# Selecting Walls for Speech Privacy

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## Summary

The sound attenuating properties of walls can be measured in laboratory tests of sound transmission loss versus frequency. These values are often reduced to the single value of the *Sound Transmission Class,* STC, rating to simplify the rank ordering of the sound insulating properties of walls. However, the average Transmission loss, TL(avg), is now known to be a better indicator of the amount of speech privacy provided by a wall for closed rooms. This report explains this new measure and presents sound transmission loss data for 74 different types of gypsum board walls with calculated TL(avg) and STC values for each type of wall. Changes to wall parameters such as: (a) gypsum board thickness, (b) stud cavity depth, and (c) stud spacing are shown to affect TL(avg) values differently than STC values. It is therefore important to select walls, intended to provide adequate speech privacy, based on their measured TL(avg) values and to not assume that all of the changes that might increase STC values will similarly increase TL(avg) values. To broaden the range of wall types, sound transmission loss data and corresponding TL(avg) and STC values for 20 concrete block walls are also included. This report is intended to familiarize readers with TL(avg) values and to aid in the selection of wall constructions that will provide adequate speech privacy for closed rooms.

# 1. Introduction

There is frequently a requirement for meeting rooms to provide speech privacy so that an eavesdropper outside the room cannot understand speech from the room or in some cases cannot even hear any speech sounds from the room. New procedures [1] for rating the speech privacy provided by a meeting room are in terms of *Speech Privacy Class*, SPC, values. SPC is the sum of the measured average level difference, LD(avg), from the meeting room to positions of potential eavesdroppers outside the room, and the average ambient noise levels, $L_n$(avg), at the same locations of potential eavesdroppers. (Here '(avg)' indicates an arithmetic average of the decibel values from 160 to 5000 Hz). At the design stage SPC values can be predicted from the combination of laboratory measurements of the *sound transmission loss,* TL(f), of walls over a range of frequencies [2] and the lowest likely ambient noise levels [3] as explained in the following section of this report.

Laboratory measurements of TL(f) values, such as described by ASTM E90 [4], are frequently reduced to *Sound transmission class,* STC, values as a convenient single valued rating of the sound insulation provided by a wall. Similar tests according to ISO 140 [5] reduce the individual ⅓-octave band results to *Weighted Sound Reduction Index*, $R_w$, ratings which have similar values to STC values. While STC and $R_w$ values are useful for rating the general acceptability of sounds transmitted through walls, they do not predict the intelligibility of transmitted speech well and hence they are not good predictors of the speech privacy of meeting rooms [6, 7, 8]. Average transmission loss values, TL(avg), have been shown to be better predictors of the speech privacy provided by various wall constructions, and walls intended to provide speech privacy should be selected based on their TL(avg) rating.

This report provides TL(avg) values for 74 different types of gypsum board wall constructions to help in the design of meeting rooms to achieve adequate speech privacy. Complete ⅓-octave band TL(f) values, as well as STC ratings, are also included. Each of the 74 sets of data is for the average of groups of measured walls with similar stud configurations and layers of gypsum board. To provide a broader range of wall types data is also included for 20 concrete block walls. Each consists of various methods of mounting gypsum board on one or both sides of the block walls.

This report describes SPC ratings, the merits of the TL(avg) measure over STC ratings, and illustrates how TL(avg) and STC ratings are differently affected by the details of the wall constructions. This information along with the sound transmission data for 94 wall types gives a designer many options for selecting wall constructions that will contribute to achieving adequate speech privacy for a closed room. This report does not include sound transmission data for floor-ceiling constructions that could be equally important to the wall data. A sufficient amount of reliable and relevant data could not be found within the time available to do this work.

Sound transmission between adjacent rooms is often influenced by other sound paths than the direct path through the common wall. Such other paths are referred to as flanking sound paths and they can frequently limit the apparent sound attenuating characteristics of walls. A common example of a flanking sound path would be sound transmission through a common (continuous) floor construction from one room to an adjacent room. There can be many types of such structural flanking sound paths and also other types of flanking sound paths such as through ventilation ducts that provide a sound path connecting spaces. If flanking sound transmission paths are ignored, it will not be possible to achieve high speech privacy. Although very important, consideration of the influence of flanking paths on the speech privacy of enclosed rooms is beyond the scope of this report.

## 2. Speech Privacy Basics

The intelligibility of speech increases with increasing speech-to-noise ratios at the position of the listener. Consequently, the speech privacy of closed rooms will increase when speech-to-noise ratios decrease at the positions of potential eavesdroppers outside the room. There are many different ways to combine the influence of different frequencies of sound in calculating signal-to-noise ratios, but research [9] has shown that a uniform-weighted, frequency-averaged, signal-to-noise ratio over speech frequencies ($SNR_{uni32}$) predicts well the audibility and intelligibility of speech transmitted through various walls. $SNR_{uni32}$ is given by,

$$SNR_{uni32} = \frac{1}{16}\sum_{f=160}^{5000}\{L_{ts}(f) - L_n(f)\}_{-32} \tag{1}$$

where, $L_{ts}$ = transmitted speech level

$L_n$ = ambient noise level

f is the ⅓-octave band frequencies from 160 to 5000 Hz

-32 indicates that all $L_{ts}(f) - L_n(f)$ differences are clipped to never be less than -32, at which point speech would be inaudible.

For most cases the -32 clipping of signal-to-noise ratios is not expected to be important and can be neglected. Then, from equation (1) the following is approximately true,

$$SNR_{uni32} = L_{sp}(avg) - LD(avg) - L_n(avg) \tag{2}$$

In equation (2) the transmitted speech level, $L_{ts}$, has been replaced by the source room average speech level, $L_{sp}$, using,

$L_{ts} = L_{sp}(avg) - LD(avg)$

LD(avg) = the level difference from a source room average to the level at a potential eavesdropper position.

Rearranging equation (2) leads to,

$$LD(avg) + L_n(avg) = L_{sp} - SNR_{uni32} \tag{3}$$

In equations (2) and (3), $L_n(avg)$ and LD(avg) are simple arithmetic averages of the noise levels and measured level differences respectively over the speech ⅓-octave band frequencies from 160 to 5000 Hz. Speech privacy increases with increases in both $L_n(avg)$ and LD(avg). The combination is referred to as the *Speech privacy Class* (SPC), that is,

$$SPC = L_n(avg) + LD(avg) \tag{4}$$

Average transmission loss values, TL(avg), have been empirically related to LD(avg) values [10] as follows,

$$TL(avg) \approx LD(avg) \tag{5}$$

Combining equations (4) and (5) gives equation (6) which can be used to estimate *Speech Privacy Class* (SPC) values at the design stage.

$$SPC = TL(avg) + L_n(avg) \tag{6}$$

Table 1 gives speech privacy criteria for 3 levels of speech privacy in terms of SPC values [3].

| SPC | Description |
|---|---|
| 75 | *Speech privacy* (speech occasionally intelligible and frequently audible) |
| 80 | *Speech security* (speech very rarely intelligible and occasionally audible) |
| 85 | *High speech security* (speech essentially not intelligible and very rarely audible) |

*Table 1. Three levels of speech privacy criteria in terms of Speech Privacy Class (SPC) values.*

TL(avg) values are simply arithmetic averages of laboratory measurements of sound transmission loss over the frequencies from 160 to 5000 Hz. Many examples of TL(avg) are given later in this report. $L_n$(avg) values can be estimated from lowest likely ambient noise level values shown in Table 2. These were one percentile ambient noise levels in spaces adjacent to meeting rooms [3]. The conversion between L(A) values and $L_n$(avg) assumed a -5 dB/octave noise spectrum typical of most indoor ambient noises.

| Period | $L_n$(avg) | L(A), dBA |
|---|---|---|
| Day (8:00 to 17:00) | 14 | 35 |
| Evening (17:00 to 24:00) | 24 | 30 |
| Night (24:00 to 8:00) | 34 | 25 |

*Table 2. Estimates of lowest likely ambient noise levels by time of day in spaces adjacent to meeting rooms for 3 different times of day periods [3].*

As an example calculation, we can use an $L_n$(avg) of 24 dB (from Table 2) and a TL(avg) of 57. Combining these using equation (6) indicates an SPC rating of 82 which is just over the minimum for a speech privacy rating corresponding to ‘Speech Security’ in Table 1.

## 3. Validating the New Ratings

The $SNR_{uni32}$ measure was developed from listening tests in which subjects rated the audibility and intelligibility of speech modified to represent transmission through walls [9]. The success of the $SNR_{uni32}$ measure was confirmed in a second listening test study [6] in which the intelligibility of speech, modified to simulate transmission through 20 different walls, was determined. The walls included STC ratings from 34 to 58 representing a wide range of sound insulation conditions. In the experiment, ambient noise levels were held constant and the only source of variation was the varied transmission loss, TL(f), of the 20 simulated walls. With noise levels, $L_n$(avg), and speech levels, $L_{sp}$(avg), held constant, equation (3) indicates that variations in transmitted speech levels are related only to LD(avg) values and consequently, according to equation (5), also to TL(avg) values.

Figures 1 and 2, from reference [6], compare how well speech intelligibility scores were related to STC and TL(avg) values. Figure 1 shows that the intelligibility of transmitted speech was not well related to the STC ratings of the walls ($R^2$ = 0.510). By comparison, Figure 2 shows that the same speech intelligibility scores were much better predicted by TL(avg) values ($R^2$ = 0.853).

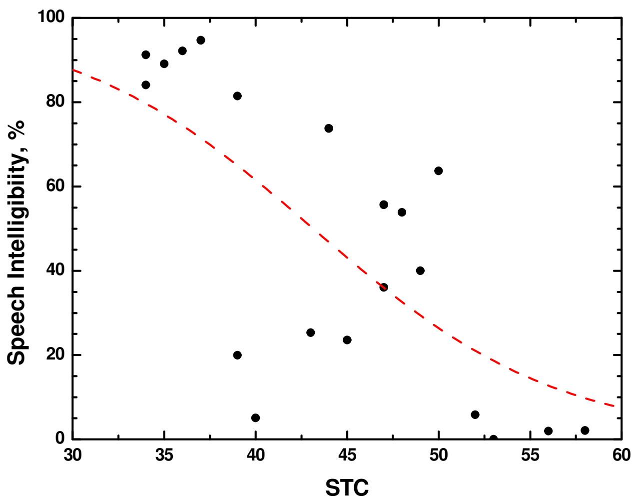



*Figure 1. Mean speech intelligibility scores versus STC ratings of 20 walls ($R^2$ = 0.510) [6]. Although there is a statistically significant trend for intelligibility to decrease with increasing STC value, there is much scatter about the mean trend and STC is not seen to be a good predictor of speech intelligibility nor of speech privacy.*

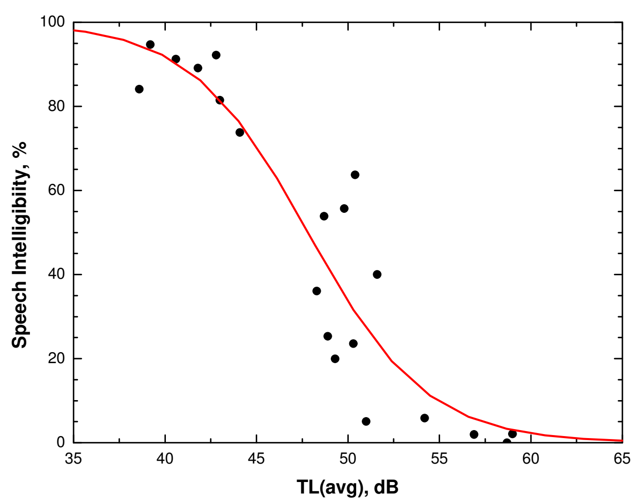



*Figure 2. Mean speech intelligibility scores versus* TL(avg) *ratings of 20 walls ($R^2$ = 0.853) [6]. In this case there is less scatter about the mean trend and the* TL(avg) *values are seen to be a more accurate predictor of speech intelligibility and hence of the speech privacy possible for various wall constructions.*

The listening test results clearly indicate that TL(avg) values are more accurate predictors of the expected speech privacy provided by a wall. Using STC values to predict speech privacy could easily lead to costly over design of the sound attenuating properties of the wall, or perhaps to even more costly outcomes due to failure to achieve adequate speech privacy.

## 4. Comparison of the TL(avg) and STC Values for 74 Types of Gypsum Board Walls

Sound transmission loss data, TL(f), were accumulated for combinations of 13 stud configurations and 6 different combinations of gypsum board layers using data from [2]. Average TL(f) values were determined for each of the groups of data corresponding to one of 74 types of gypsum board wall constructions. All walls had stud cavities that were filled with porous sound absorbing material, but results were not separated according to the type of porous absorbing material because it is less influential on transmission loss values, and there was not sufficient data to represent all of the possible combinations. Similarly, gypsum board was only categorized by its nominal thickness, although most data was for walls constructed with type X gypsum board. The 6 combinations of gypsum board layers included are described in Table 3. The 13 different stud configurations are described in Table 4.

| Gypsum board thickness | Numbers of layers | Description |
|---|---|---|
| 13 | 1 & 1 | 1 layer of 13 mm gypsum board on each side of the wall. |
| 13 | 1 & 2 | 1 layer of 13 mm gypsum board on one side of the wall and 2 layers of 13 mm gypsum board on the other side of the wall. |
| 13 | 2 & 2 | 2 layers of 13 mm gypsum board on side each of the wall. |
| 16 | 1 & 1 | 1 layer of 16 mm gypsum board on each side of the wall. |
| 16 | 1 & 2 | 1 layer of 16 mm gypsum board on one side of the wall and 2 layers of 16 mm gypsum board on the other side of the wall. |
| 16 | 2 & 2 | 2 layers of 16 mm gypsum board on each side of the wall. |

*Table 3. Description of the 6 combinations of gypsum board layers included in the 74 types of gypsum board walls.*

| Stud configuration | Description |
|---|---|
| SS65(406) | Single 65 mm 25 gauge steel studs at 406 mm spacing |
| SS65(610) | Single 65 mm 25 gauge steel studs at 610 mm spacing |
| SS90(406) | Single 90 mm 25 gauge steel studs at 406 mm spacing |
| SS90(610) | Single 90 mm 25 gauge steel studs at 610 mm spacing |
| SS90(406)_RC | Single 90 mm 16 gauge steel studs at 406 mm spacing with resilient channels on one side |
| WS90(406)_RC | Single 90 mm wood studs at 406 mm spacing with resilient channels on one side |
| WS90(610)_RC | Single 90 mm wood studs at 610 mm spacing with resilient channels on one side |
| SWS90(406) | Staggered 90 mm wood studs at 406 mm spacing |
| SWS90(406)_RC | Staggered 90 mm wood studs at 406 mm spacing with resilient channels on 1 side |
| SWS90(610) | Staggered 90 mm wood studs at 610 mm spacing with resilient channels on 1 side |
| D_SS40(610) | Double 40 mm 25 gauge steel studs at 610 mm spacing with 25 mm gap between stud sets |
| D_SS65(610) | Double 65 mm 25 gauge steel studs at 610 mm spacing with 25 mm gap between stud sets |
| D_WS90(610) | Double 90 mm wood studs at 610 mm spacing with 25 mm gap between stud sets |

*Table 4. Description of the 13 stud system configurations for which data were available.*

There were no data for 4 of the 78 possible combinations of 13 stud configurations and 6 combinations of gypsum board layers, resulting in 74 types of gypsum board wall categories with data. By calculating averages of the measurements of each of the 74 groups of similar constructions, the results are generically representative of each construction but would not reflect the usually small differences in results due to particular materials such as specific brands or types of sound absorbing material or gypsum board. Such details were beyond the intent of this work, and would make it impossible to create a concise summary of gypsum board walls. Because most data was for walls with Type X gypsum board, one should assume this type of gypsum board is required to achieve the ratings in this report. Table 5 includes the average TL(avg) values and average STC values for each of the 74 types of wall constructions as well as drawings of sections through the walls of each stud configuration type. These data were obtained by averaging the ⅓-octave band TL(f) values and then calculating TL(avg) and STC values for each set of the average TL(f) values.  The complete average TL(f) values are included in Appendix A.

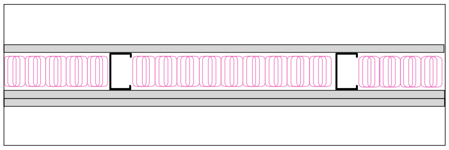
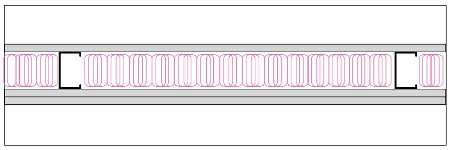
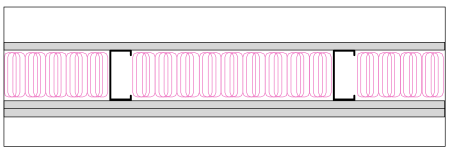
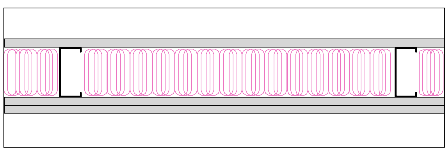
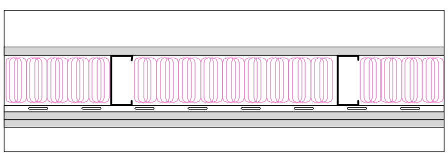
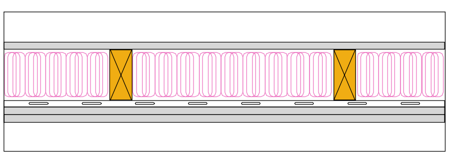
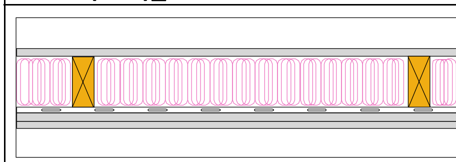
| TL(avg) /STC values | 13 mm gypsum board | | | 16 mm gypsum board | | |
|---|---|---|---|---|---|---|
| Construction | 1 & 1 | 1 & 2 | 2 & 2 | 1 & 1 | 1 & 2 | 2 & 2 |
|  SS65(406) | 51.0 /35 | 53.5 /40 | 56.7 /46 | 51.3 /40 | 54.9 /45 | 58.2 /52 |
|  SS65(610) | 49.5 /43 | 53.1 /48 | 55.9 /54 | 50.9 /43 | 54.3 /50 | 56.6 /55 |
|  SS90(406) | 52.0 /42 | 54.4 /48 | 57.4 /53 | 51.5 /45 | 55.3 /50 | 58.3 /54 |
|  SS90(610) | 52.3 /48 | 55.1 /53 | 55.9 /55 | 51.9 /49 | 54.6 /53 | 57.6 /56 |
|  SS90(406)_RC | 55.1 /48 | 58.8 /54 | 62.7 /60 | 53.5 /60 | - | - |
|  WS90(406)_RC | 53.8 /43 | 57.1 /48 | 61.0 /55 | 52.0 /45 | 57.3 /51 | 60.7 /56 |
|  WS90(610)_RC | 53.2 /47 | 57.3 /54 | 60.5 /59 | 54.4 /49 | 57.3 /54 | 61.3 /59 |

*Table 5 (part A). Group average TL(avg) and STC values for 42 types of gypsum board walls. Each row shows TL(avg) and STC data for a different stud configuration. Each data column includes TL(avg) and STC data for different numbers of layers of gypsum board for each stud configuration. The wall section drawings for each stud configuration illustrate the case with one layer of gypsum board on one side and 2 layers on the other side. TL(avg) values have one decimal place and are followed by the integer STC values.*

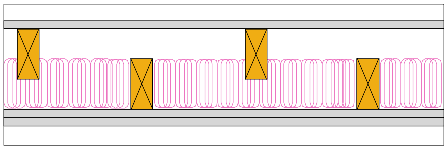
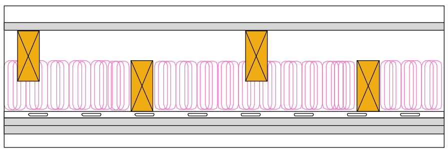
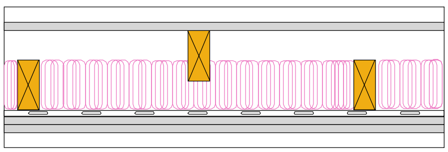
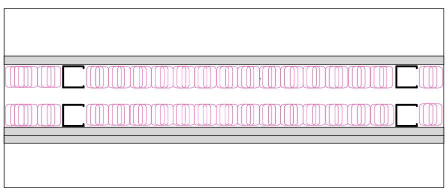
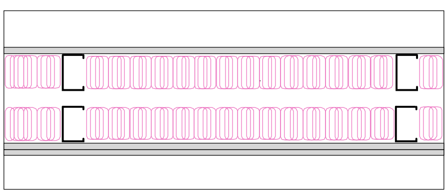
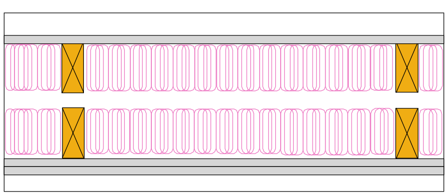
| TL(avg) /STC values | 13 mm gypsum board | | | 16 mm gypsum board | | |
|---|---|---|---|---|---|---|
| Construction | 1 & 1 | 1 & 2 | 2 & 2 | 1 & 1 | 1 & 2 | 2 & 2 |
|  **SWS90(406)** | 54.1 /45 | 53.8 /50 | 56.2 /53 | 50.8 /49 | 54.6 /53 | 57.2 /57 |
|  **SWS90(406)_RC13** | 63.7 /50 | 65.7 /54 | 66.7 /60 | 60.7 /53 | 65.1 /58 | 65.9 /63 |
|  **SWS90(610)_RC13** | 57.8 /49 | 63.6 /54 | - | 53.4 /52 | 61.7 /56 | 68.6 /62 |
|  **SS40(610)_AIR25_SS40(610)** | 61.6 /53 | 63.8 /59 | 66.1 /63 | 65.8 /55 | - | 69.6 /65 |
|  **SS65(610)_AIR25_S65(610)** | 59.3 /54 | 62.4 /60 | 64.5 /62 | 58.5 /55 | 62.2 /61 | 64.9 /65 |
|  **WS90(610)_AIR25_WS90(610)** | 66.6 /55 | 70.2 /59 | 72.6 /65 | 67.9 /59 | 68.8 /64 | 72.2 /68 |

*Table 5 (part B). Group average TL(avg) and STC values for 36 types of gypsum board walls. Each row shows TL(avg) and STC data for a different stud configuration. Each data column includes TL(avg) and STC data for different numbers of layers of gypsum board for each stud configuration. The wall section drawings for each stud configuration illustrate the case with one layer of gypsum board on one side and 2 layers on the other side. TL(avg) values have one decimal place and are followed by the integer STC values.*

## 5. Comparisons of TL(avg) and STC Values for The 74 Types of Gypsum Board Walls

The first analysis of the data was to examine the relationship between the mean TL(avg) values of each of the 74 wall types and the corresponding mean STC values. The differences between TL(avg) and the corresponding STC values in Table 5 (and Appendix A) indicate that TL(avg) values were between 0.2 and 16.0 dB greater than the corresponding STC values with a standard deviation of 3.55 dB.

The TL(avg) values are plotted versus the corresponding STC values in Figure 3. Each data point represents the average results of one of the 74 types of gypsum board walls corresponding to the values in Table 5. There is a statistically significant relationship ($R^2$ = 0.720) between the TL(avg) and STC for the 74 values. However, the scatter about the mean trend is quite large and the RMS variation of the TL(avg) values about the mean trend is ±3.05 dB. That is, for a given STC value there is a substantial range of possible TL(avg) values.

The red solid lines on the graph represent possible speech privacy requirements in terms of either STC or TL(avg). The vertical line corresponds to conditions with STC 52, which has been, a commonly used STC requirement for adequate speech privacy. The horizontal line, corresponding to TL(avg) values of 57 dB, represents a possible speech privacy recommendation using the new approach [3]. The 11 data points that are plotted as open circles, or in one case as an 'X', are the conditions with TL(avg) values within 1 dB of 57 dB. It is seen that they correspond to STC values varying from 46 to 57. In some cases an STC 52 wall might provide adequate speech privacy, but in many cases it would not. It is important to select walls in terms of a desired TL(avg) value because it is much more likely to provide the expected degree of speech privacy.

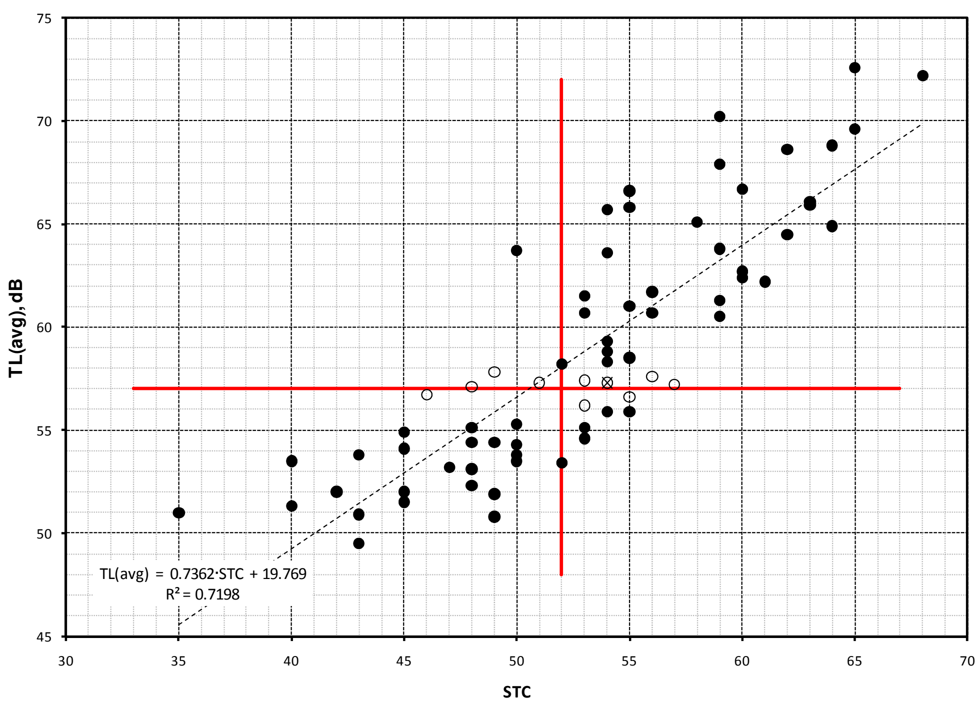



*Figure 3. Plot of mean TL(avg) versus mean STC for each of the 74 types of gypsum board walls.*

## 6. Wall Parameters Influencing TL(avg) and STC Values

The details of the measured TL(f) values for walls are influenced by several parameters describing the walls such as: (a) gypsum board thickness, (b) stud thickness (i.e. stud cavity depth), and (c) stud spacing. Examination of the data shows that these parameters have different effects on TL(avg) values than on STC values. In some cases changes to a wall construction, that would usually significantly change STC ratings, have only very small effects on TL(avg) values and vice versa. It is important to specify walls in terms of their measured TL(avg) values rather than to guess the effects of improvements to walls by various modifications to them.

**6.1 Gypsum board thickness:** The data in Table 5 show that when going from 13 mm gypsum board to the same number of layers of 16 mm gypsum board, STC values increase by 0 to 6 STC points with an average increase of 2.4 STC points. For the same change in gypsum board, TL(avg) values increased by between -4.4 and +4.3 dB with an average of 0.1 dB. That is, the normally beneficial effects of thicker (and heavier) gypsum board on STC values are not always seen for TL(avg) values. Some explanation of these effects can be seen in the plots of TL(f) versus frequency for various combinations of wall constructions. Figure 4 compares 65 mm steel stud walls (lower) and 90 mm steel stud walls (upper) with 13 mm and 16 mm gypsum board in terms of TL(f) values versus ⅓-octave band frequency. In changing from 13 mm gypsum board to 16 mm gypsum board, the coincidence dip is seen to shift from the 3150 Hz band to the 2500 Hz band. At the same time the mid and lower frequency TL(f) values tend to increase a little due to the increased mass of the thicker gypsum board. The net result is often only a small change in TL(avg) values but a larger increase in STC values. The STC values tend to increase because for these walls the STC value is limited by the 8-dB rule and the changes at and just above 125 Hz lead to increased STC values for the thicker gypsum board.

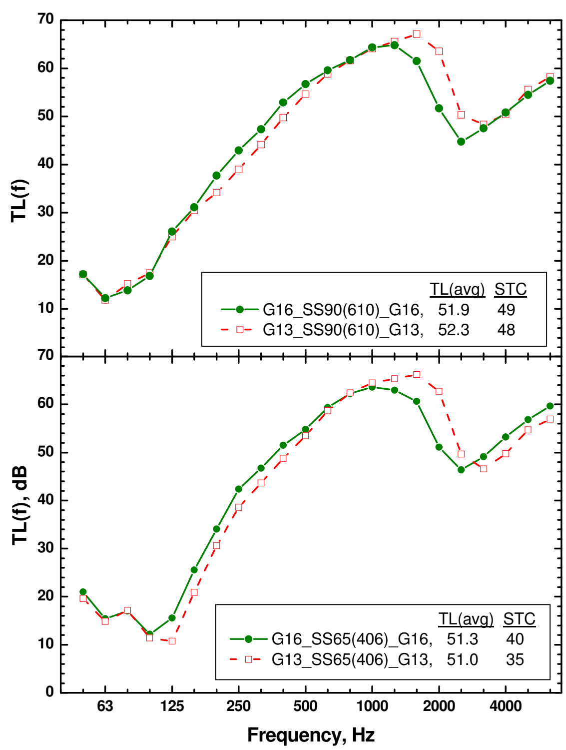



*Figure 4. Comparison of 65 mm steel stud walls (lower) and 90 mm steel stud walls (upper) with 13 mm and 16 mm gypsum board in terms of TL(f) versus ⅓-octave band frequency.*

**6.2 Stud depth (cavity depth):** Varying the depth of the studs for light-weight single steel stud walls also had a smaller effect on TL(avg) values than on STC values. Comparing the results for the 12 types of walls with 65 mm steel studs with the 12 types of walls with 90 mm single steel studs in Table 5, showed that for the larger stud depth, TL(avg) values were 0 to 2.8 dB larger with an average change of 0.9 dB. For the same comparison of constructions, STC values increased by between 1 and 7 STC points with and an average change of 4.6 STC points. Again the effect of stud depth was greater for STC values than for TL(avg) values. Figure 5 further illustrates the effects of stud depth for 65 and 90 mm single steel stud walls. When there is no change in gypsum board thickness as in these data, the coincidence dip does not shift in frequency, but the low frequency resonance dips in the TL(f) versus frequency plots change and cause much of the curve to appear to shift a little to lower frequencies (to the left on the graphs) for the walls with the larger studs. Again the low frequency changes have greater influence on STC values than on TL(avg) that include only the effects of TL(f) values from 160 to 5000 Hz.

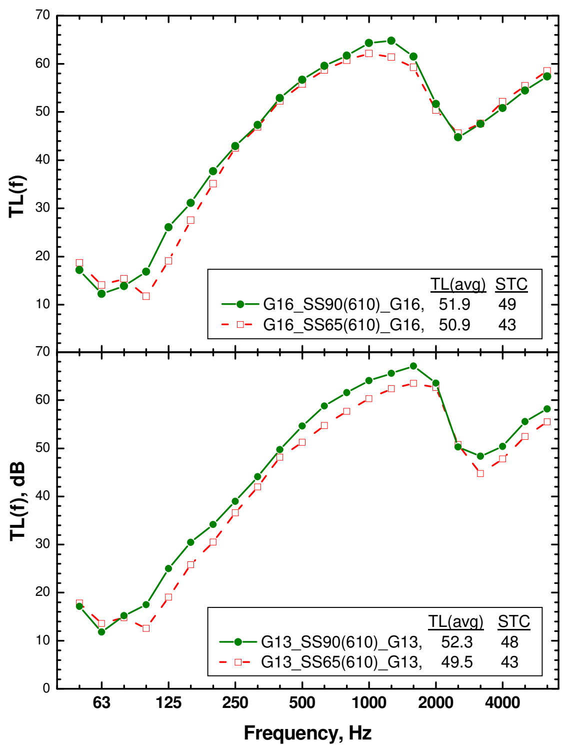



*Figure 5. Comparison of 65 and 90 mm steel stud walls with single layers of 13 mm gypsum board (lower) and 16 mm gypsum board (upper).*

**6.3 Stud Spacing:** The spacing of studs in single steel stud walls is another factor that was seen to influence STC values more than TL(avg) values in most constructions. When increasing the stud spacing from 406 to 610 mm, STC values increased by between 2 and 8 STC points (average 4.4 STC points). By comparison, for the same increase in stud spacing, TL(avg) values increased by between -1.5 and +11.4 with an average of 1.2 dB and for most cases increases were closer to the average value. Figure 6 shows that increasing the stud spacing again does not shift the coincidence dip but does modify one of the low frequency resonance dips. This again has more effect on STC values than on TL(avg) because the STC values are often strongly influenced by low frequency TL(f) due to the 8-dB rule incorporated in the STC rating procedure.

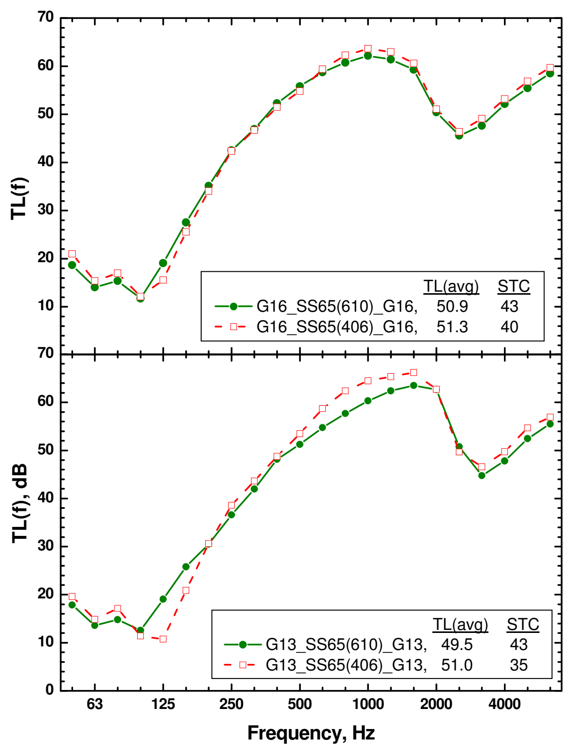



*Figure 6. Comparison of 13 mm (lower) and 16 mm (upper) steel stud wall TL(f) values for 406 and 610 mm stud spacing.*

## 7. Sound Transmission Loss Ratings of Block Walls

This section includes sound transmission loss ratings of walls including concrete blocks with gypsum board surface layers to expand the range of wall types for which speech privacy ratings were determined. The data is from an extensive research study [11, 12] that included a number of measurements of the sound transmission loss of concrete block walls that included gypsum board mounted on various types of wood or metal studs or resilient channels attached to the blocks. Although the original study indicates these results could be extended to other types of concrete block, data is included for only two types in this report. These are described in Table 6 for the 190 mm normal weight blocks (BLK190) and for 140 mm 75% solid concrete blocks (BLK140).

| Symbol | Height, mm | Length, mm | Depth, mm | Kg/m$^2$ |
|---|---|---|---|---|
| BLK140 | 190 | 390 | 140 | 240.1 |
| BLK190 | 190 | 390 | 140 | 236.2 |

*Table 6. Dimensions and mass per unit wall surface area for the two types of concrete blocks.*

The walls included 16 mm Gypsum board attached to one or both surfaces using one of 5 systems including: conventional resilient channels and different wood or steel furring systems. Data is provided for gypsum board added to one side of the wall and to both sides of the wall. In all cases the cavities between the block and the gypsum board were filled with glass fibre batts. The 5 systems for mounting the gypsum board are described in Table 7.

| Symbols | Cavity depth, mm | Description |
|---|---|---|
| WS40 | 40 | Wood studs (strapping) |
| RC13 | 13 | Conventional resilient channels (25 gauge steel) |
| ZC50 | 50 | Z-bar, steel furring channels (25 gauge steel) |
| SS65 | 65 | Steel studs (25 gauge steel) |
| ZC75 | 75 | Z-bar, steel furring channels (25 gauge steel) |

*Table 7. Description of the 5 types of mounting of gypsum board on block walls. Cavity depth is that due to the addition of each of the 5 types of mounting of gypsum board surface layers. In all cases the cavity between the gypsum board and the block was filled with glass fibre batt insulation.*

The sound transmission loss versus frequency TL(f) values obtained from [11] are included in Appendix A. From these TL(avg) and STC values were calculated. Table 8 shows the calculated TL(avg) and STC values for the 20 different combinations of block types and surface treatments. Each row of the table shows TL(avg) and STC values for one of the 4 different constructions including treatment of one or both surfaces for two different block types. For each of these 4 constructions TL(avg) and STC values are given for 5 different surface treatments described in Table 7.

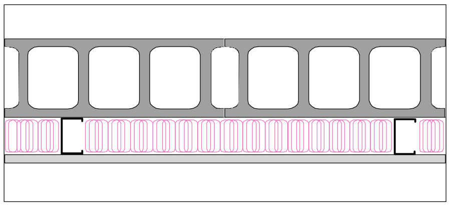
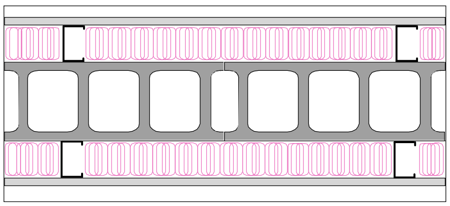
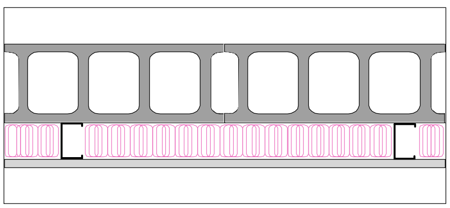
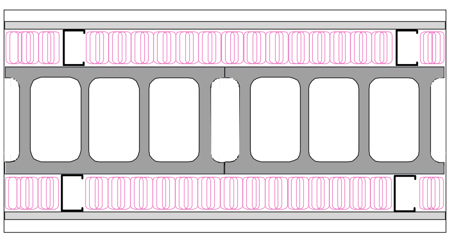
| TL(avg) /STC values | Single layer G16 supported by one of: | | | | |
|---|---|---|---|---|---|
| **Construction** | **WS40** | **RC13** | **ZC50** | **SS65** | **ZC75** |
|  **BLK140 – G16 on one side of block** | 55.0 / 54 | 55.7 / 53 | 57.9 / 58 | 60.6 / 60 | 60.6 /61 |
|  **BLK140 – G16 on both sides of block** | 60.2 / 60 | 61.6 / 54 | 65.9 / 66 | 71.5 / 72 | 71.5 /72 |
|  **BLK190 – G16 on one side of block** | 55.7 / 55 | 56.3 / 53 | 58.5 / 59 | 61.3 / 61 | 61.3 / 62 |
|  **BLK190 – G16 on both sides of block** | 60.9 / 60 | 62.2 / 50 | 66.6 / 65 | 72.1 / 71 | 72.1 / 72 |

Table 8. *TL(avg) and STC values for 20 types of block walls. Each row shows TL(avg) and STC data for one of the 4 combinations of 2 types of block and one or both surfaces treated. Each column includes TL(avg) and STC data for one of the 5 different surface treatments. The wall section drawings for each wall construction illustrate the case with gypsum board mounted on 65 mm steel studs on one or both sides of the wall. TL(avg) values have one decimal place and are followed by the integer STC values.*

## Appendix A. Transmission Loss Data for All Wall Types Included in this Report

This appendix includes the complete TL(f) values for the 74 types of stud walls and the 20 concrete block walls. For the 74 stud walls, each set of data is the average of the results from tests of a number of nominally similar walls. Also included are the corresponding TL(avg) and STC values which were calculated for each of the 74 sets of average TL(f) data. The number of sets of wall data, N, for each group of similar walls is given in the column to the right of the TL(avg) values.  The concrete block wall data is from an extensive series of measurements of concrete block walls with various surface treatments [11, 12].

The construction of each wall is described by a set of symbols indicating the wall components in order from one side to the other. These are explained in Table A-1 below. For example, G13_WS90(610)_RC13_2G13, describes a wall composed of 13 mm gypsum board (G13), mounted on 90 mm wood studs, spaced at 610 mm intervals (WS90(610)), with 13 mm resilient channels (RC13), and 2 layers of 13 mm gypsum board on the other side of the studs (2G13).

| Symbols | Description |
|---|---|
| G13 | One layer of 13 mm thick gypsum board |
| 2G16 | Two layers of 16 mm thick gypsum board |
| SS65(406) | 65 mm steel studs, spaced at 406 mm intervals |
| WS90(610) | 90 mm wood studs spaced at 610 mm intervals |
| RC13 | 13 mm resilient channels (between gypsum board and studs) |
| SWS90(406) | 90 mm staggered wood studs spaced at 406 mm intervals (on a 140 mm plate) |
| BLK140 | 140 mm concrete block |
| BLK190 | 190 mm concrete block |
| ZC50 | 50 mm Z-bar resilient channels  (25 gauge) |
| ZC75 | 75 mm Z-bar resilient channels  (25 gauge) |

*Table A-1. Explanations of symbols used to describe wall constructions.*

The data for the 74 types of stud walls are included in the 4 parts of Table A-2 and are grouped under headings for each of the 13 different stud configurations. Table A-22 includes similar data for the 20 types of block walls.  All walls had stud cavities filled with porous sound absorbing material. All double stud walls had a 25 mm air gap between the two sets of studs. Steel studs are light weight, 25 gauge steel studs except where the construction included resilient channels (RC13) on load bearing (16 gauge) steel studs.

| | | | | 1/3 Octave Band Transmission Loss | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Description** | **STC** | **TL(avg)** | **N** | **100** | **125** | **160** | **200** | **250** | **315** | **400** | **500** | **630** | **800** | **1000** | **1250** | **1600** | **2000** | **2500** | **3150** | **4000** | **5000** |
| | | | | | | | | | | | | | | | | | | | | | |
| **65 mm steel studs - 406 mm stud spacing** | | | | | | | | | | | | | | | | | | | | | |
| G13_SS65(406)_G13 | 35 | 51.0 | 6 | 11.4 | 10.8 | 20.9 | 30.6 | 38.5 | 43.6 | 48.8 | 53.5 | 58.7 | 62.4 | 64.5 | 65.3 | 66.2 | 62.7 | 49.7 | 46.6 | 49.7 | 54.7 |
| G13_SS65(406)_2G13 | 40 | 53.5 | 2 | 13.3 | 16.3 | 27.1 | 36.1 | 43.5 | 47.7 | 52.3 | 56.1 | 60.4 | 62.9 | 64.4 | 65.3 | 66.3 | 63.3 | 51.4 | 49.0 | 52.7 | 57.2 |
| 2G13_SS65(406)_2G13 | 46 | 56.7 | 2 | 16.1 | 21.6 | 31.8 | 40.3 | 47.7 | 52.1 | 56.2 | 58.8 | 63.1 | 65.2 | 66.5 | 66.8 | 68.1 | 65.3 | 53.5 | 52.8 | 56.9 | 61.3 |
| G16_SS65(406)_G16 | 40 | 51.3 | 6 | 12.2 | 15.6 | 25.6 | 34.1 | 42.3 | 46.7 | 51.5 | 54.8 | 59.4 | 62.3 | 63.6 | 63.0 | 60.6 | 51.1 | 46.4 | 49.1 | 53.2 | 56.8 |
| G16_SS65(406)_2G16 | 45 | 54.9 | 1 | 14.1 | 21.1 | 31.1 | 39.1 | 47.6 | 51.3 | 55.1 | 58.4 | 63.0 | 65.5 | 65.8 | 64.9 | 62.5 | 53.5 | 49.2 | 52.6 | 56.9 | 61.2 |
| 2G16_SS65(406)_2G16 | 52 | 58.2 | 1 | 18.5 | 28.3 | 37.1 | 44.0 | 52.1 | 55.9 | 59.1 | 61.4 | 64.7 | 66.9 | 66.7 | 66.7 | 64.8 | 56.3 | 53.1 | 56.2 | 60.4 | 65.1 |
| | | | | | | | | | | | | | | | | | | | | | |
| **65 mm steel studs - 610 mm stud spacing** | | | | | | | | | | | | | | | | | | | | | |
| G13_SS65(610)_G13 | 43 | 49.5 | 6 | 12.6 | 19.1 | 25.8 | 30.5 | 36.6 | 42.0 | 48.2 | 51.2 | 54.7 | 57.7 | 60.3 | 62.4 | 63.5 | 62.7 | 50.8 | 44.8 | 47.8 | 52.5 |
| G13_SS65(610)_2G13 | 48 | 53.1 | 5 | 15.6 | 24.2 | 31.5 | 36.1 | 41.2 | 45.8 | 51.3 | 55.1 | 58.2 | 61.0 | 63.1 | 65.1 | 66.0 | 63.7 | 52.3 | 48.9 | 52.9 | 57.9 |
| 2G13_SS65(610)_2G13 | 54 | 55.9 | 3 | 22.2 | 31.0 | 37.4 | 39.7 | 43.5 | 49.3 | 54.3 | 57.8 | 59.8 | 62.4 | 64.2 | 65.6 | 66.8 | 65.8 | 55.5 | 53.0 | 57.6 | 62.0 |
| G16_SS65(610)_G16 | 43 | 50.9 | 2 | 11.8 | 19.1 | 27.6 | 35.1 | 42.5 | 46.9 | 52.3 | 55.8 | 58.7 | 60.8 | 62.1 | 61.4 | 59.3 | 50.4 | 45.6 | 47.6 | 52.1 | 55.4 |
| G16_SS65(610)_2G16 | 50 | 54.3 | 2 | 16.8 | 26.0 | 33.5 | 40.3 | 46.0 | 50.6 | 56.2 | 59.1 | 61.0 | 63.2 | 64.3 | 63.5 | 62.0 | 54.7 | 49.3 | 51.0 | 55.5 | 58.9 |
| 2G16_SS65(610)_2G16 | 55 | 56.6 | 1 | 21.3 | 32.2 | 37.9 | 44.0 | 48.1 | 53.3 | 58.8 | 61.3 | 61.8 | 63.3 | 64.2 | 64.3 | 63.3 | 56.0 | 52.1 | 54.2 | 59.4 | 63.3 |
| | | | | | | | | | | | | | | | | | | | | | |
| **90 mm steel studs - 406 mm stud spacing** | | | | | | | | | | | | | | | | | | | | | |
| G13_SS90(406)_G13 | 48 | 52.3 | 11 | 17.5 | 25.0 | 30.5 | 34.2 | 39.0 | 44.1 | 49.7 | 54.6 | 58.8 | 61.6 | 64.1 | 65.6 | 67.1 | 63.5 | 50.3 | 48.4 | 50.4 | 55.6 |
| G13_SS90(406)_2G13 | 48 | 54.4 | 8 | 14.6 | 23.6 | 30.8 | 36.8 | 43.0 | 48.0 | 54.0 | 57.5 | 61.2 | 63.2 | 65.0 | 66.1 | 67.2 | 64.2 | 53.0 | 50.0 | 52.8 | 57.2 |
| 2G13_SS90(406)_2G13 | 53 | 57.4 | 8 | 20.0 | 28.6 | 35.5 | 41.8 | 47.0 | 51.9 | 57.0 | 59.5 | 63.1 | 65.3 | 66.4 | 67.4 | 68.9 | 66.3 | 55.1 | 54.2 | 57.5 | 61.9 |
| G16_SS90(406)_G16 | 45 | 51.5 | 39 | 13.5 | 20.6 | 28.4 | 35.3 | 42.0 | 47.2 | 53.0 | 55.7 | 59.8 | 61.6 | 63.0 | 62.9 | 60.2 | 49.9 | 45.5 | 49.3 | 52.9 | 56.6 |
| G16_SS90(406)_2G16 | 50 | 55.3 | 12 | 17.8 | 25.6 | 33.2 | 40.0 | 46.1 | 51.3 | 56.4 | 58.6 | 62.5 | 64.6 | 65.5 | 65.5 | 63.2 | 53.8 | 50.4 | 54.4 | 58.2 | 61.8 |
| 2G16_SS90(406)_2G16 | 54 | 58.3 | 12 | 21.5 | 29.9 | 37.5 | 43.9 | 50.4 | 55.2 | 60.1 | 61.2 | 64.1 | 66.2 | 66.6 | 66.9 | 64.9 | 55.9 | 53.7 | 57.9 | 61.9 | 66.0 |
| | | | | | | | | | | | | | | | | | | | | | |
| **90 mm steel studs - 610 mm stud spacing** | | | | | | | | | | | | | | | | | | | | | |
| G13_SS90(610)_G13 | 42 | 52.0 | 6 | 11.4 | 17.5 | 25.5 | 32.7 | 38.5 | 44.4 | 51.4 | 55.6 | 59.9 | 62.9 | 65.0 | 66.3 | 66.9 | 62.2 | 49.2 | 47.0 | 49.6 | 54.3 |
| G13_SS90(610)_2G13 | 53 | 55.1 | 2 | 22.5 | 30.0 | 36.3 | 40.2 | 43.5 | 47.9 | 52.9 | 57.2 | 60.6 | 62.9 | 64.8 | 66.4 | 68.2 | 64.8 | 51.7 | 51.1 | 54.0 | 58.4 |
| 2G13_SS90(610)_2G13 | 55 | 55.9 | 1 | 28.2 | 34.8 | 40.1 | 41.7 | 43.5 | 48.1 | 51.2 | 57.0 | 59.5 | 62.3 | 63.7 | 65.6 | 67.3 | 66.3 | 55.3 | 54.5 | 57.6 | 60.6 |
| G16_SS90(610)_G16 | 49 | 51.9 | 40 | 16.8 | 26.1 | 31.2 | 37.7 | 42.9 | 47.3 | 52.9 | 56.7 | 59.6 | 61.7 | 64.3 | 64.8 | 61.5 | 51.7 | 44.7 | 47.5 | 50.8 | 54.4 |
| G16_SS90(610)_2G16 | 53 | 54.6 | 2 | 21.2 | 30.1 | 35.1 | 42.2 | 45.4 | 49.4 | 54.3 | 57.7 | 60.7 | 62.6 | 65.4 | 66.3 | 63.4 | 54.5 | 49.1 | 52.1 | 55.8 | 59.5 |
| 2G16_SS90(610)_2G16 | 56 | 57.6 | 2 | 22.6 | 33.2 | 37.9 | 44.4 | 47.9 | 52.0 | 56.9 | 60.6 | 62.5 | 64.7 | 67.0 | 68.0 | 65.6 | 57.5 | 53.7 | 56.9 | 60.9 | 64.7 |
| | | | | | | | | | | | | | | | | | | | | | |
| **90 mm steel studs & RCs - 406 mm stud spacing** | | | | | | | | | | | | | | | | | | | | | |
| G13_SS90(406)_RC_G13 | 48 | 55.1 | 1 | 17.8 | 24.0 | 30.0 | 37.9 | 45.2 | 50.2 | 54.6 | 58.5 | 61.2 | 63.8 | 65.5 | 66.5 | 67.5 | 65.5 | 53.9 | 51.0 | 53.5 | 56.7 |
| G13_SS90(406)_RC_2G13 | 54 | 58.8 | 7 | 23.8 | 30.4 | 35.7 | 42.9 | 50.4 | 55.3 | 58.6 | 61.4 | 64.4 | 66.4 | 68.4 | 69.5 | 70.2 | 67.3 | 56.3 | 55.2 | 57.8 | 61.5 |
| 2G13_SS90(406)_RC_2G13 | 60 | 62.7 | 3 | 28.7 | 35.6 | 41.0 | 47.1 | 54.7 | 59.0 | 62.1 | 65.0 | 67.4 | 69.5 | 71.1 | 72.2 | 72.9 | 70.9 | 61.2 | 60.3 | 63.3 | 66.2 |
| G16_SS90(406)_RC_G16 | 50 | 53.5 | 3 | 19.2 | 25.7 | 31.7 | 38.8 | 46.9 | 51.5 | 53.6 | 56.8 | 60.0 | 62.0 | 63.3 | 63.6 | 60.6 | 50.5 | 47.9 | 52.7 | 56.6 | 59.1 |
| G16_SS90(406)_RC_2G16 | | | | | | | | | | | | | | | | | | | | | |
| 2G16_SS90(406)_RC_2G16 | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |

*Table A-2 (part a). Average transmission loss data, TL(f), for 74 types of gypsum board walls. Also shown TL(avg) and STC ratings for each wall type and 'N' the number of sets of results included in each average.*

| Description | STC | TL(avg) | N | 1/3 Octave Band Transmission Loss | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 100 | 125 | 160 | 200 | 250 | 315 | 400 | 500 | 630 | 800 | 1000 | 1250 | 1600 | 2000 | 2500 | 3150 | 4000 | 5000 |
| | | | | | | | | | | | | | | | | | | | | | |
| **90 mm wood studs & RCs - 406 mm stud spacing** | | | | | | | | | | | | | | | | | | | | | |
| G13_WS90(406)_RC_G13 | 43 | 53.8 | 12 | 15.4 | 19.1 | 26.6 | 34.2 | 41.9 | 46.9 | 52.0 | 55.5 | 59.0 | 62.4 | 64.7 | 66.9 | 67.4 | 65.1 | 54.5 | 51.2 | 54.0 | 59.1 |
| G13_WS90(406)_RC_2G13 | 48 | 57.1 | 12 | 19.3 | 24.5 | 30.9 | 38.2 | 45.6 | 50.0 | 54.9 | 58.3 | 61.3 | 64.4 | 66.6 | 68.6 | 69.3 | 68.1 | 59.4 | 55.9 | 58.8 | 63.6 |
| 2G13_WS90(406)_RC_2G13 | 55 | 61.0 | 8 | 24.9 | 31.4 | 37.0 | 43.0 | 50.4 | 54.9 | 59.2 | 61.6 | 65.1 | 67.1 | 69.1 | 70.8 | 72.6 | 70.9 | 62.6 | 60.3 | 63.7 | 68.3 |
| G16_WS90(406)_RC_G16 | 45 | 52.0 | 12 | 16.6 | 20.7 | 27.6 | 34.5 | 42.9 | 48.3 | 51.6 | 53.4 | 57.8 | 60.3 | 61.6 | 62.9 | 60.3 | 51.9 | 48.7 | 52.8 | 56.7 | 60.7 |
| G16_WS90(406)_RC_2G16 | 51 | 57.3 | 5 | 20.8 | 27.1 | 33.7 | 39.8 | 47.2 | 51.8 | 55.4 | 57.4 | 61.8 | 64.3 | 65.8 | 67.5 | 65.4 | 58.1 | 56.1 | 60.4 | 64.2 | 68.2 |
| 2G16_WS90(406)_RC_2G16 | 56 | 60.7 | 5 | 25.6 | 32.2 | 38.4 | 44.5 | 51.2 | 55.7 | 59.5 | 61.3 | 64.3 | 66.7 | 67.6 | 69.5 | 67.9 | 60.8 | 59.5 | 64.4 | 68.0 | 71.6 |
| | | | | | | | | | | | | | | | | | | | | | |
| **90 mm wood studs & RCs - 610 mm stud spacing** | | | | | | | | | | | | | | | | | | | | | |
| G13_WS90(610)_RC_G13 | 47 | 53.2 | 1 | 16.8 | 22.6 | 30.8 | 37.8 | 43.2 | 45.2 | 51.4 | 53.7 | 57.8 | 61.2 | 63.7 | 66.4 | 67.0 | 63.7 | 50.6 | 48.7 | 52.5 | 57.4 |
| G13_WS90(610)_RC_2G13 | 54 | 57.3 | 2 | 22.9 | 30.2 | 36.1 | 42.8 | 46.7 | 48.0 | 53.4 | 56.2 | 60.1 | 63.4 | 66.3 | 69.0 | 70.5 | 68.3 | 57.5 | 55.6 | 59.2 | 63.8 |
| 2G13_WS90(610)_RC_2G13 | 59 | 60.5 | 2 | 29.0 | 35.4 | 40.7 | 47.1 | 50.9 | 51.4 | 56.0 | 59.2 | 62.9 | 65.8 | 68.8 | 71.3 | 72.7 | 70.9 | 60.7 | 59.3 | 63.4 | 67.6 |
| G16_WS90(610)_RC_G16 | 49 | 54.4 | 12 | 16.7 | 24.5 | 31.1 | 37.3 | 45.0 | 49.5 | 53.3 | 57.4 | 60.5 | 63.3 | 64.9 | 66.3 | 63.7 | 54.6 | 50.0 | 53.7 | 58.3 | 61.9 |
| G16_WS90(610)_RC_2G16 | 54 | 57.3 | 3 | 21.2 | 30.1 | 35.6 | 41.2 | 47.9 | 50.7 | 54.0 | 58.0 | 60.5 | 64.0 | 66.1 | 68.0 | 65.8 | 58.7 | 54.9 | 59.3 | 64.1 | 67.8 |
| 2G16_WS90(610)_RC_2G16 | 59 | 61.3 | 2 | 26.6 | 34.8 | 41.8 | 46.4 | 52.7 | 54.6 | 57.8 | 61.5 | 64.1 | 67.1 | 68.8 | 70.9 | 69.3 | 62.6 | 59.4 | 63.7 | 68.7 | 71.8 |
| | | | | | | | | | | | | | | | | | | | | | |
| **90 mm staggered wood studs - 406 mm stud spacing** | | | | | | | | | | | | | | | | | | | | | |
| G13_SWS90(406)_G13 | 45 | 54.1 | 10 | 19.2 | 21.0 | 28.8 | 35.7 | 41.3 | 45.0 | 49.8 | 52.6 | 54.9 | 59.4 | 62.0 | 64.8 | 66.8 | 66.9 | 58.0 | 55.1 | 59.3 | 65.3 |
| G13_SWS90(406)_2G13 | 50 | 53.8 | 6 | 23.3 | 25.7 | 31.9 | 38.3 | 43.4 | 46.6 | 51.4 | 52.5 | 54.3 | 57.5 | 59.7 | 62.6 | 64.8 | 64.8 | 56.6 | 54.4 | 58.4 | 63.8 |
| 2G13_SWS90(406)_2G13 | 53 | 56.2 | 5 | 27.0 | 29.0 | 34.5 | 41.0 | 45.7 | 48.8 | 53.6 | 54.9 | 56.8 | 59.6 | 61.0 | 63.4 | 66.1 | 66.9 | 59.6 | 57.4 | 61.9 | 68.0 |
| G16_SWS90(406)_G16 | 49 | 50.8 | 4 | 21.4 | 24.6 | 29.2 | 34.8 | 43.3 | 45.8 | 49.3 | 50.9 | 52.4 | 54.6 | 57.1 | 58.5 | 56.8 | 49.8 | 49.0 | 54.9 | 60.9 | 66.5 |
| G16_SWS90(406)_2G16 | 53 | 54.6 | 6 | 25.9 | 29.5 | 34.0 | 39.6 | 47.4 | 51.1 | 53.6 | 54.9 | 56.0 | 57.7 | 59.8 | 61.4 | 59.6 | 52.8 | 52.9 | 58.8 | 64.6 | 70.1 |
| 2G16_SWS90(406)_2G16 | 57 | 57.2 | 3 | 32.1 | 34.6 | 37.6 | 43.0 | 50.8 | 54.8 | 56.3 | 57.2 | 57.7 | 59.1 | 60.6 | 63.0 | 61.1 | 54.6 | 56.1 | 62.1 | 67.8 | 72.8 |
| | | | | | | | | | | | | | | | | | | | | | |
| **90 mm staggered wood studs & RCs - 406 mm stud spacing** | | | | | | | | | | | | | | | | | | | | | |
| G13_SWS90(406)_RC_G13 | 50 | 63.7 | 2 | 21.5 | 26.2 | 33.6 | 39.8 | 46.5 | 51.9 | 58.2 | 63.5 | 67.9 | 72.5 | 75.3 | 78.9 | 80.6 | 79.5 | 66.6 | 63.0 | 67.5 | 74.0 |
| G13_SWS90(406)_RC_2G13 | 54 | 65.7 | 2 | 27.3 | 30.3 | 37.1 | 43.4 | 50.7 | 55.4 | 61.3 | 65.6 | 68.5 | 72.1 | 74.8 | 77.5 | 79.0 | 78.7 | 69.8 | 68.0 | 72.6 | 77.5 |
| 2G13_SWS90(406)_RC_2G13 | 60 | 66.7 | 1 | 33.2 | 35.6 | 42.2 | 48.6 | 54.5 | 57.4 | 62.6 | 66.6 | 69.6 | 71.7 | 74.2 | 77.3 | 78.6 | 77.7 | 68.7 | 68.4 | 72.7 | 77.0 |
| G16_SWS90(406)_RC_G16 | 53 | 60.7 | 4 | 23.0 | 28.5 | 34.7 | 40.6 | 46.8 | 51.8 | 56.7 | 60.9 | 63.9 | 68.0 | 70.2 | 73.0 | 72.1 | 63.1 | 58.8 | 64.4 | 70.3 | 75.2 |
| G16_SWS90(406)_RC_2G16 | 58 | 65.1 | 4 | 29.6 | 33.6 | 39.2 | 45.1 | 51.7 | 57.0 | 61.6 | 66.0 | 68.4 | 71.4 | 73.3 | 76.1 | 75.0 | 67.2 | 64.2 | 70.1 | 75.4 | 79.3 |
| 2G16_SWS90(406)_RC_2G16 | 63 | 65.9 | 4 | 35.9 | 38.7 | 43.1 | 48.3 | 54.6 | 58.6 | 62.2 | 65.9 | 67.9 | 71.4 | 72.7 | 75.2 | 74.2 | 67.0 | 65.4 | 71.7 | 76.2 | 80.2 |
| | | | | | | | | | | | | | | | | | | | | | |
| **90 mm staggered wood studs & RCs - 610 mm stud spacing** | | | | | | | | | | | | | | | | | | | | | |
| G13_SWS90(610)_G13 | 49 | 57.8 | 2 | 22.2 | 24.8 | 32.9 | 37.6 | 42.0 | 47.8 | 55.4 | 58.6 | 62.2 | 65.6 | 67.9 | 70.2 | 71.7 | 70.2 | 59.2 | 56.3 | 60.9 | 66.9 |
| G13_SWS90(610)_2G13 | 54 | 63.6 | 1 | 27.3 | 30.3 | 38.0 | 44.2 | 50.4 | 53.9 | 58.4 | 62.9 | 65.8 | 69.4 | 72.3 | 75.0 | 76.4 | 75.8 | 66.3 | 65.2 | 69.7 | 74.3 |
| 2G13_SWS90(610)_2G13 | | | | | | | | | | | | | | | | | | | | | |
| G16_SWS90(610)_G16 | 52 | 53.4 | 3 | 25.0 | 29.9 | 34.0 | 38.9 | 44.0 | 45.7 | 51.0 | 56.1 | 57.8 | 59.8 | 61.1 | 62.9 | 60.3 | 51.7 | 50.0 | 55.3 | 60.7 | 65.4 |
| G16_SWS90(610)_2G16 | 56 | 61.7 | 2 | 28.9 | 32.2 | 37.5 | 43.4 | 50.1 | 53.8 | 57.4 | 61.7 | 64.6 | 68.2 | 69.7 | 71.7 | 70.9 | 63.1 | 60.8 | 67.3 | 71.9 | 75.3 |
| 2G16_SWS90(610)_2G16 | 62 | 68.6 | 1 | 34.6 | 38.0 | 43.4 | 49.9 | 56.6 | 62.1 | 65.8 | 70.3 | 71.5 | 73.7 | 75.1 | 78.1 | 76.1 | 68.4 | 68.2 | 74.4 | 79.8 | 84.6 |

*Table A-2 (part b). Average transmission loss data, TL(f), for 74 types of gypsum board walls. Also shown TL(avg) and STC ratings for each wall type and 'N' the number of sets of results included in each average.*

| | | | | 1/3 Octave Band Transmission Loss | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Description** | **STC** | **TL(avg)** | **N** | **100** | **125** | **160** | **200** | **250** | **315** | **400** | **500** | **630** | **800** | **1000** | **1250** | **1600** | **2000** | **2500** | **3150** | **4000** | **5000** |
| **Double 40 mm steel stud walls - 610 mm stud spacing** | | | | | | | | | | | | | | | | | | | | | |
| G13_SS40(610)_SS40(610)_G13 | 53 | 61.5 | 1 | 24.1 | 29.1 | 34.6 | 39.8 | 45.4 | 50.4 | 54.8 | 59.0 | 63.3 | 70.2 | 74.6 | 77.4 | 80.2 | 78.4 | 64.1 | 60.9 | 62.3 | 68.0 |
| G13_SS40(610)_SS40(610)_2G13 | 59 | 63.8 | 1 | 29.3 | 34.9 | 40.7 | 44.8 | 49.7 | 53.8 | 56.5 | 59.4 | 62.0 | 68.5 | 74.2 | 77.3 | 80.6 | 79.7 | 67.5 | 64.8 | 67.6 | 72.9 |
| 2G13_SS40(610)_SS40(610)_2G13 | 63 | 66.1 | 1 | 33.6 | 39.4 | 46.0 | 48.1 | 53.5 | 56.7 | 59.1 | 61.3 | 63.6 | 68.0 | 74.5 | 77.5 | 80.9 | 80.3 | 70.0 | 68.8 | 72.5 | 77.5 |
| G16_SS40(610)_SS40(610)_G16 | 55 | 65.8 | 3 | 23.7 | 30.7 | 36.9 | 42.5 | 48.8 | 53.7 | 59.3 | 63.6 | 68.2 | 73.7 | 77.7 | 80.2 | 79.4 | 70.1 | 67.2 | 72.6 | 77.5 | 81.5 |
| G16_SS40(610)_SS40(610)_2G16 | | | | | | | | | | | | | | | | | | | | | |
| 2G16_SS40(610)_SS40(610)_2G16 | 65 | 69.6 | 2 | 35.4 | 40.5 | 46.9 | 52.2 | 57.7 | 61.1 | 65.3 | 67.8 | 69.6 | 73.3 | 77.5 | 79.1 | 79.0 | 71.1 | 70.3 | 76.4 | 81.1 | 85.6 |
| **Double 65 mm steel stud walls - 610 mm stud spacing** | | | | | | | | | | | | | | | | | | | | | |
| G13_SS65(610)_SS65(610)_G13 | 54 | 59.3 | 1 | 25.0 | 30.4 | 36.0 | 40.8 | 45.4 | 49.4 | 53.4 | 56.9 | 61.1 | 65.5 | 68.9 | 74.6 | 77.3 | 74.0 | 62.1 | 58.1 | 60.7 | 64.7 |
| G13_SS65(610)_SS65(610)_2G13 | 60 | 62.4 | 1 | 31.4 | 35.8 | 41.1 | 45.3 | 49.6 | 52.7 | 56.5 | 59.9 | 62.2 | 66.4 | 70.8 | 74.8 | 77.9 | 76.2 | 65.3 | 63.0 | 66.6 | 70.3 |
| 2G13_SS65(610)_SS65(610)_2G13 | 62 | 64.5 | 1 | 36.5 | 39.9 | 45.5 | 48.1 | 52.4 | 54.5 | 58.4 | 60.7 | 62.4 | 66.0 | 71.4 | 74.9 | 78.7 | 78.0 | 68.4 | 67.1 | 70.9 | 74.6 |
| G16_SS65(610)_SS65(610)_G16 | 55 | 58.5 | 1 | 25.8 | 31.2 | 35.9 | 42.8 | 47.5 | 50.2 | 54.9 | 57.6 | 60.2 | 66.0 | 68.6 | 71.6 | 71.0 | 59.9 | 57.1 | 60.8 | 64.4 | 66.8 |
| G16_SS65(610)_SS65(610)_2G16 | 61 | 62.2 | 1 | 31.0 | 36.6 | 40.7 | 47.9 | 52.3 | 54.3 | 58.3 | 61.1 | 62.5 | 66.4 | 70.8 | 73.4 | 73.5 | 64.1 | 61.6 | 66.1 | 69.8 | 72.8 |
| 2G16_SS65(610)_SS65(610)_2G16 | 64 | 64.9 | 1 | 34.7 | 40.2 | 43.7 | 51.6 | 55.3 | 56.4 | 60.8 | 62.9 | 63.6 | 67.0 | 72.5 | 75.0 | 75.1 | 66.8 | 65.6 | 70.3 | 74.4 | 78.3 |
| **Double 90 mm wood stud walls - 610 mm stud spacing** | | | | | | | | | | | | | | | | | | | | | |
| G13_WS90(610)_WS90(610)_G13 | 55 | 66.6 | 8 | 25.1 | 31.0 | 37.6 | 43.7 | 49.3 | 51.7 | 57.0 | 60.5 | 64.8 | 70.1 | 74.6 | 79.1 | 83.8 | 84.5 | 76.0 | 73.4 | 77.3 | 82.4 |
| G13_WS90(610)_WS90(610)_2G13 | 59 | 70.2 | 1 | 29.4 | 35.3 | 41.7 | 47.4 | 52.9 | 55.7 | 60.7 | 63.2 | 67.7 | 71.7 | 76.5 | 81.5 | 86.1 | 87.7 | 83.5 | 78.3 | 81.7 | 87.4 |
| 2G13_WS90(610)_WS90(610)_2G13 | 65 | 72.6 | 1 | 35.0 | 40.9 | 47.0 | 52.3 | 57.4 | 60.5 | 65.0 | 67.0 | 70.7 | 73.1 | 77.5 | 82.8 | 86.9 | 88.1 | 83.7 | 79.0 | 82.9 | 88.4 |
| G16_WS90(610)_WS90(610)_G16 | 59 | 67.9 | 5 | 27.9 | 34.7 | 40.4 | 45.7 | 51.9 | 55.2 | 59.5 | 63.8 | 67.8 | 72.6 | 76.0 | 79.4 | 81.4 | 74.7 | 71.5 | 76.8 | 82.7 | 87.3 |
| G16_WS90(610)_WS90(610)_2G16 | 64 | 68.8 | 2 | 33.1 | 40.1 | 44.9 | 49.2 | 54.5 | 57.1 | 60.5 | 64.5 | 67.5 | 72.0 | 75.6 | 79.1 | 79.6 | 72.4 | 71.8 | 78.1 | 84.4 | 89.0 |
| 2G16_WS90(610)_WS90(610)_2G16 | 68 | 72.2 | 2 | 38.3 | 44.5 | 49.8 | 53.9 | 58.7 | 61.0 | 63.8 | 67.4 | 70.1 | 74.6 | 78.4 | 82.7 | 82.6 | 75.4 | 75.7 | 81.9 | 87.7 | 91.8 |

*Table A-2 (part c). Average transmission loss data, TL(f), for 74 types of gypsum board walls. Also shown TL(avg) and STC ratings for each wall type and 'N' the number of sets of results included in each average.*

| Description | STC | TL(avg) | 1/3 Octave Band Transmission Loss | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 100 | 125 | 160 | 200 | 250 | 315 | 400 | 500 | 630 | 800 | 1000 | 1250 | 1600 | 2000 | 2500 | 3150 | 4000 | 5000 |
| **16 mm gypsum board on one side of 140 mm blocks** | | | | | | | | | | | | | | | | | | | | |
| G16_WS40_GFB38_BLK140 | 54 | 55.0 | 28.7 | 39.1 | 44.1 | 45.3 | 42.9 | 43.8 | 48.1 | 48.7 | 51.1 | 54.1 | 56.9 | 59.9 | 60.8 | 60.8 | 60.7 | 64.2 | 66.6 | 72.3 |
| G16_RC13_GFB13_BLK140 | 53 | 55.7 | 28.4 | 33.3 | 37.3 | 38.1 | 40.2 | 45.7 | 49.3 | 51.3 | 53.0 | 56.2 | 59.0 | 61.2 | 61.3 | 62.4 | 65.8 | 67.8 | 69.1 | 73.5 |
| G16_ZC50_GFB50_BLK140 | 58 | 57.9 | 31.9 | 41.0 | 43.9 | 43.3 | 42.8 | 48.3 | 52.8 | 54.6 | 57.1 | 59.9 | 61.5 | 63.0 | 61.3 | 62.4 | 65.1 | 67.3 | 69.0 | 73.3 |
| G16_SS65_GFB65_BLK140 | 60 | 60.6 | 36.7 | 43.9 | 46.7 | 47.4 | 48.1 | 52.4 | 55.7 | 57.2 | 59.1 | 61.3 | 62.2 | 62.5 | 63.0 | 65.1 | 68.3 | 72.1 | 72.8 | 76.0 |
| G16_ZC75_GFB75_BLK140 | 61 | 60.6 | 38.4 | 44.9 | 49.0 | 47.9 | 47.3 | 50.6 | 56.3 | 58.5 | 60.3 | 61.6 | 62.4 | 63.8 | 64.8 | 65.7 | 65.9 | 69.3 | 71.8 | 74.9 |
| **16 mm gypsum board on both sides of 140 mm blocks** | | | | | | | | | | | | | | | | | | | | |
| G16_WS40_GFB38_BLK140_GFB38_WS40_G16 | 60 | 60.2 | 23.2 | 41.4 | 49.7 | 55.0 | 51.3 | 49.4 | 56.0 | 55.1 | 57.0 | 60.0 | 62.6 | 66.3 | 66.7 | 64.3 | 60.8 | 65.2 | 68.9 | 75.7 |
| G16_RC13_GFB13_BLK140_GFB13_RC13_G16 | 54 | 61.6 | 22.6 | 29.8 | 36.2 | 40.6 | 46.1 | 53.2 | 58.4 | 60.1 | 60.9 | 64.1 | 66.9 | 68.8 | 67.7 | 67.4 | 70.9 | 72.5 | 73.7 | 78.2 |
| G16_ZC50_GFB50_BLK140_GFB50_ZC50_G16 | 66 | 65.9 | 29.6 | 45.2 | 49.4 | 51.0 | 51.2 | 58.5 | 65.3 | 66.8 | 68.9 | 71.6 | 71.9 | 72.5 | 67.9 | 67.5 | 69.7 | 71.5 | 73.6 | 77.8 |
| G16_SS65_GFB65_BLK140_GFB65_SS65_G16 | 72 | 71.5 | 39.2 | 51.0 | 54.9 | 59.1 | 61.9 | 66.7 | 71.0 | 72.0 | 73.1 | 74.4 | 73.3 | 71.6 | 71.3 | 72.8 | 75.9 | 81.0 | 81.1 | 83.2 |
| G16_ZC75_GFB75_BLK140_GFB75_WS75_G16 | 72 | 71.5 | 42.6 | 53.1 | 59.5 | 60.2 | 60.2 | 63.1 | 72.3 | 74.7 | 75.4 | 75.0 | 73.7 | 74.1 | 74.9 | 74.1 | 71.3 | 75.6 | 79.1 | 81.0 |
| **16 mm gypsum board on one side of 190 mm blocks** | | | | | | | | | | | | | | | | | | | | |
| G16_WS40_GFB38_BLK190 | 55 | 55.7 | 29.9 | 35.3 | 43.3 | 48.9 | 49.7 | 49.2 | 50.8 | 50.3 | 52.4 | 54.3 | 56.1 | 58.4 | 60.7 | 60.5 | 57.9 | 61.6 | 66.1 | 70.4 |
| G16_RC13_GFB13_BLK190 | 53 | 56.3 | 29.6 | 29.5 | 36.5 | 41.7 | 47.0 | 51.1 | 52.0 | 52.9 | 54.3 | 56.4 | 58.2 | 59.7 | 61.2 | 62.1 | 63.0 | 65.2 | 68.6 | 71.6 |
| G16_ZC50_GFB50_BLK190 | 59 | 58.5 | 33.1 | 37.2 | 43.1 | 46.9 | 49.6 | 53.7 | 55.5 | 56.2 | 58.4 | 60.1 | 60.7 | 61.5 | 61.2 | 62.1 | 62.3 | 64.7 | 68.5 | 71.4 |
| G16_SS65_GFB65_BLK190 | 61 | 61.3 | 37.9 | 40.1 | 45.9 | 51.0 | 54.9 | 57.8 | 58.4 | 58.8 | 60.4 | 61.5 | 61.4 | 61.0 | 62.9 | 64.8 | 65.5 | 69.5 | 72.3 | 74.1 |
| G16_ZC75_GFB75_BLK190 | 62 | 61.3 | 39.6 | 41.1 | 48.2 | 51.5 | 54.1 | 56.0 | 59.0 | 60.1 | 61.6 | 61.8 | 61.6 | 62.3 | 64.7 | 65.4 | 63.1 | 66.7 | 71.3 | 73.0 |
| **16 mm gypsum board on both sides of 190 mm blocks** | | | | | | | | | | | | | | | | | | | | |
| G16_WS40_GFB38_BLK190_GFB38_WS40_G16 | 60 | 60.9 | 24.4 | 37.6 | 48.9 | 58.6 | 58.1 | 54.8 | 58.7 | 56.7 | 58.3 | 60.2 | 61.8 | 64.8 | 66.6 | 64.0 | 58.0 | 62.6 | 68.4 | 73.8 |
| G16_RC13_GFB13_BLK190_GFB13_RC13_G16 | 50 | 62.2 | 23.8 | 26.0 | 35.4 | 44.2 | 52.9 | 58.6 | 61.1 | 61.7 | 62.2 | 64.3 | 66.1 | 67.3 | 67.6 | 67.1 | 68.1 | 69.9 | 73.2 | 76.3 |
| G16_ZC50_GFB50_BLK190_GFB50_ZC50_G16 | 65 | 66.6 | 30.8 | 41.4 | 48.6 | 54.6 | 58.0 | 63.9 | 68.0 | 68.4 | 70.2 | 71.8 | 71.1 | 71.0 | 67.8 | 67.2 | 66.9 | 68.9 | 73.1 | 75.9 |
| G16_SS65_GFB65_BLK190_GFB65_SS65_G16 | 71 | 72.1 | 40.4 | 47.2 | 54.1 | 62.7 | 68.7 | 72.1 | 73.7 | 73.6 | 74.4 | 74.6 | 72.5 | 70.1 | 71.2 | 72.5 | 73.1 | 78.4 | 80.6 | 81.3 |
| G16_ZC75_GFB75_BLK190_GFB75_WS75_G16 | 72 | 72.1 | 43.8 | 49.3 | 58.7 | 63.8 | 67.0 | 68.5 | 75.0 | 76.3 | 76.7 | 75.2 | 72.9 | 72.6 | 74.8 | 73.8 | 68.5 | 73.0 | 78.6 | 79.1 |

*Table A-3. Transmission loss data, TL(f), for 20 types of concrete block walls. Also shown TL(avg) and STC ratings for each wall type.*

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