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Aggregate Subjective Ratings of Airborne Sound Insulation

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Introduction

This paper reports the results of a survey of sound insulation between homes in multi-family dwellings. The survey included interviews of 600 subjects and airborne sound insulation measurements of their 300 party walls. The subjects lived in both row housing and multi-floor apartment buildings in three different Canadian cities. The questionnaire first asked about general issues concerning the subjects building followed by more specific questions rating the sound insulation and the audibility of various noises. Sound transmission loss measurements were made in 1/3-octave bands from 100 to 4000 Hz. In addition to the standard ISO and ASTM single number ratings, 20 other single number sound isolation measures were calculated.

Acoustical Data

Figure 1 summarises the results of the sound transmission loss measurements of the 300 walls. This figure shows the average, ± 1 standard deviation and the complete range of transmission loss values in each frequency band. Measured effective STC values varied from 38 to 60 with an average of 49.7 and a standard deviation of ± 4.7 dB. (In this paper responses are primarily related to the standard The effective Sound transmission Class value which is referred to as STC1 to discriminate from other non-standard versions.).

The average noise levels recorded in the 600 homes and their standard deviations were LeqD 47.5 ±8.9 dBA, LeqN 39.8 ±8.4 dBA, Leq24 46.2 ±7.9 dBA. A summary of the acoustical measurements was published some time ago [1].

Principal Survey Results

Subjects were first approached by letter and asked to participate in a neighbourhood satisfaction survey. They were subsequently interviewed in their homes. Initial questions were to obtain spontaneous responses without any mention of sound insulation or noise. These included responses concerning satisfaction with their building, whether they would like to move and how considerate their neighbours were. Subsequent questions obtained directly elicited responses concerning whether they heard various sounds and how annoying they were. For most survey questions, responses were obtained using 7-point response scales. For convenience this paper concentrates on 3 principal responses: the single question response giving a subjective evaluation of the residents' sound insulation and composite response scales concerning sounds that they heard (HEAR) and the resulting annoyance (ANOY).

A number of spontaneous responses were significantly related to STC1 values. (STC1 is the ASTM standard STC rating including the 8-dB rule). Residents with party walls having lower sound insulation were more likely to want to move and less likely to be satisfied with their building. There was also a statistically significant relationship between STC1 values and how considerate neighbours were rated. That is, people with poor sound insulation tended to blame the resulting disturbance on inconsiderate neighbours rather than on poor sound insulation.

The principal elicited responses were also significantly related to measured sound insulation. Figure 2 plots aggregate subjective ratings of sound insulation as a function of measured STC1 values. For the 2nd order polynomial fit shown in this figure the associated R^2 value was 0.939 and there is clearly a strong relationship between objective and subjective ratings of sound insulation. On average, people can accurately evaluate the amount of sound insulation between them and their neighbours. Composite ANOY responses were similarly related to measured STC1 values. (R^2 = 0.960). Annoyance decreased with increasing values of STC1 and appeared to approach a rating of 1 (Not at all annoyed) at approximately STC1 = 65 dB.

Figure 3 shows the relationship between the composite HEAR responses. Again there is a very strong relationship with STC1 val-

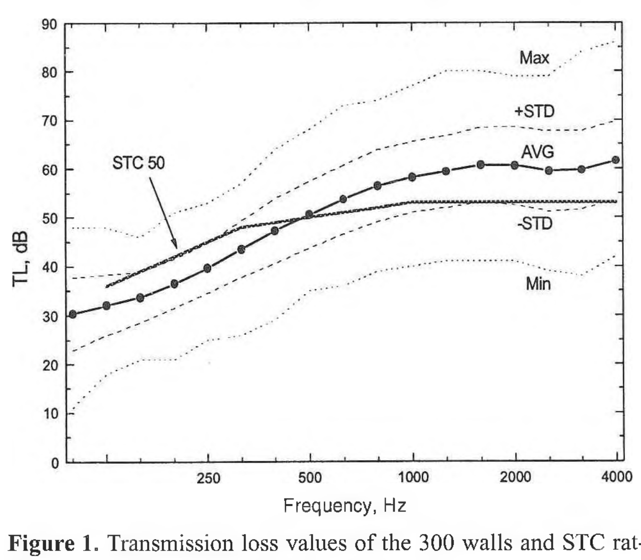

Figure 1. Transmission loss values of the 300 walls and STC rating contour of the average wall

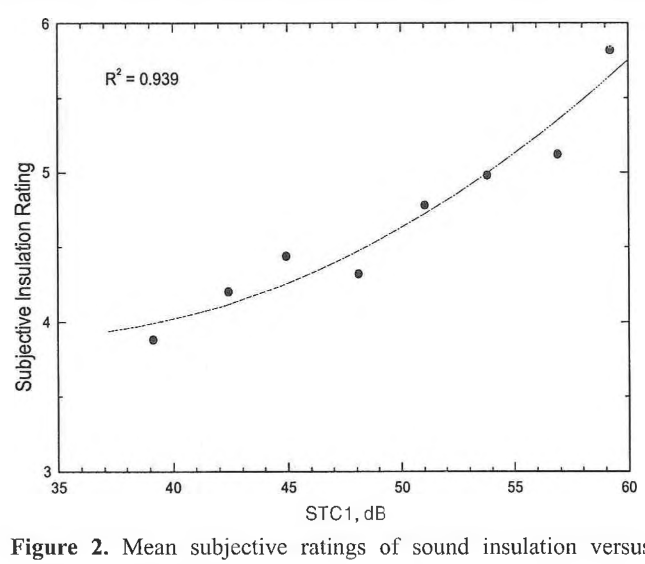

Figure 2. Mean subjective ratings of sound insulation versus aggregate STC1 values.

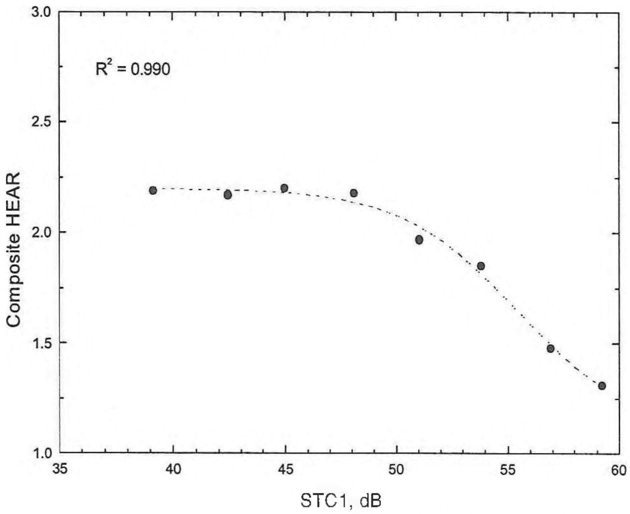

Figure 3. Figure 3. Mean subjective ratings of the composite HEAR scale versus aggregate STC1 values.

ues but the form of the relationship is quite different than for the previous two cases. Above about STC1 = 50, residents report hearing the sounds from their neighbours less often as STC1 values increase. That is, when there is better sound insulation they hear their neighbours less often. Extrapolating this trend would suggest that between an STC1 60 and 65 they would not hear their neighbours at all. However, below about STC1 = 50 this HEAR response does not vary with STC1. This is because how often they hear their neighbours depends not only on sound insulation but also on how often neighbours typically make audible sounds. It appears that below an STC1 of about 50 responses are not influenced by sound insulation but only by how frequently neighbours make audible sounds. For a party wall to minimize this disturbance it must have an STC1 of greater than 50 and a party-wall sound insulation of STC1 = 55 or more is required to significantly reduce the disturbance that neighbours hear. Other responses led to similar relationships and support this trend.

Other Measures of Sound Insulation

The ASTM STC and the ISO R_W are now the most commonly used single number measures of sound insulation. These and a number of other measures were tested using second order polynomial fits to the principal responses. The R^2 values from these relationships are given in Figure 4. The standard STC1 measure was best correlated with all three responses. Correlations with STC2 (excluding the 8 dB rule) and variations of the ISO R_W measure were slightly less successful although the differences were not statistically significant. Various average TL values [2] were less successful. It was concluded that these results give no reason to change the standard STC measure (including the 8 dB).

Conclusions

In this study the average party wall corresponded to STC 50. This may suggests that 50% of party walls in Canada provide less insulation than the current recommendations of the National Building Code.

There is considerable evidence that residents in multi-unit buildings are disturbed by noises from there neighbours and that this disturbance decreases with increasing sound insulation between the homes. Residents even mistakenly blame neighbours for being inconsiderate when poor sound insulation is the cause of the disturbance.

Many responses do not decrease unless party-wall sound insulation exceeds STC 50 and significant reductions in these responses require party-wall sound insulation of STC 55 or more.

STC 55 is therefore recommended as a realistic goal for better sound insulation to reduce annoyance and disturbance.

STC 60 is identified as a more ideal goal for party-wall sound insulation that would essentially eliminate disturbance by noise from neighbours.

References

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Acknowledgements

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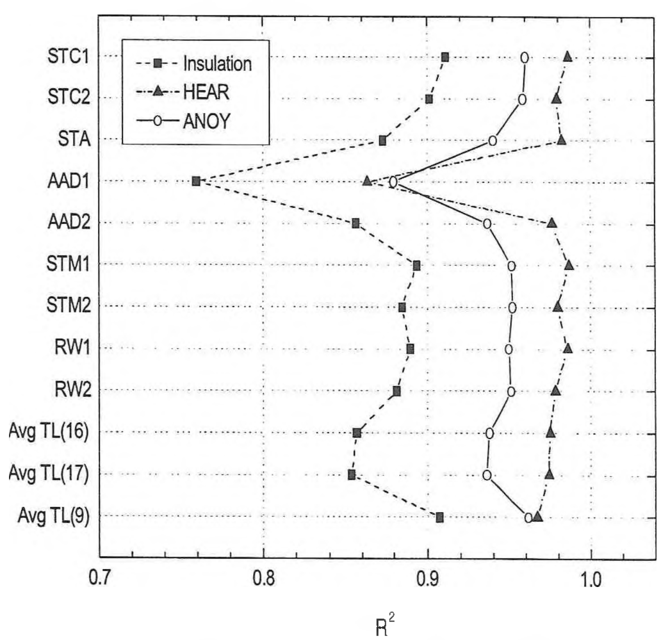

Figure 4. R^2 values associated with 2nd order polynomial fits of 3 principal survey responses with single number sound insulation measures.