resistance to the transmission of sound" a study was undertaken to investigate their implications in relation to the current standards and methods of rating sound insulation used in Scotland. Both the Part H standards and ADE guidance documents have similar documented constructions which are recommended to comply with the performance criteria.

2. COMPARING STANDARDS

The current sound insulation standards in Scotland are set within the Technical Standards (Scotland) Part H. The levels of sound insulation to be achieved for new build and conversions are the same. The airborne sound insulation criteria is $D_{nT,w}$ and the impact criteria is $L'_{nT,w}$.

The comparison *proposals* offer lower target levels of sound insulation for conversions when compared to new build. The airborne sound insulation criteria would be $D_{nTw}+C_{tr}$ and the impact criteria is $L'_{nT,w}+C_I$.

Table 1 shows the performance target levels for both Scotland Part H and the *proposals* as outlined in England and Wales Part E 2001 for new build dwellings.

Table 1 - Current Part H [2] criteria compared with the proposals [1]

	Scotland Part H	The Proposals
Airborne sound insulation		
separating walls	Target mean minimum 53dB* $D_{nT,w}$	Minimum 45dB** $D_{nT,w}+C_{tr}$
separating floors	Target mean minimum 52dB* $D_{nT,w}$	Minimum 45dB** $D_{nTw}+C_{tr}$
Impact sound transmission		
separating floors	Target mean maximum 61dB* $L_{nT,w}$	Maximum 62dB** $L_{nT,w}+C_I$

* For 2 or more measurements an individual value may be 4dB worse than the mean but regardless the mean target must be achieved.
** Value may be 2dB worse than the minimum / maximum and may be given on any measurement (at Building Authority's discretion)

As it is not possible to immediately compare set performance insulation values with different base rating criteria the study has focused on the effect in real buildings using on-site measurements of the implications of the different criteria. To compare current standards against the *proposals* the levels of fails and passes were recorded for each criteria using the same set of on-site measured test data. So if a series of walls records failures of 5% under the existing standards and the same series of walls records failures of 10% under the proposals, the failure rate has increased and standards are being raised.

In addition to the initial study to investigate the implications from the BPC database of existing test data, a series of tests were undertaken on a range of sites across the UK.

3. ISO 717 SPECTRUM ADAPTATION TERM (C_{tr})

The use of C_{tr} spectrum adaptation term proposed in England and Wales for airborne sound insulation of separating walls and floors introduces a significant emphasis on low frequencies, particularly 100Hz – 315Hz. This term [3] is normally used for external facades for buildings adjacent to low frequency noise sources such as diesel locomotives or propeller driven aircraft. It can also be used for buildings adjacent to discoteques or roads carrying heavy good vehicles. It is not representative of the standard living noises which occur between dwellings and the strong emphasis at low frequencies places a greater importance on the accuracy of measurement at these frequencies. Variations in measurement of 2-3dB at these lower frequencies can result in a significant negative C_{tr} correction value change from –5 to –12dB.

Measurement accuracy at these frequencies is restricted in the modal response of the room and the separating wall or floor under test. A low modal overlap between the test structure and adjacent rooms results in significant variations when carrying out repeat measurements on the same structure. The room size and the flexibility of the wall or floor/ceiling linings can also influence the final result significantly when using C_{tr}. The mass of the structure, cavities present, quantity of isolation or de-coupling all play important roles in the final result recorded at these low frequencies. Whilst these factors may not often affect the overall measured curve at important frequencies for normal living noises such as speech, the impact within the low frequency zone of 100Hz-315Hz and the outcome of the final weighted single value should not be underestimated. Hence a change of –5dB to –12dB for C_{tr} due to slight variations in the low frequency measurement results in a single weighted value dropping by -7dB but without being influenced by the mid and high frequencies.

The possible consequences of using the C_{tr} term from the measurement perspective are:

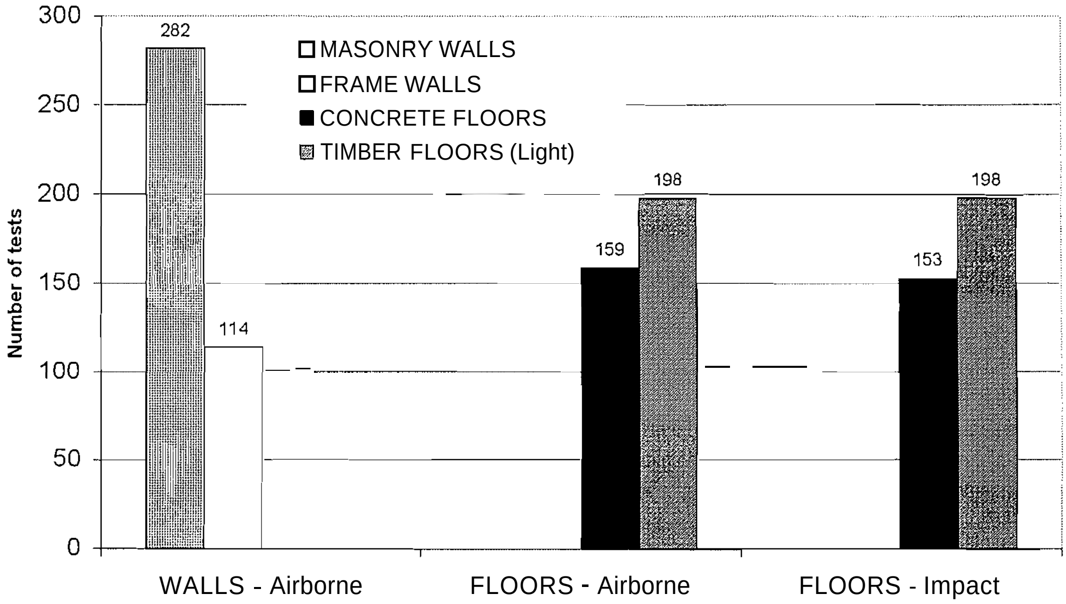
- restricted room volume sizes which can be tested,
- inaccuracy of the measurement criteria when compared with using only $D_{nT,w}$,
- significant variation in measuring the same structures using different testers,
- structures would normally fail due to noise transmission at speech frequencies would now be able to pass,
- different industry types of wall or floor structures, (i.e. timber or concrete) being influenced markedly (and perhaps unfairly) in their ability to pass or fail the performance standards,
- significant emphasis on the accuracy of L_2 and T_2 measurements at low frequencies 100Hz-315Hz
- pass or fail influence whether using T_{20} or T_{30} reverberation time measurements,
- possible alteration of the current ISO 140 source speaker and measurement microphone minimum distances to the test room envelope,
- additional restraints on the level of background noise possible during on-site sound tests and the implications of development locations under test.

4. FIELD TEST DATA ANALYSIS

New Build

The field test data used for the comparison study was collated for the period between 1992 and 2001. The starting date of 1992 was chosen due to the last changes to the Building Regulations Scotland occurring in 1990. The post construction testing results at any one site may involve only 1 test to over 40 tests.

Figure 1 - Number of New Build Separating Walls and Floors used in Study



As such only a maximum of three tests were chosen from any one site and in chronological order in which they were recorded to be as random as possible. A total of 1,104 field tests involving new build dwellings were included in the study. The majority of test data in the study was sourced from test reports involving 4 or less tests.

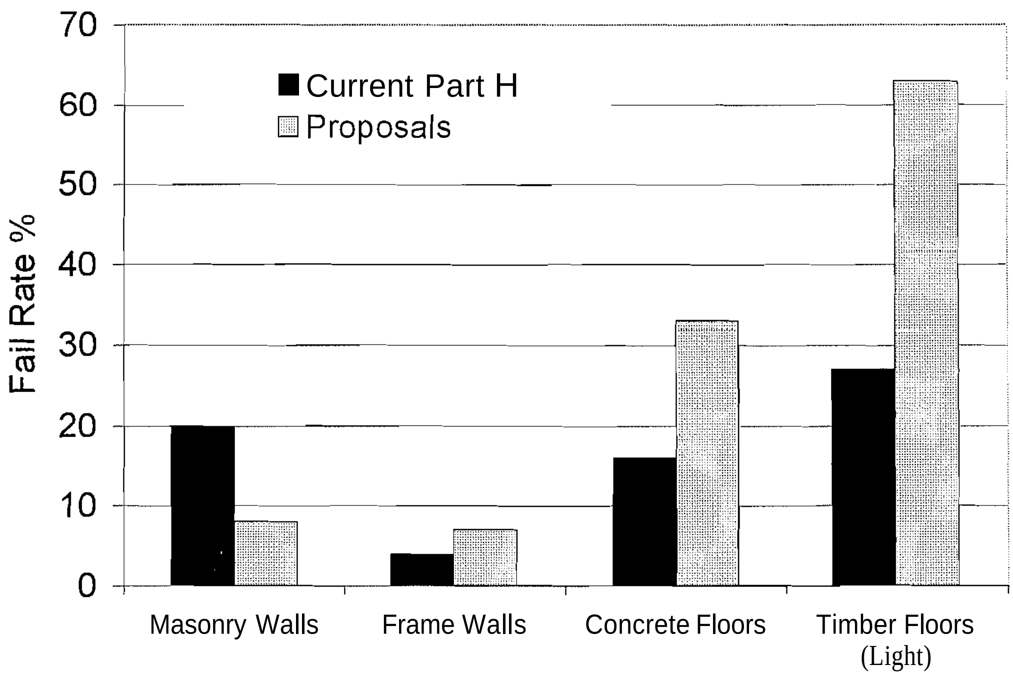
Due to the expected different emphasis of C_{tr} as a result of the mass and material used within a wall or floor the test structures were divided into categories as shown in Figure 1. Further subdivisions per structure type were also undertaken but are not presented in this paper. The single weighted values ($D_{nT,w}$) of each of the test results were recalculated from the original 1/3rd octave data (100Hz – 3150Hz), as a check on the values recorded at that time, and the new single weighted value ($D_{nT,w}$+C_{tr}) under the *proposals* was then calculated with the additional spectrum adaptation term C_{tr}.

The following analysis lists the 'average fail rate' recorded over a 9 year period. As a result of on-site testing it was found that many of the Regulation Guidance structures in Part H (Scotland) similar to Part E (England and Wales) would struggle to cope with the required performance targets. As such industry has over the 9 year period (1992-2001) decreasingly used some of the low performing Part H / ADE guidance structures and increasingly builds to a higher specification. The resultant fail rate as a consequence of building more robust constructions has fallen from typically 40% (pre 1992) to less than 5% (2001) and may fall further in 2003.

<u>Analysis of airborne target current mean minimum versus proposals minimum</u>

Figure 2 shows a comparison between the required target performance values for new build walls and floors at any one site under the current standards versus the proposals. It can be seen that different structures are affected in different ways.

Figure 2 - Comparison of fail rate between current criteria and proposals using Ctr



Whilst the mean target is the required performance level the minimum individual value permissible under a group of tests is 4dB lower. If the 45dB minimum value was compared against the individual minimum the proposals would effect different structures by either raising standards or staying the same.

However, the comparison between the current individual value and the proposals is not effectively a correct comparison of target values and as such the improvement sought should be that which is above the current mean minimum standards. As such only lightweight timber floors would really see a 3dB increase. If the proposals were used in Scotland masonry walls would see a −2dB reduction in current criteria, frame walls and concrete floors would see an increase by 1 dB and timber floors (light) would see an increase of +3dB.

5. INFLUENCE OF REVERBERATION TIME MEASUREMENT

Currently reverberation time (RT) measurements may be recorded in T_{20} or T_{30} and converted into an equivalent T_{60} value. As the slope or rate of decay can be slightly different between T_{20} and T_{30} such variations may affect the overall single weighted value. On site testing is measuring the RT of real size rooms (unlike laboratory measurements which use larger rooms) and it may be difficult to determine accurately the RT of a dwelling room from the limited measurements undertaken under ISO 140. These inaccuracies at lower frequencies as a result of room size and shape, resultant variation between T_{20} and T_{30} recorded and application of C_{tr} after the RT correction can amplify these differences for frequencies 100Hz to 315Hz. As a result it has been found that whilst the $D_{nT,w}$ value may remain constant for using T_{20} or T_{30} the minor differences at low frequencies with the application of C_{tr} afterwards can sometimes lead to a 2dB variation in the reported $D_{nT,w}+C_{tr}$ single weighted value, (where L_1 and L_2 are the same, but either T_{20} or T_{30} is used).

6. DIFFERENT OPERATIVES

Due to the measurement inaccuracies at low frequencies and the Ctr emphasis the issue of different operatives is important. Using the same equipment testing the exact same site separating wall it has been found that whilst 'the $D_{nT,w}$ value changed by 1 dB the $D_{nT,w}+C_{tr}$ value changed by 3dB, using the same RT factor T_{30}.

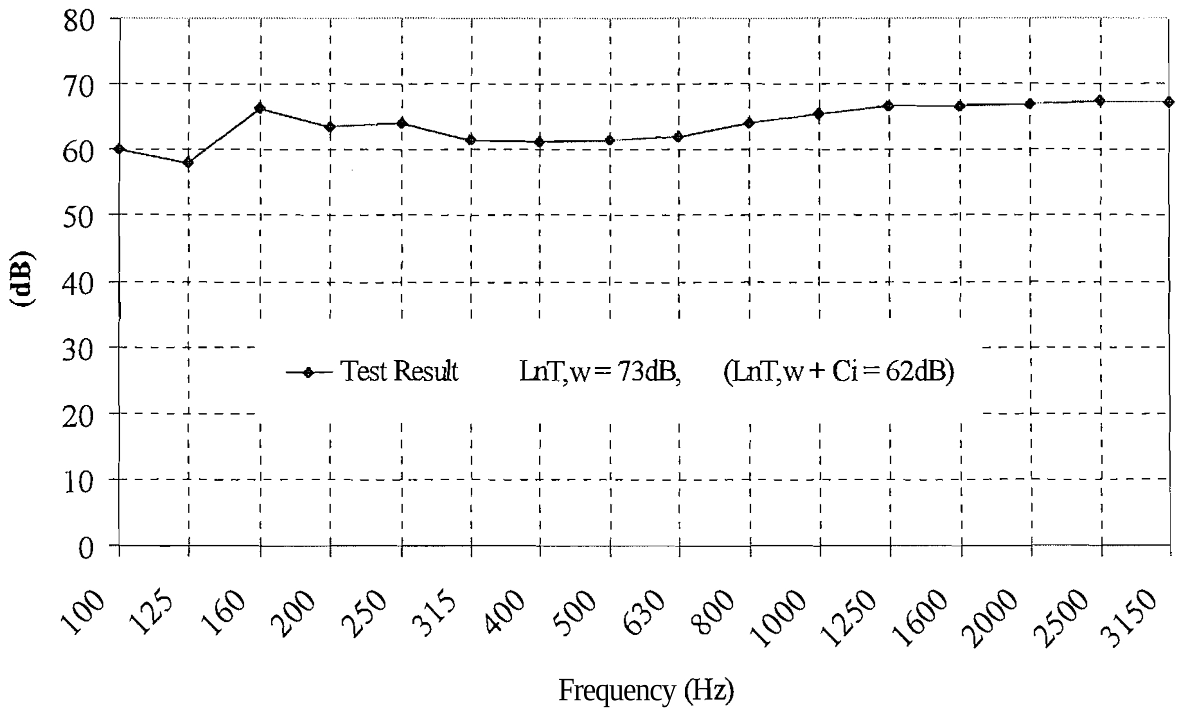
7. DIFFERENT OPERATIVES AND DIFFERENT EQUIPMENT

Extending this study further there are a range of sound sources available to choose from and also fixed and rotating microphone positions. Given the inaccuracies at low frequencies and now analysing the effect of both operatives and equipment it was found that the maximum change in $D_{nT,w}$ was 2dB but that the $D_{nT,w}+C_{tr}$ value changed by 4dB for a cavity wall and 5dB for a floor.

8. ISO 717-2 IMPACT TERM C_I

To investigate the influence of the application of impact term C_I (4) the field test database was used to evaluate the effect on pass and fails under the current criteria and proposals. It was found that in most cases there no improvement. In some cases where the low frequency performance was quite good and high frequency was 'poor 'the mid and higher frequency performance were almost ignored in the final weighted value. Figure 3 shows an example where a concrete floor had failed under the current impact standards by 12dB due to a poor resilient layer. Under the new *proposals* this floor would now pass. From some occupier surveys of response to sound insulation, impact values in excess of 62dB $L'_{nT,w}$ are described as intolerable. The floor result shown in Figure 3 would be able to pass the new proposals despite the fact that it records a value of 73dB L'_{nTw}.

Figure 3 - Example of test result for a concrete separating floor compared under current and propsed criteria



9. CONCLUSIONS

The study has found that the use of some of ISO 717 spectrum adaptation terms are not suited as a rating criteria for sound insulation between adjoining dwellings. The adoption of C_{tr} for airborne sound insulation between adjoining dwellings raises a number of inaccuracies which may have legal implications for the regulatory body, housebuilder, material manufacturer, developer and dweller.

Since this study was undertaken in 2001 the ADE guidance document [5] has removed the use of C_I spectrum adaptation term and has also removed the lower airborne discretionary value given to building control authorities. However, the minimum airborne value has been set at 45dB and this study has demonstrated that whilst this does raise some standards for some structures it lowers the performance targets for other structures.

10. AKNOWLEDGEMENTS

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11. REFERENCES

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(4) BS EN ISO 717-2. Acoustics – Ratings of sound insulation in buildings and of building elements. Part 2. Impact sound insulation. BSI 1997.

(5) The Building Regulations 2000 - Approved Document E (Edition 2003). Office of the Deputy Prime Minister. HMSO 2003