Proceedings of The Institute of Acoustics

The Relationship Between the BS5821 Method and the AAD Method of Rating Sound Insulation

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Introduction

It is most expedient to express the sound insulation performance of walls and floors in terms of a single figure rating. In the UK, the Building Regulations (1,2) specify the aggregate adverse deviation (AAD) method for single figure rating, whereas the most widely used method is based on the system recommended by the International Standards Organisation and now approved as British Standard BS5821: 1980.(3). There are many people in Britain who are more familiar with the well-established AAD method than the more recent BS5821 method. This paper shows how the two rating methods can be related empirically, and evaluates the effectiveness of using BS5821 equivalent values to replace the important 23AAD Building Regulations criterion.

The AAD Method

The AAD of a wall or floor is obtained by comparing measured standardized level differences with reference values specified in the Building Regulations. An adverse deviation occurs where the measured value is lower than the reference value for airborne insulation, higher for impact insulation. The aggregate adverse deviation is the sum of these differences in decibel units. The reference values are fixed and so any set of standardized level differences which completely satisfy the criteria, has an AAD of zero. Therefore, the AAD method cannot rank the sound insulation of partitions which have characteristics better than the Building Regulations standard. In the case of separating walls, the standard is based on the average performance of plastered solid brick walls.

The BS5821 Method

For airborne sound insulation measured between rooms in buildings, the rating is called the 'weighted standardized level difference' denoted DnTw*. Similarly, for impact sound insulation the rating is called the 'weighted standardized impact sound pressure level' denoted LnTw*. These ratings are obtained by moving a standard reference curve up or down in 1dB steps until the sum of the adverse deviations of the measured values relative to the reference curve is as large as possible without exceeding 32dB. The rating is the level of the reference curve at 500Hz. Since the reference curve is of fixed shape and can be moved, this method can continuously rank all categories of sound insulation.

*Since the paper is printed without typesetting, the rating notations used are simplified. DnTw should actually be D subscript nT,w and LnTw should be L' subscript nT,w.

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Method of Comparison

Three different comparisons are made between the AAD method and the BS5821 method of rating sound insulation: two for airborne sound insulation (walls and floors), and one for impact sound insulation. For each comparison a scatter diagram is drawn in which each data point is defined by the AAD value (abcissa) and the BS5821 value (ordinate) obtained from the same measured set of standardized level differences. The data used for the comparisons are the results of the large survey of sound insulation in dwellings carried out by the Building Research Establishment during the 1970s. The data comprises approximately 1400 wall, 560 floor and 570 impact test results. There is no reason to be selective for the purpose of these comparisons and so all the available data have been used. The survey results are shown summarised as AAD and BS5821 histograms in Figure 1. To facilitate comparison, the AAD and BS5821 result pairs use identical number scales and approximately the same class interval (8 AAD $\approx$ 1DnTw), but not the same distribution position.

Analysis and Results

Figures 2,3 and 4 show the scatter diagrams together with a quadratic curve fitted to the data by the method of least squares. All data points with an AAD of zero, or greater than 120 are excluded from the quadratic calculation in order to correctly weigh the data in the region of interest. All three graphs show a high degree of correlation between the two variables: in fact, the linear correlation coefficients are -0.92, -0.87 and 0.91 respectively, despite the apparent curvature. Estimates of the quadratic curve coefficients are shown tabulated in figure 5 together with the standard deviation of the residuals, that is the predicted value minus the observed value. Inspection of figures 1 to 3 reveals that this standard deviation is not constant throughout the AAD range, having a higher value in the 1 AAD to 20 AAD region. This fact, and the integer nature of the variables makes it difficult to estimate conventional confidence intervals for the curves. However,since the sample sizes are extremely large, it is enough to calculate the percentage of values falling within given residual limits. Figure 6 shows a table of such percentages for residual limits of zero to ±4 and demonstrates that the curve can predict BS5821 ratings from AAD values quite successfully.

Percentage of Values Within Limits

Residual Limit	Walls	Floors	Impact
0	37%	31%	28%
±1	79%	78%	66%
±2	94%	96%	84%
±3	98%	99%	93%
±4	99%	99%	98%

Figure 6

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Pass/Fail Criteria

The British Building Regulations require that an AAD of 23dB should not be exceeded for the airborne and impact sound insulation measured in dwellings. From figure 5, the predicted BS5821 values for walls, floors and impact for an AAD of 23 are DnTw 54, DnTw 51 and LnTw 58 respectively. If these values are used as the pass criteria, how many partitions would be incorrectly classified as passes or fails relative to 23 AAD?

Figure 7 shows results of an analysis where the AAD>23 fail criterion is kept constant while the BS5821 fail criterion is varied around the equivalent value. The analysis confirms that the predicted BS5821 values are indeed the best equivalent choices and result in about 10% of the partitions being rated incorrectly as passes or fails re 23 AAD. Moreover, the incorrect passes tend to balance the incorrect fails so that a more general analysis would obscure this result. For instance, figure 8 illustrates a table which simply gives percentage pass and percentage fail and shows that the AAD/BS5821 results differ by only 2 or 3 per cent. The fact that 10% of the partitions are classified differently as passes or fails is indiscernable.

Conclusions

There is a close relationship between the AAD method and the BS5821 method of rating sound insulation. The relationship can be numerically described so that BS5821 ratings can be predicted from AAD ratings with a satisfactory degree of accuracy. An AAD of 23dB has a nearest equivalent of DnTw 54 for walls, DnTw 51 for floors and LnTw 58 for impact insulation. If these values are used as pass criteria, then about 90% of partitions will be correctly rated as passes or fails relative to the present British Building Regulations.

Acknowledgements

I am indebted to the Building Research Establishment for making available the data used in this study. The support of the Science and Engineering Research Council is also gratefully acknowledged.

References

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2. The Building Regulations 1976. Part G: Sound Insulation. Statutory Instrument 1976, No 1676. London HMSO, 1976.

3. British Standards Institution. Methods for rating sound insulation in buildings and of building elements. British Standard BS5821: 1980. London BSI, 1980.

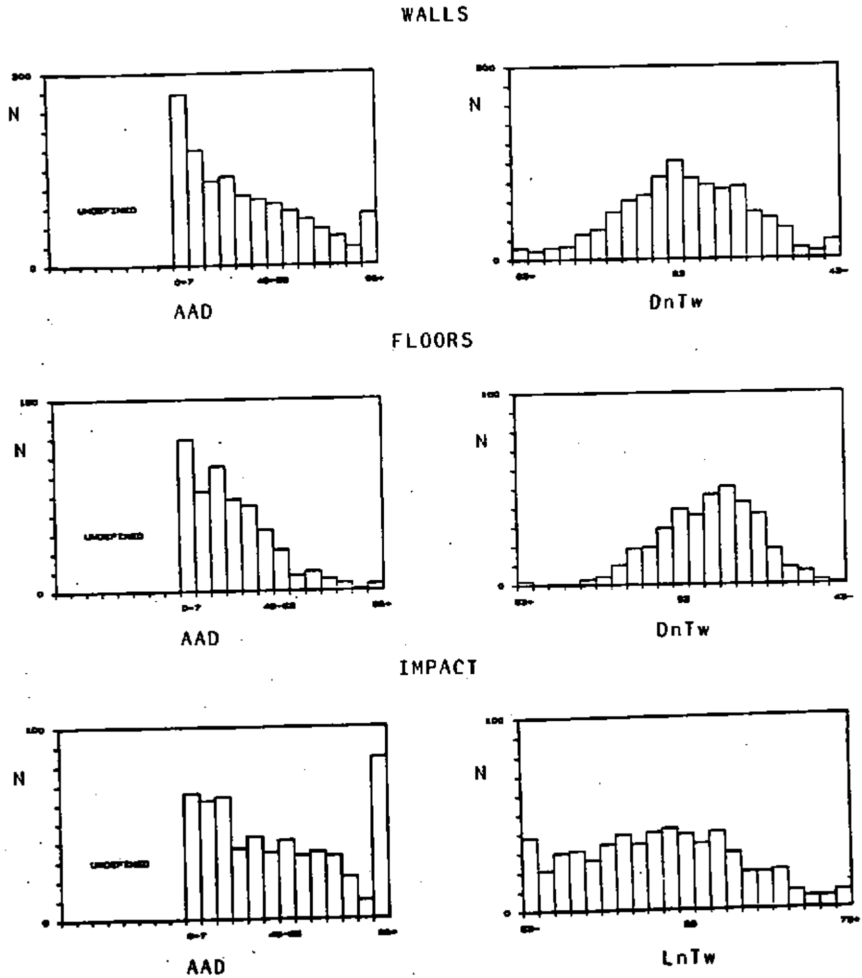

Figure 1: AAD and BS5821 data distributions

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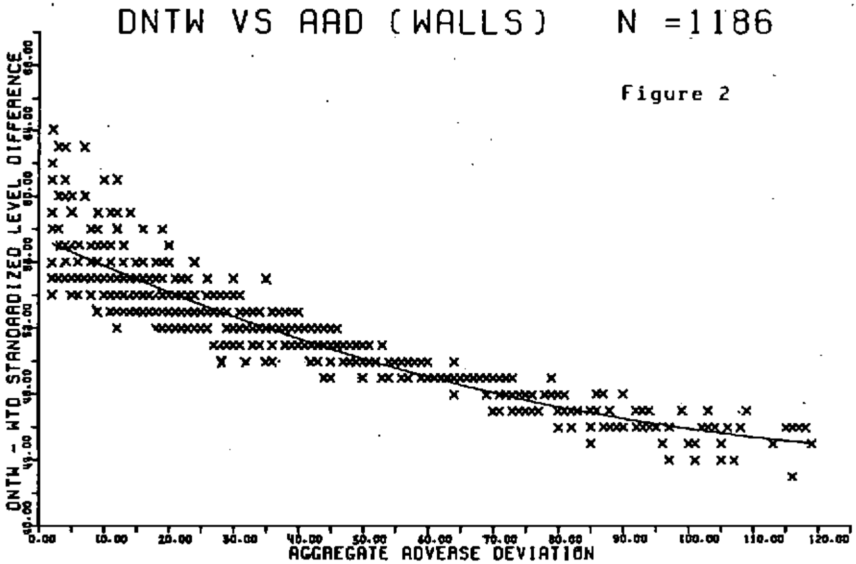

Figure 2

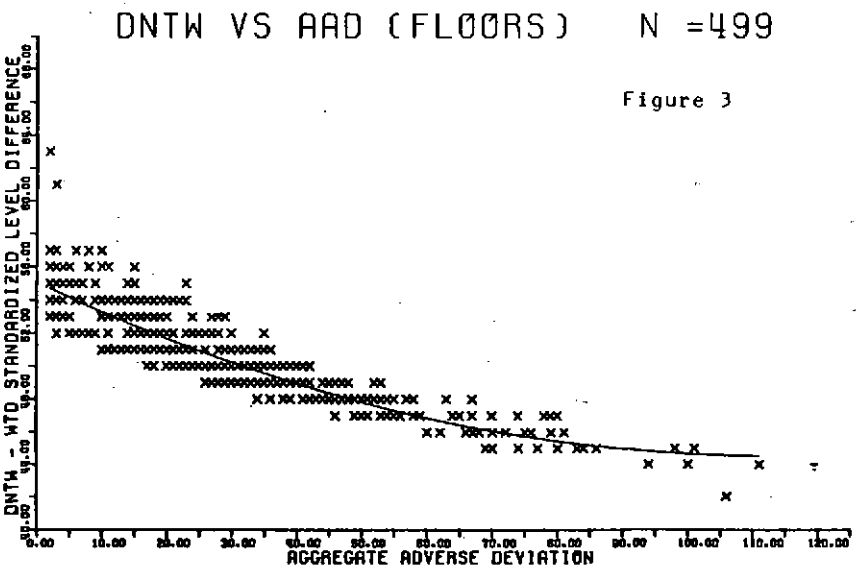

Figure 3

The Relationship Between the BS5821 Method and the AAD method of Rating Sound Insulation

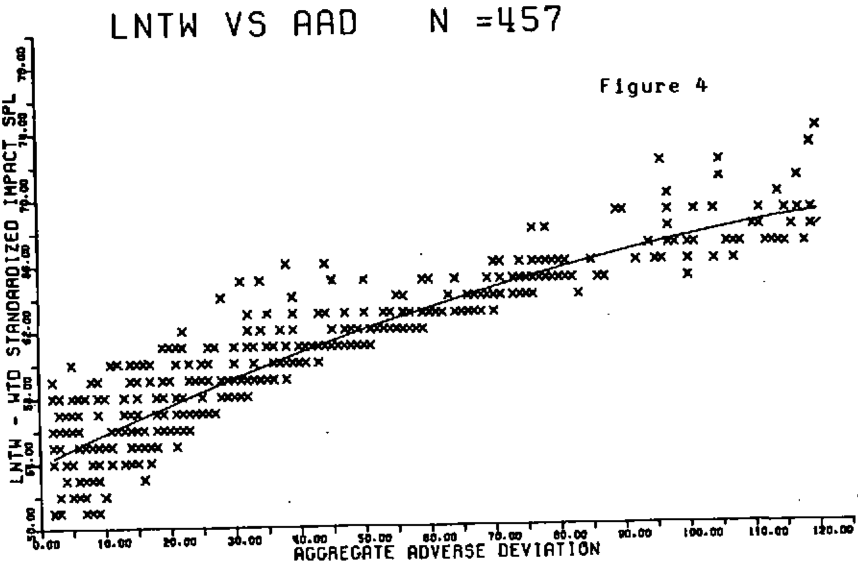

Figure 4

Figure 5 Table of Quadratic Coefficient Estimates and Standard Deviations from Quadratic

	WALLS	FLOORS	IMPACT
A0	57.47	55.09	53.97
A1	-0.175	-0.185	0.186
A2	0.00059	0.00081	-0.00052
SD	1.37	1.34	1.80

BS5821 Index ≈ NEAREST INTEGER $(A0 + A1.AAD + A2.AAD^2)$

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Figure 7 Table of Pass/Fail Rates for Different DnTw and LnTw Criteria

IN ALL CASES THE AAD FAIL CRITERION IS AAD>23 dB

	DnTw FAIL CRITERION	<53	<54	<55
	FAIL AAD/FAIL DnTw (%)	48.6	55.2	57.7
WALLS	PASS AAD/FAIL DnTw (%)	1.4	5.7	12.3
	FAIL AAD/PASS DnTw (%)	9.8	3.2	0.7
	PASS AAD/PASS DnTw (%)	40.2	35.9	29.3

	DnTw FAIL CRITERION	<50	<51	<52
	FAIL AAD/FAIL DnTw (%)	30.8	40.0	44.7
FLOORS	PASS AAD/FAIL DnTw (%)	0.0	4.3	12.1
	FAIL AAD/PASS DnTw (%)	16.7	7.5	2.9
	PASS AAS/PASS DnTw (%)	52.5	48.2	40.3

	LnTw FAIL CRITERION	>57	>58	>59
	FAIL AAD/FAIL LnTw (%)	64.8	62.7	58.2
IMPACT	PASS AAD/FAIL LnTw (%)	9.4	5.5	3.0
	FAIL AAD/PASS LnTw (%)	1.2	3.4	7.8
	PASS AAD/PASS LnTw (%)	24.6	28.4	31.0

Figure 8 Table of All Pass/All Fail Rates for Best DnTw and LnTw Criteria

WALLS	FAIL CRITERION	AAD>23	DnTw<54	DIFF.
	FAIL (%)	58.4	60.9	-2.5
	PASS (%)	41.6	39.1	+2.5
FLOORS	FAIL CRITERION	AAD>23	DnTw<51	DIFF.
	FAIL (%)	47.5	44.3	+3.2
	PASS (%)	52.5	55.7	-3.2
IMPACT	FAIL CRITERION	AAD>23	LnTw>58	DIFF.
	FAIL (%)	66.0	68.1	-2.1
	PASS (%)	34.0	31.9	+2.1