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Apparent sound insulation in wood-framed buildings

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RR-336
Apparent Sound Insulation in Wood-Framed Buildings

Christoph Hoeller, David Quirt, Markus Mueller-Trapet

December 2017

National Research Council Canada
Conseil national de recherches Canada

Canada

Scope

This Report presents the results from substantial experimental studies of sound transmission, together with an explanation of calculation procedures to predict the sound transmission between adjacent spaces in a building with wood-framed walls and floors.

This Report presents two types of experimental data for wood-framed constructions:

- Test data for direct sound transmission through typical wood-framed wall assemblies and wood-framed floor assemblies, plus a summary of trends for such constructions and references to compilations of additional data
- Test data for flanking sound transmission measured following the procedures of ISO 10848 for coupled wall/floor junctions and wall/wall junctions

Worked examples for calculating the apparent sound transmission class (ASTC) rating between adjacent dwelling units are presented to illustrate how the experimental data can be applied.

Acknowledgments

The research studies on which this Report is based were supported by the Canadian Wood Council and a variety of other industry partners whose participation is recognized in the research reports referenced in the Appendix. The development of this Report was supported by the Canadian Wood Council. The financial support is gratefully acknowledged.

Disclaimer

Although it is not repeated at every step of this Report, it should be understood that some variation in sound insulation is to be expected in practice due to changes in the specific design details, quality of workmanship, substitution of “generic equivalents”, or simply rebuilding the construction. It would be prudent to allow a margin of error of 2-3 ASTC points to ensure that a design will satisfy a specific requirement.

Despite this caveat, the authors believe that methods and results shown here do provide a good estimate of the apparent sound insulation for the types of constructions presented.

Contents

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1 Sound Transmission via Many Paths

The simplest approach to sound transmission between adjacent rooms in buildings considers only the sound transmission through the separating wall or floor. This perspective has been entrenched in North American building codes, which for many decades have considered only the ratings for the separating assembly: sound transmission class (STC) or field sound transmission class (FSTC) for airborne sources and impact insulation class (IIC) for footstep noise.

Implicit in this approach (illustrated in Figure 1.1) is the simplistic assumption that sound is transmitted only through the obvious separating assembly – the separating wall assembly when the rooms are side-by-side, or the floor/ceiling assembly when rooms are one-above-the-other. If the sound insulation is inadequate, this is attributed to errors in either the design of the separating assembly or the workmanship of those who built it, and remediation focusses on that assembly. Unfortunately, this paradigm is still common among designers and builders in North America.

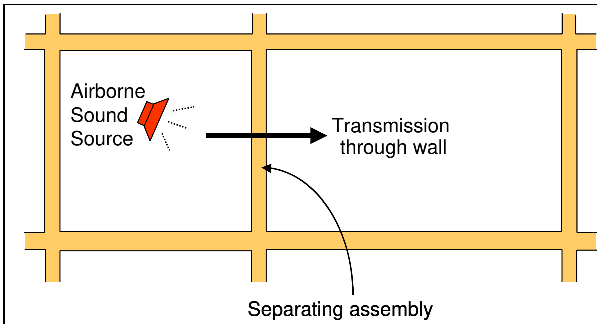


Figure 1.1: The drawings in Figure 1.1 and 1.2 show a cross-section through a building with two adjacent rooms. Part of the sound from an airborne source in one unit (represented by the red loudspeaker in the drawings, which could include anything from a home theatre to people talking loudly) is transmitted to the adjacent unit. The historic approach, illustrated in Figure 1.1, considers *only* the direct sound transmission through the separating assembly.

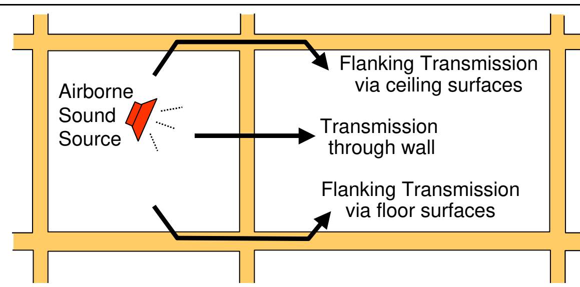


Figure 1.2: In reality, there are many paths for sound transmission between adjacent rooms, including both direct transmission through the separating assembly and indirect structure-borne paths, a few of which are indicated here (see Section 1.4 for more detail). The structure-borne paths usually significantly affect the overall sound transmission.

In reality, the technical issue is more complex, as illustrated in Figure 1.2. There is direct transmission of sound through the separating assembly, but that is only part of the story of how sound is transmitted between adjacent rooms. As shown in the figure, the airborne sound source excites all the surfaces in the source space and all of these surfaces vibrate in response. Some of this vibrational energy is transmitted as structure-borne sound across the surfaces abutting the separating assembly, through the junctions where these surfaces join the separating assembly, and into surfaces of the adjoining space. These surfaces in the receiving room then radiate part of the vibrational energy as airborne sound. The sound transmission by these paths is called flanking sound transmission.

It follows that the sound insulation between adjacent rooms is always worse than the sound insulation provided by the obvious separating assembly. Occupants of the adjacent room actually hear the combination of sound due to direct transmission through the separating assembly plus sound due to structure-borne flanking sound transmission involving all the other elements coupled to the separating assembly. Furthermore, there is also transmission of sound through leaks (openings) in the walls. The importance of including all of the transmission paths has long been recognized in principle (and the fundamental science was largely explained decades ago, by Cremer *et al.* [8]). The challenge has been to reduce the complicated calculation process to manageable engineering that yields trustworthy quantitative estimates, and to standardize that process to facilitate its inclusion in a regulatory framework.

For design or regulation, there is well-established terminology to describe the overall sound transmission including all paths between adjacent rooms. ISO ratings such as the weighted apparent sound reduction index (R'_w) have been used in many countries for decades, and ASTM E336 defines the corresponding apparent sound transmission class (ASTC), which is used in the examples in this Report.

Although measuring the ASTC in a building (following ASTM Standard E336) is quite straightforward, predicting the ASTC due to the set of transmission paths in a building is more complex. However, standardized frameworks for calculating the overall sound transmission have been developed. These start from standardized measurements to characterize sub-assemblies, and have been used for more than a decade to support performance-based European code systems.

In 2005, ISO published a calculation method, ISO 15712-1, “Building acoustics — Estimation of acoustic performance of buildings from the performance of elements — Part 1: Airborne sound insulation between rooms”. This is one part of a series of standards: Part 2 deals with “impact sound insulation between rooms”, Part 3 deals with “airborne sound insulation against outdoor sound”, and Part 4 deals with “transmission of indoor sound to the outside”.

There are two significant impediments to applying the methods of ISO 15712-1 in a North American context:

- ISO 15712-1 provides very reliable estimates for buildings constructed from heavy, homogeneous building elements, but not for buildings constructed from lightweight (steel- or wood-) framed elements widely used in North America.
- ISO standards for building acoustics have many differences from the ASTM standards used by the construction industry in North America – both in their terminology and in specific technical requirements for measurement procedures and ratings.

The following sections of this chapter outline a strategy for dealing with these limitations, both explaining how to merge ASTM and ISO test data and procedures, and providing recommendations for adapting the calculation procedures for wood-framed constructions.

This Report was developed in a project established by the National Research Council Canada and the Canadian Wood Council to support the transition of construction industry practice to using ASTC rather than STC for sound control objectives in the National Building Code of Canada (NBCC). However, the potential range of application goes beyond the minimum requirements of the NBCC. The Report also facilitates design to provide enhanced levels of sound insulation, and should be generally applicable to construction with wood-framed assemblies in both Canada and the USA.

1.1 Predicting Sound Transmission in a Building

As noted above, ISO 15712-1 provides reliable estimates of apparent sound transmission for buildings constructed from heavy, homogeneous building elements, but it is less accurate for some other common types of construction, especially for lightweight wood-framed and steel-framed constructions.

ISO 15712-1 has other limitations, too. For example, in several places the Standard identifies situations (especially for lightweight framed construction) where the detailed calculation is not appropriate. However, the Standard does not provide specific guidance on how to deal with such cases. Many of these limitations can be overcome by using data from laboratory testing according to the ISO 10848 series of standards that were developed to deal with measuring flanking sound transmission for various combinations of construction types and junctions. Because the current (2005) edition of ISO 15712-1 replicates a European standard developed before 2000, it does not reference more recent standards such as the ISO 10848 series, or the ISO 10140 series that are replacing the ISO 140 series referenced in ISO 15712-1. The 2015 edition of the National Building Code of Canada deals with this problem by specifying suitable procedures and test data to deal with calculating ASTC for different types of construction. These procedures are also explained in the NRC Research Report RR-331, "Guide to Calculating Airborne Sound Transmission in Buildings" [13].

For wood-framed constructions[1], the calculation procedure of ISO 15712-1 (both the Detailed Method and the Simplified Method) must be modified to obtain accurate results. This Report outlines the steps of the calculation process and the standard measurement data required for such calculations. These modifications are consistent with the requirements in the 2015 National Building Code of Canada.

This Report is restricted to consideration of buildings where all wall and floor assemblies are framed with wood studs or wood joists[5]. The scope could be expanded to include the combination of wood-framed assemblies with other construction types. Sound transmission data for wood-framed floors connected to masonry concrete block walls is provided in the NRC Research Report RR-334, "Apparent Sound Insulation in Concrete Block Buildings" [15.2].

In order to respect copyright, the Report does not reproduce the equations of ISO 15712-1, but it does indicate which equations apply in each context and provides key adaptations of the ISO expressions needed to apply the concepts in an ASTM context.

[1] Superscripted notes in this Report refer to the endnotes on page 166.

1.2 Standard Scenario for Examples in this Report

The prediction of the sound transmitted in buildings depends not only on the construction details of the transmission paths, but also on the size and shape of each of the room surfaces and on the sound absorption in the receiving room. The ability to adjust the calculation to fit the dimensions in a specific building or to normalize to different receiving room conditions enables a skilled designer to obtain more accurate predictions.

However, for purposes of this Report where results will be presented for a variety of constructions, easy and meaningful comparison of results is facilitated by calculating all the examples for a common set of room geometry and dimensions. This is particularly useful where only small changes are made between the construction details in the examples, since any change in the ASTC rating can then be attributed to the changes which were made in the construction details.

Therefore, a Standard Scenario has been adopted for all the examples, with the following constraints:

- Sound is transmitted between adjacent rooms, either side-by-side or one-above-the-other.
- The adjacent rooms are mirror images of each other, (with one side of the separating assembly facing each room, and constituting one complete face of each rectangular room).

The Standard Scenario is illustrated in Figures 1.3 and 1.4, for the cases where one room is beside the other, or one is above the other, respectively.

Figure 1.3:
Standard Scenario for the "horizontal room pair" case where the pair of rooms are side-by-side with a separating wall assembly between the two rooms.

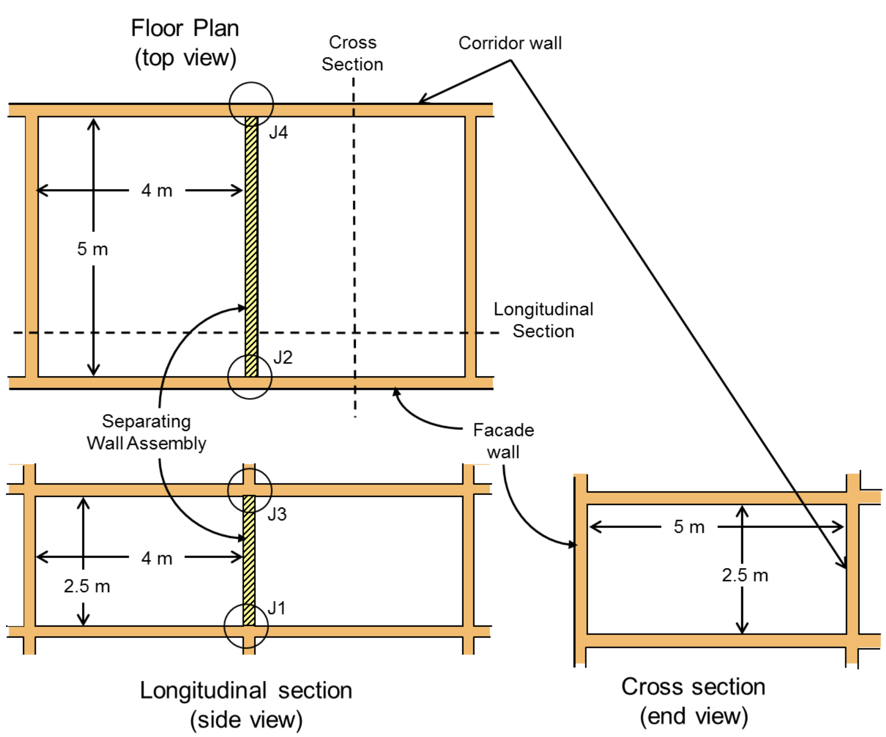
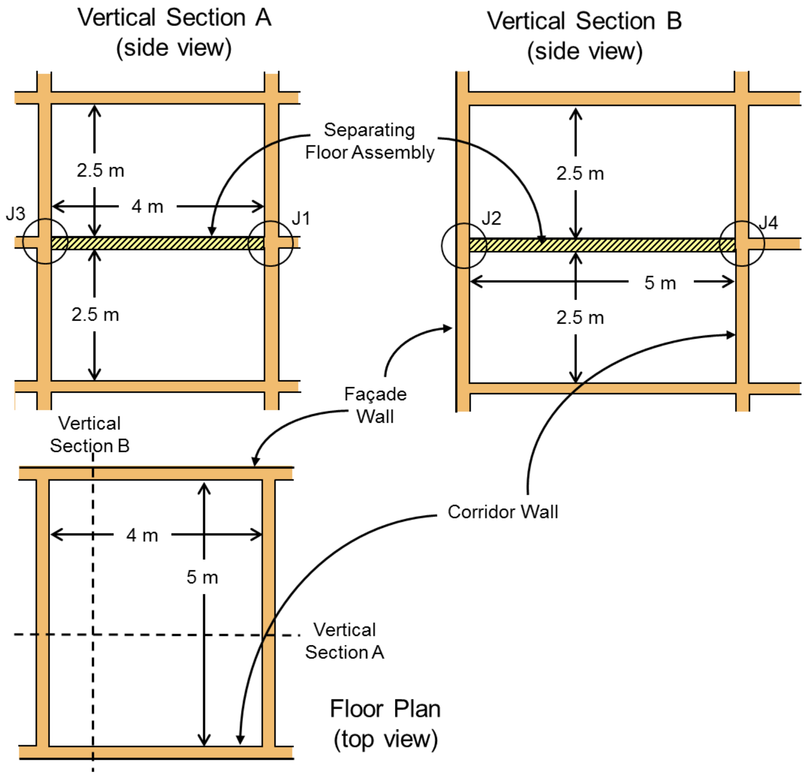


Figure 1.4: Standard Scenario for the "vertical room pair" case where one of the pair of rooms is above the other, with the floor/ceiling assembly between the two rooms.



The pertinent dimensions and junction details are shown in Figures 1.3 and 1.4.

- Note the labelling of junctions at the four edges of the separating assembly (J1 to J4) in Figures 1.3 and 1.4. These junction designations are used in the design examples throughout this Report.
- For horizontal room pairs (i.e. rooms are side-by-side) the separating wall is 2.5 m high by 5 m wide, flanking floor/ceilings are 4 m by 5 m, and flanking walls are 2.5 m high by 4 m wide.
- For vertical room pairs (i.e. one room is above the other) the separating floor/ceiling is 4 m by 5 m wide and flanking walls in both rooms are 2.5 m high.
- In general, it is assumed that junctions at one side of the room (at the separating wall if rooms are side-by-side) are cross-junctions, while one or both of the other two junctions are T-junctions. This enables the examples to illustrate typical differences between the two common junction cases.
- For a horizontal pair, the separating wall has T-junctions with the flanking walls at both the façade and corridor sides, and cross-junctions at floor and ceiling.
- For a vertical pair, the façade wall has a T-junction with the separating floor, but the opposing corridor wall has a cross-junction, as do the other two walls.

Deviations from the Standard Scenario, such as room pairs where one room is an end unit with T-junctions instead of cross-junctions, can be calculated by substituting the appropriate junction details in the calculation procedures and in the worked examples in this Report.

1.3 Applying the Concepts of ISO Standards in an ASTM Environment

Although the building acoustics standards developed by ASTM are very similar in concept to the corresponding ISO standards, there are differences in the terminology and technical requirements between the two that present numerous barriers to using a mix of standards from the two domains.

Although ASTM standard E336 recognizes the contribution of flanking to apparent sound transmission, there is neither an ASTM standard for measuring the structure-borne flanking sound transmission that often dominates sound transmission between rooms, nor an ASTM counterpart of ISO 15712-1 for predicting the combination of direct and flanking sound transmission. In the absence of suitable ASTM standards, this Report uses the procedures of ISO 15712-1 and data from the complementary ISO 10848 series, but connects this ISO calculation framework to the ASTM terms and test data widely used by the North American construction industry. This methodology combines identifying where data from ASTM laboratory tests can reasonably be used in place of their ISO counterparts, and presenting the results using ASTM terminology (or new terminology for flanking sound transmission that is consistent with existing ASTM terms) to facilitate their use and understanding by a North American audience. Some obvious counterparts in the terminology are presented in Table 1.1.

ISO Designation	Description	ASTM Counterpart
ISO 10140 Parts 1 and 2 (formerly ISO 140-3)	Laboratory measurement of airborne sound transmission through a wall or floor	ASTM E90
sound reduction index, R (from ISO 10140-2)	Fraction of sound power transmitted (in dB) at each frequency, in laboratory test	sound transmission loss, TL (ASTM E90)
weighted sound reduction index, R_w (ISO 717-1)	Single-number rating determined from R or TL values in standard frequency bands	sound transmission class, STC (ASTM E413)
apparent sound reduction index, R' (ISO 16283-1)	Fraction of sound power transmitted (in dB) at each frequency, including all paths in a building	apparent sound transmission loss, ATL (ASTM E336)
weighted apparent sound reduction index, R'_w (ISO 717-1)	Single-number rating determined from R' or ATL values in standard frequency bands	apparent sound transmission class, ASTC (ASTM E413)

Table 1.1: Standards and terms used in ISO 15712-1 for which ASTM has close counterparts

Note that the description “counterpart” does not imply that the ASTM and ISO standards or terms are exactly equivalent. R_W and STC are not interchangeable. Neither are R'_W and ASTC because of systematic differences in the calculation procedures. However, the laboratory test used to measure airborne sound transmission through wall or floor assemblies – ASTM E90 and its counterpart ISO 10140-2 – are based on essentially the same procedure, with minor variants in facility requirements. Therefore, the measured quantities “sound transmission loss” from the ASTM E90 test and “sound reduction index” from the ISO standard are sufficiently similar so that data from ASTM E90 tests can be used in place of data from ISO 10140-2 tests in the calculations of ISO 15712-1 to obtain a sensible answer. Similarly, the simplified calculation of ISO 15712-1 may be performed using STC ratings to predict the ASTC rating. The close parallel between “sound reduction index” and “sound transmission loss” also means that results from ISO 15712-1 calculations (normally expressed as R’ values) can confidently be treated as calculated apparent sound transmission loss (ATL) values and then used in the procedure of ASTM E413 to calculate the ASTC rating, which is the objective for designers or regulators in the North American context.

For purposes of this Report, a glossary of new terms with counterparts in ISO 15712-1 (using terminology consistent with measures used in ASTM standards) and of other key terms from pertinent ISO standards such as ISO 15712-1 and ISO 10848 is presented in Table 1.2.

In addition, several scientific terms used in ISO 15712-1 at various stages of the calculation have been used without change. These include: radiation efficiency, internal loss factor, total loss factor, equivalent absorption length, and transmission factor. They are described in the glossary in Annex A of ISO 15712-1.

Terms used in this Report	Description
Structural reverberation time (T_S)	Structural reverberation time is a measure indicating the rate of decay of vibration energy in an element and can apply either to a laboratory wall or floor specimen, or to a wall or floor assembly in-situ in a building.
Transmission loss in-situ (TL_{situ})	Transmission loss in-situ is the counterpart of sound reduction index in-situ (R_{situ}) described in ISO 15712-1 as "the sound reduction index of an element in the actual field situation".
Flanking sound transmission loss (Flanking TL_{ij})	Flanking sound transmission loss is the counterpart of flanking sound reduction index (R_{ij}) in ISO 15712-1. It is a measure of sound transmission via the flanking path from element i in the source room to element j in the receiving room, normalized like apparent sound transmission loss, as described in Section 1.4.
Flanking sound transmission class (Flanking STC_{ij})	Flanking STC is the single-number rating calculated from the flanking sound transmission loss following the STC calculation procedure of ASTM E413.

Table 1.2: Key terms used in this Report to deal with concepts from ISO 15712-1 and ISO 10848 for which ASTM acoustics standards have no counterparts.

1.4 Combining Sound Transmitted via Many Paths

The calculations of ISO 15712-1 must deal with combining the sound power transmitted via the direct path and via a set of flanking paths. To keep track of the sound transmission paths, it is useful to introduce the labeling convention for the paths that is used in ISO 15712-1. It is shown in Figure 1.5.

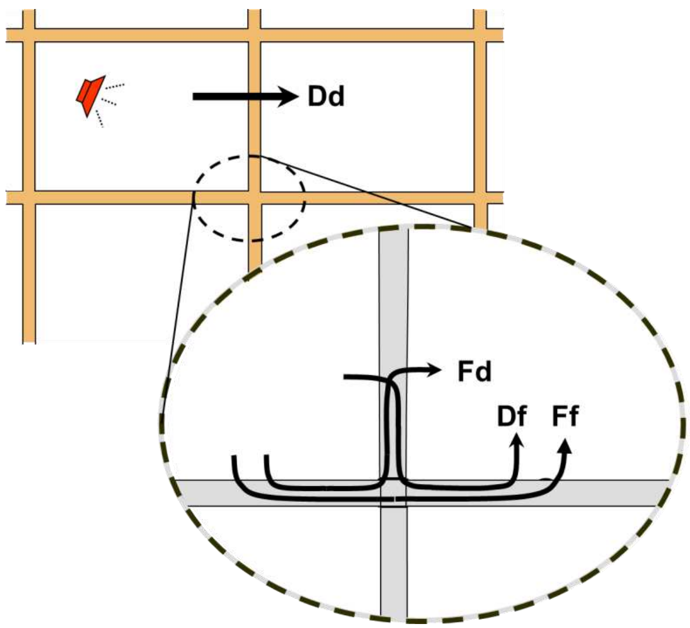


Figure 1.5: This figure shows the labelling convention for transmission paths used in ISO 15712-1. Consider the transmission of airborne sound from a source room (left) to a receiving room (right). Each transmission path involves one surface in the source room (denoted by a capital letter) and one in the receiving room (denoted by a lower case letter). Direct transmission through the separating assembly is path **Dd**. For each edge of the separating assembly there are three flanking paths: **Ff** from flanking surface F to flanking surface f, **Df** from direct surface D to flanking surface f, and **Fd** from flanking surface F to direct surface d.

Note that the letter "F" or "f" denotes **f**lanking surface, and "D" or "d" denotes the surface for **d**irect transmission, i.e. the surface of the separating assembly. These surfaces may be either wall or floor/ceiling assemblies.

The labels for the flanking surfaces of the Standard Scenarios are detailed in the following Table 1.3.

Room Pair	Surfaces D and d	Flanking Surfaces F and f	Junction
Horizontal (Fig. 1.3)	Separating wall	Junction 1: floor F and f Junction 2: façade wall F and f Junction 3: ceiling F and f Junction 4: corridor wall F and f	Cross-junction T-junction Cross-junction T-junction
Vertical (Fig. 1.4)	Separating floor/ceiling	Junction 1: wall F and f Junction 2: façade wall F and f Junction 3: wall F and f Junction 4: corridor wall F and f	Cross-junction T-junction Cross-junction Cross-junction

Table 1.3: Surfaces (D, d, F and f) for flanking paths at each junction, as in the Standard Scenario.

In Canada, building elements are normally tested according to the ASTM E90 standard, and building code requirements are given in terms of apparent sound transmission class (ASTC) determined from the apparent sound transmission loss (ATL) for the set of frequency bands from 125 Hz to 4000 Hz, following the procedure in ASTM E413. Merging this context with using the ISO 15712-1 procedures in this Report, the terms "direct sound transmission loss" and "flanking sound transmission loss" have been introduced to provide consistency with ASTM terminology while matching the function of the direct and flanking sound reduction indices defined in ISO 15712-1.

Section 4.1 of ISO 15712-1 defines a process to calculate the apparent sound transmission by combining the sound power transmitted via the direct path and the twelve first-order flanking paths (3 at each edge of the separating assembly, as illustrated in Figure 1.5). Equation 14 in ISO 15712-1 is recast here with slightly different grouping of the paths (treating the set of paths at each edge of the separating assembly in turn) to match the presentation approach chosen for the examples in this Report.

The apparent sound transmission loss (ATL) between two rooms (assuming the room geometry of Section 1.2 and neglecting sound that is by-passing the building structure, for example sound transmitted through leaks and ducts) is the resultant of the direct sound transmission loss (TL_{Dd}) through the separating wall or floor element and the set of flanking sound transmission loss contributions of the three flanking paths ($\mathrm{TL}_{Ff,}$ TL_{Fd}, and TL_{Df}) for each junction at the four edges of the separating element as shown in Figure 1.5:

$$ATL = -10 \cdot \log_{10}\left(10^{-0.1 \cdot TL_{Dd}} + \sum_{edge=1}^{4}\left(10^{-0.1 \cdot TL_{Ff}} + 10^{-0.1 \cdot TL_{Fd}} + 10^{-0.1 \cdot TL_{Df}}\right)\right) \quad \text{Eq. 1.1}$$

Note that this equation differs slightly from the calculation of the apparent sound transmission defined in Equation 14 of ISO 15712-1. Equation 1.1 of this Report treats the set of paths at each edge of the separating assembly in turn to match the presentation for the examples in this Report. Equation 1.1 is universally valid for all building systems, and the remaining challenge is to find the right expressions to calculate the path transmission for the chosen building system and situation.

Each of the flanking sound transmission loss values for a specific path is normalized like the apparent sound transmission loss, and can be considered as the ATL that would be observed if only this single path were contributing to the sound transmitted into the receiving room. Normalization of direct and flanking sound transmission input data so that the receiving room absorption is numerically equal to the area of the separating assembly (i.e. using apparent sound transmission loss and ASTC as the measure of system performance) requires suitable corrections to data calculated according to ISO 15712-1, or values of flanking sound transmission loss from laboratory testing according to ISO 10848, so that the set of path transmission loss values can be properly combined or compared. This normalization process is fully described in the calculation procedures in Chapter 4.

The standard ISO 15712-1 describes two methods of calculating the apparent sound insulation in a building: the Detailed Method and the Simplified Method. This Report describes the Simplified Method to calculate the apparent sound insulation in a building consisting of wood-framed elements. The Simplified Method uses the single-number ratings (STC or Flanking STC for each transmission path) instead of the frequency-dependent transmission loss values and yields the ASTC directly:

$$ASTC = -10 \cdot \log_{10}\left[10^{-0.1 \cdot STC_{Dd}} + \sum_{edge=1}^{4}\left(10^{-0.1 \cdot STC_{Ff}} + 10^{-0.1 \cdot STC_{Fd}} + 10^{-0.1 \cdot STC_{Df}}\right)\right] \quad \text{Eq. 1.2}$$

The Simplified Method has been widely used by designers in Europe for many years for calculations based on R_W data. Its primary advantage is the simplicity of the procedure, which makes it usable by non-specialists, as illustrated by the worked examples in Section 4.2. Although it is less rigorous than the Detailed Method, the differences between the results using the two methods are small, and the calculations for the Simplified Method use approximations that should ensure the results are slightly conservative.

Cautions and limitations to examples presented in this Report:

This Report was developed to support the transition to ASTC ratings for sound control objectives in the National Building Code of Canada. Simplifications were made to meet the specific needs of that application, where sound insulation is addressed only in the context of multi-unit residential buildings. The simplifications include that:

- Transmission around or through the separating assembly due to leaks at its perimeter or penetrations such as ventilation systems are assumed negligible.
- Indirect airborne transmission (for example airborne flanking via an unblocked attic or crawl space) is assumed to be suppressed by normal fire blocking requirements.

For adjacent occupancies in a multi-family residential building, these two issues should be dealt with by normal good practice for fire and sound control between adjoining dwellings.

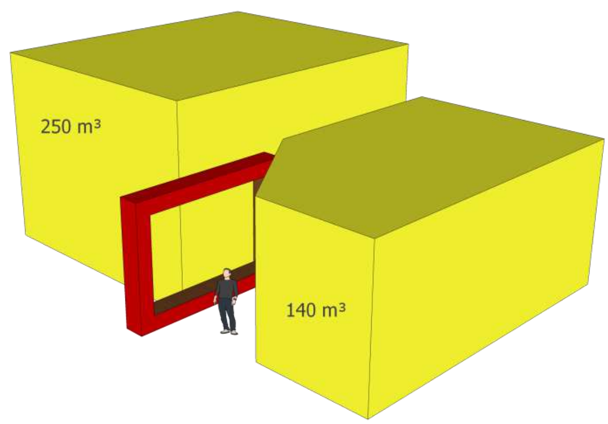
If this Report is applied to situations other than separation between adjacent units in multi-family residential buildings, some of these issues may have to be explicitly addressed in the calculation process. For example, for adjoining rooms within a single office or home, flanking paths such as ventilation ducts or open shared plenum spaces may be an issue. The flanking sound transmission associated with these additional paths should be determined and included in the calculated ASTC. ISO 15712-1 includes specific guidance for such issues, and the examples in this Report allow for such a correction.

2 Sound Transmission through Wood-Framed Walls and Floors

This chapter presents the results of direct sound transmission loss tests of wall and floor assemblies with several variants of wood framing. The tested assemblies include assemblies with a variety of framing details and linings covering the surfaces of the wood framing.

ASTM E90 Test Method

Direct sound transmission loss tests of wall and floor assemblies were conducted in NRC's Wall and Floor Sound Transmission Facilities according to the ASTM E90 test protocol [1]. Concept drawings of the sound transmission facilities are presented in Figure 2.1.



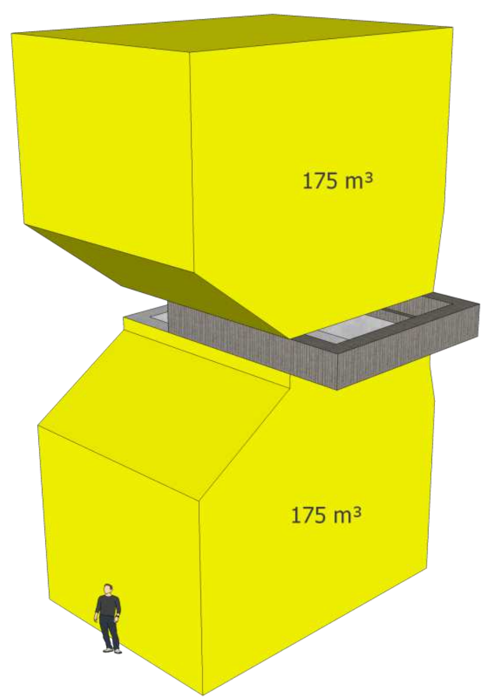


Figure 2.1: A concept drawing of the Wall Sound Transmission Facility at the NRC is presented in the upper drawing. The NRC Floor Sound Transmission Facility, shown in the lower drawing, is similar except that one room is above the other.

In both cases, full scale test assemblies are mounted in the massive concrete movable test frames between the two reverberant rooms. The test openings are 3.66 m wide and 2.44 m high for walls and 4.70 m by 3.78 m for floors.

In the wall facility, the rooms (designated "large chamber" and "small chamber") have approximate volumes of 250 m^3 and 140 m^3 respectively. In the floor facility, both chambers have volumes of approximately 175 m^3. All the facility rooms are hard-walled reverberation chambers that are vibration-isolated from each other and from the specimen frame. The rooms have fixed and/or moving diffusor panels to enhance diffusivity of the sound fields.

The facilities (including instrumentation) and the test procedures satisfy or exceed all requirements of ASTM E90.

Each facility is equipped with an automated measurement system for data acquisition and post-processing. In each room, a calibrated Brüel & Kjaer condenser microphone (type 4166 or 4165) with preamp is moved under computer control to nine positions, and measurements are made in both rooms using a National Instruments NI-4472 data acquisition system installed in a computer. Each room has four bi-amped loudspeakers driven by separate amplifiers and noise sources. To increase randomness of the sound field, there are fixed diffusing panels in each room.

Measurements of the direct airborne sound transmission loss (TL) were conducted in accordance with the requirements of ASTM E90-09, “Standard Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions”. The sound transmission loss tests were performed in both directions – from the large chamber to the small chamber and vice-versa for walls, and from the upper chamber to the lower chamber and vice-versa for floors. The results presented in this Report are given as the averages of the two transmission directions to reduce measurement uncertainty due to factors such as calibration errors and local variations in the sound fields.

For every measurement, direct sound transmission loss values were calculated from the average sound pressure levels in the source room and the receiving room and the average reverberation times of the receiving room. One-third octave band sound pressure levels were measured for 32 seconds at nine microphone positions in each room and then averaged to get the average sound pressure level in each room. Five sound decays were averaged to get the reverberation time at each microphone position in the receiving room; these times were averaged to get the average reverberation times for each room.

The frequency-dependent direct sound transmission loss was measured in one-third octave bands in the frequency range from 50 Hz to 5000 Hz. However, only the frequency range between 125 Hz and 4000 Hz is considered in the calculation of the sound transmission class (STC) single-number rating in accordance with ASTM E413 [3].

This chapter presents a summary of results in terms of the single-number STC ratings that are required for the calculations in Chapter 4 to determine the ASTC rating. For each type of wall and floor assembly, dependence of the STC on the construction details is discussed in the discussion of trends. The Chapter focuses on wall and floor assemblies that are capable of meeting the sound insulation requirements in the 2015 National Building Code of Canada (ASTC not less than 47), i.e. on wall and floor assemblies with an STC rating of at least 47. Data for wall and floor assemblies with lower STC ratings can be found in the NRC publications referenced in the Appendix [16.2, 16.4, 16.7].

2.1 Coding System for Specimen Descriptions

A coding system is used throughout this Report to minimize long descriptions of floor or wall constructions. Each surface layer in a floor or wall is coded as follows:

- An integer representing the number of layers of material - if the number of layers is one, the leading 1 is omitted
- A sequence of letters to indicate the material in the layer (see Table 2.1 below)
- A number representing the thickness in mm of each sheet or element in the layer
- Underscores separating the codes for each layer

The coding system is also applied to elements that do not constitute surface layers such as joists, studs, and resilient metal channels. For such elements, the number following the letters is the depth of each element (the dimension along the axis perpendicular to the surface of the assembly) and the number in parentheses following the depth code is the separation between adjacent elements.

Table 2.1: Examples of the codes used to identify materials and to describe constructions.

Code	Material
CONxx	Concrete “xx” mm thick
GCONxx	Gypsum concrete “xx” mm thick
GFBxx	Glass fibre batts “xx” mm thick
MFBxx	Mineral or rock fibre batts “xx” mm thick
CFLxx	Blown-in cellulose fibre “xx” mm thick
PLYxx	Plywood “xx” mm thick
OSBxx	Oriented strandboard “xx” mm thick
WJxx(ss)	Solid-sawn wood joists with nominal dimensions 38 mm thick and “xx” mm deep, spaced “ss” mm on centre
WIxx(ss)	Wood I-joists fabricated from engineered wood products with nominal dimensions “xx” mm deep, spaced “ss” mm on centre
WTxx(ss)	Wood trusses with nominal dimensions “xx” mm deep, spaced “ss” mm on centre
WSxx(ss)	Wood studs with nominal dimensions 38 mm thick and “xx” mm deep, spaced “ss” mm on centre
RCxx(ss)	Resilient metal channels with nominal depth of “xx” mm, spaced “ss” mm on centre
Gxx	Gypsum board “xx” mm thick

Note that the coding system is a convenience and actual dimensions may not be exactly as coded. For example, the nominal 16 mm thick gypsum board would be labelled by the manufacturer as 5/8 in. or 15.9 mm thick.

For brevity, not all pertinent parameters are included in the short codes. For example, the weight per unit length or per unit area is not indicated. This information is given wherever pertinent in specimen descriptions in the tables of measurement results and the calculation examples.

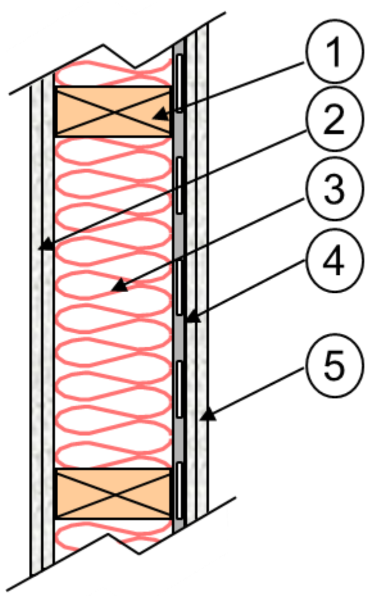
Thus the code OSB15_WJ235(400)_GFB150_RC13(600)_2G16 describes a floor with the following construction details:

- A 15 mm-thick oriented strandboard (OSB) subfloor
- 38 mm x 235 mm (2x10) wood floor joists, spaced 400 mm on centre
- 150 mm-thick glass fibre batts in the cavities between the joists
- 13 mm-deep resilient metal channels screwed to the bottom of the joists and oriented perpendicular to the joists, spaced 600 mm on centre
- Two layers of gypsum board, each 15.9 mm thick, attached to the resilient metal channels

2.2 Wall Assemblies Framed with 1 Row of Wood Studs

The focus of this section is the direct sound transmission loss of wall assemblies framed with one row of wood studs with gypsum board attached on both sides of the studs. The gypsum board was fastened directly to the studs or supported on resilient metal channels. Most of the tested assemblies had sound-absorbing material in the cavities between the studs. The typical construction of the wall assemblies described in this Section had a single row of wood studs as shown in Figure 2.2.1.

Figure 2.2.1:
Horizontal cross-section of a wall assembly with a single row of wood studs showing the typical components. Variations and element properties are listed in more detail on the right.



Drawings are not exactly to scale.

1. Single row of wood studs[1] (with cross-section 38 mm x 89 mm or 38 mm x 140 mm) nominally spaced either 400 mm (16 in.) or 600 mm (24 in.) on centre.
2. Surface of 1 or 2 layers of fire-rated gypsum board[2] screwed directly to one face of the wood studs. Gypsum board may be designated either as G13 (nominal thickness of 1/2 in., 12.7 mm) or as G16 (nominal thickness of 5/8 in., 15.9 mm).
3. Sound-absorbing material[3] in the cavities between studs may be glass fibre batts (GFB) or mineral fibre batts (MFB) or blown-in cellulose fibre (CFL) approximately filling the cavities.
4. Resilient metal channels, formed from light sheet steel with suitable profile[4] and screwed to the face of the wood studs. Resilient metal channels were spaced either 400 mm (16 in.) or 600 mm (24 in.) on centre.
5. Surface of 1 or 2 layers of fire-rated gypsum board[2] screwed to resilient metal channels whose other flange is fastened to the studs. Gypsum board may be designated either as G13 (nominal thickness of 1/2 in., 12.7 mm) or as G16 (nominal thickness of 5/8 in., 15.9 mm).

NOTE: For the notes on this page please see the corresponding endnotes on page 166.

NOTE: The tests reported in this section include results from different test series. The year of testing is coded in the report number for each result. The older tests (1992 to 2005) are documented in the referenced reports and are the basis for the tables of STC ratings in Part 9 of the National Building Code of Canada. Repeated tests indicate that the older results are consistent with newer ones within the expected range of reproducibility for the test method.

Table 2.2.1: STC values for wall assemblies with a single row of wood studs[1] with a cross-section of 38 mm x 89 mm (2x4). The results are numbered and organized in groups by common features within each group. All listed assemblies have fire-rated gypsum board, resilient metal channels on one side, and sound-absorbing material essentially filling the cavities between the studs. Some assemblies without sound-absorbing material were tested, but none of those had an STC rating over 48.

Specimen ID	Descriptive Short Code	Reference		STC
		NBCC	NRC Test	
WS89-4a	G16_WS89(400)_GFB89_RC13(400,600)_2G16	W4a	TL93-118, -120	**51**
WS89-5a	2G16_WS89(400)_GFB89_RC13(400,600)_G16	W5a		**51**
WS89-6a	2G16_WS89(400,600)_GFB89_RC13(400)_2G16	W6a	TL93-119	**55**
WS89-4b	G16_WS89(600)_GFB89_RC13(400,600)_2G16	W4b	TL93-099, -101	**54**
WS89-5b	2G16_WS89(600)_GFB89_RC13(400,600)_G16	W5b		**54**
WS89-6b	2G16_WS89(400,600)_GFB89_RC13(600)_2G16	W6b	TL93-086, -092	**58**
WS89-4c	G13_WS89(400)_GFB89_RC13(400,600)_2G13	W4c	TL93-126, -150, -180, -186	**49**
WS89-5c	2G13_WS89(400)_GFB89_RC13(400,600)_G13	W5c		**49**
WS89-6c	2G13_WS89(400)_GFB89_RC13(400,600)_2G13	W6c	TL93-127, -151	**53**
WS89-4d	G13_WS89(600)_GFB89_RC13(400,600)_2G13	W4d	TL93-97, -99, -101	**53**
WS89-5d	2G13_WS89(600)_GFB89_RC13(400,600)_G13	W5d		**53**
WS89-6d	2G13_WS89(400)_GFB89_RC13(600)_2G13	W6d		**55**
WS89-6e	2G13_WS89(600)_GFB89_RC13(400)_2G13	W6e		**55**
WS89-6f	2G13_WS89(600)_GFB89_RC13(600)_2G13	W6f	TL93-096	**58**

NOTES:

1. The listed STC values correspond to the values in Table 9.10.3.1. of the 2015 National Building Code of Canada (NBCC).
2. Note that the entries for walls in the W4x and W5x series are for nominal spacing of 400 mm or 600 mm between resilient channels.
3. Results from individual NRC tests scatter around STC values in NBCC Table 9.10.3.1., typically within a range of ±2 points as noted below in the discussion of trends. Some NRC Test References are blank because there is no test corresponding to those specimen details.
4. Entries in the table show “GFB89” (for glass fibre batt), but MFB (mineral or rock fibre batt) or CFL (blown in cellulose fibre) of similar thickness would usually have the same STC rating.
5. For additional assemblies of this type, see NRC Report IR-761 [16.2] or NBCC Table 9.10.3.1.

Trends in the Sound Transmission for Wood-Framed Walls with 1 Row of Studs

The effects of key parameters on the sound transmission loss of wood-framed walls with a single row of studs were evaluated by regression analysis. This regression equation was developed as one of the algorithms for a software tool called SOCRATES (for **SO**und **C**lassification **RAT**ing **Es**timator) [16.9]. The dataset used for the analysis comprised 127 walls constructed using solid wood studs, gypsum board, resilient metal channels, and sound-absorbing material. Parameters varied included:

- Type, thickness, and number of layers of gypsum board
- Type and thickness of the sound-absorbing material
- Dimensions and spacing of the wood studs
- Spacing of the resilient metal channels

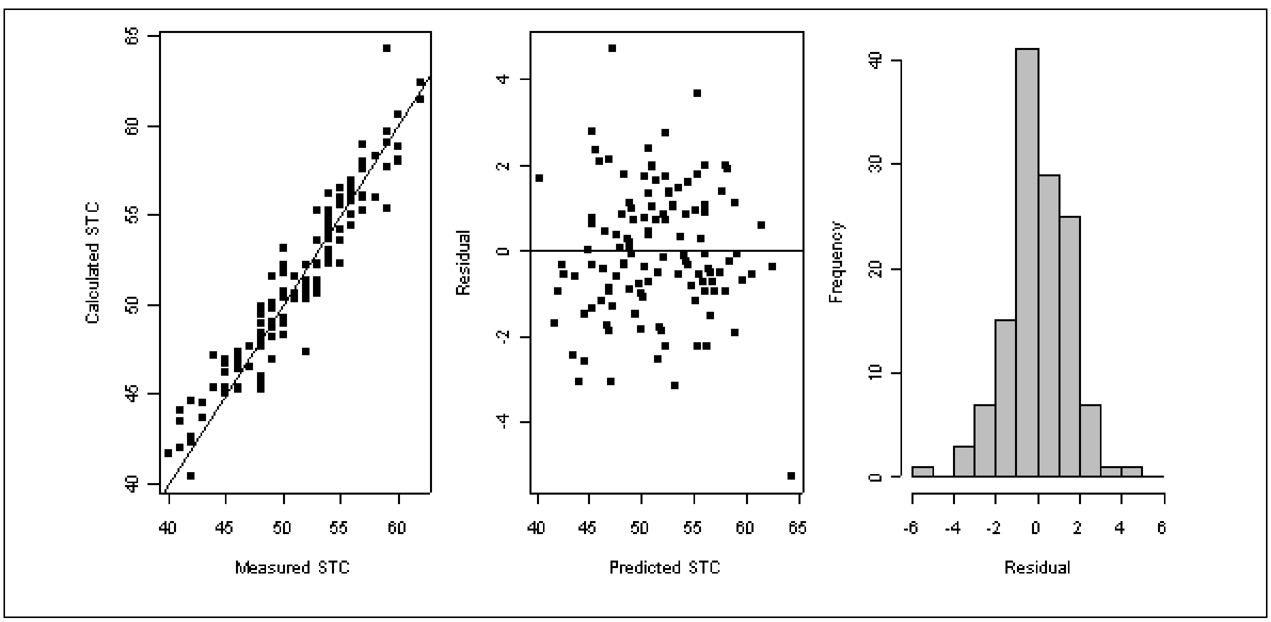
The regression analysis yields Equation 2.2.1 for estimating STC ratings:

$$STC = 7.3 + 17.8[\log m_1 + \log m_2] + 0.091[CavityDepth] - 0.028[AbsDens] - 1.65[Ncontacts] \quad \text{Eq. 2.2.1}$$

The quality of the fit is indicated in Figure 2.2.2. The significant parameters are:

- m_1 and m_2 are the masses per unit area (kg/m^2) of the gypsum boards on each face of the wall
- $CavityDepth$ is the distance between the internal faces of the gypsum board in mm
- $AbsDens$ is the density of the sound-absorbing material in kg/m^3
- $Ncontacts = 1/[Stud\_Spacing \times RC\_Spacing]$, where both spacing values are in m

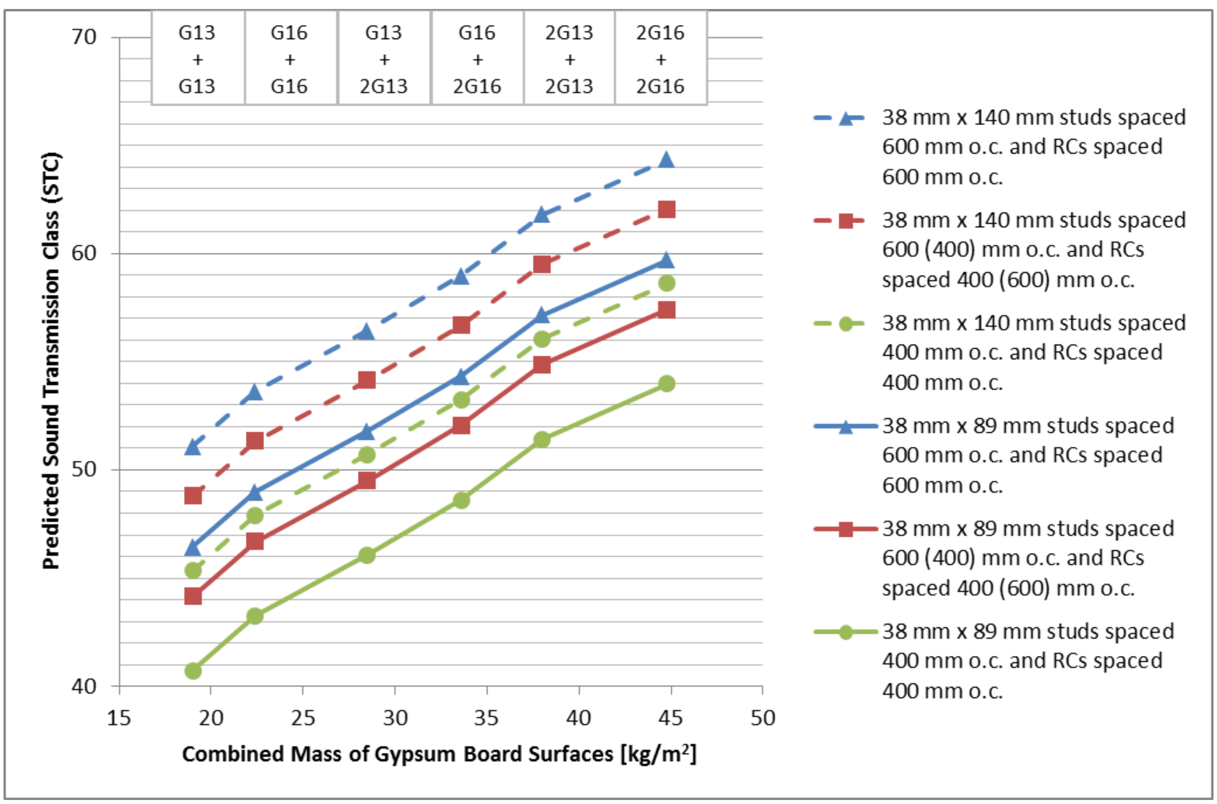
Figure 2.2.2: Plots to show how the predicted values agree with measurements and the distribution of the residuals (measured STC minus predicted STC). Summary values for the fit: Residual Standard Error = 1.5 dB, and Adjusted R^2 (quality of the fit) = 0.91.



Some constraints should be noted. All cases used for the analysis had sound-absorbing material essentially filling the cavities, which removed absorption thickness from the significant variables, and restricts application of the equation to similar constructions. To estimate the STC rating for a specific construction, insert parameter values from Table 2.2.2 in Equation 2.2.1, or use the calculated STC results for common cases shown in Figure 2.2.3.

Table 2.2.2: Typical values for the parameters in Equation 2.2.1. These essentially span the ranges for the data set and hence define limits for applying the equation.	*m_1 or m_2:*	9.5 (kg/m^2) for each layer of 12.7 mm fire-rated gypsum board 11.2 (kg/m^2) for each layer of 15.9 mm fire-rated gypsum board
	CavityDepth:	102 (mm) for 38 mm x 89 mm (2x4) studs 153 (mm) for 38 mm x 140 mm (2x6) studs
	AbsDens:	13 (kg/m^3) for glass fibre batts 34 (kg/m^3) for mineral fibre batts 50 (kg/m^3) for blown-in cellulose
	Ncontacts:	6.25 for *Stud_Spacing* = 400 mm o.c. and *RC_Spacing* = 400 mm o.c. 4.17 for *Stud_Spacing* = 400 mm o.c. and *RC_Spacing* = 600 mm o.c. 4.17 for *Stud_Spacing* = 600 mm o.c. and *RC_Spacing* = 400 mm o.c. 2.78 for *Stud_Spacing* = 600 mm o.c. and *RC_Spacing* = 600 mm o.c.

Figure 2.2.3: STC values calculated using Equation 2.2.1 for glass fibre batts (*AbsDens* = 13) filling the inter-stud cavities and other parameters as indicated in the legend and labels on the graph.

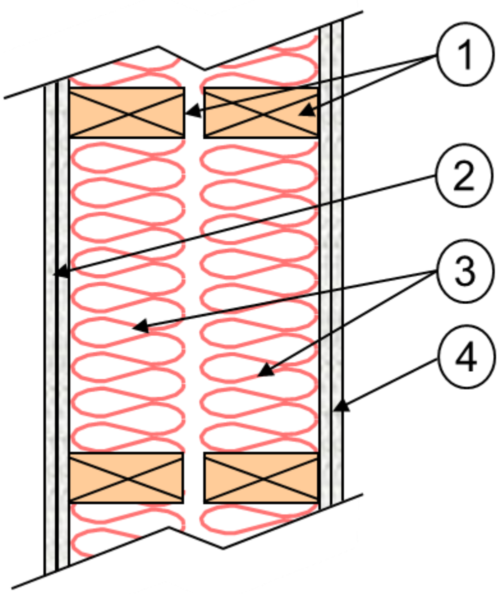


2.3 Wall Assemblies Framed with 2 Rows of Wood Studs

The focus of this section is the direct sound transmission loss of wall assemblies framed with two rows of wood studs on separate plates with gypsum board attached on both sides of the studs. The gypsum board was fastened directly to the studs. Most of the tested assemblies had sound-absorbing material in the cavities between the studs in one row or both rows.

The typical construction of the wall assemblies described in this Section had a double row of wood studs on separate plates as shown in Figure 2.3.1.

Figure 2.3.1:
Horizontal cross-section of a wall assembly with a double row of wood studs showing the typical components. Variations and element properties are listed in more detail on the right.



Drawings are not exactly to scale.

1. Double row of wood studs[1] (with cross-section 38 mm x 89 mm) nominally spaced either 400 mm (16 in.) or 600 mm (24 in.) on centre, each on a separate 38 mm x 89 mm plate, with a space of 25 mm (1/2 in.) between the two rows of studs.
2. Surface of 1 or 2 layers of fire-rated gypsum board[2] screwed directly to one face of the wood studs. Gypsum board may be designated either as G13 (nominal thickness of 1/2 in., 12.7 mm) or as G16 (nominal thickness of 5/8 in., 15.9 mm).
3. Sound-absorbing material[3] in the cavities between studs may be glass fibre batts (GFB) or mineral fibre batts (MFB) or blown-in cellulose fibre (CFL) approximately filling the cavities. There may be sound-absorbing material on one side or both sides.
4. Surface of 1 or 2 layers of fire-rated gypsum board[2] screwed directly to one face of the wood studs. Gypsum board may be designated either as G13 (nominal thickness of 1/2 in., 12.7 mm) or as G16 (nominal thickness of 5/8 in., 15.9 mm).

NOTE: For the notes on this page please see the corresponding endnotes on page 166.

NOTE: The tests reported in this section include results from different test series. The year of testing is coded in the report number for each result. The older tests (1992 to 2005) are documented in the referenced reports and are the basis for the tables of STC ratings in Part 9 of the National Building Code of Canada. Repeated tests indicate that the older results are consistent with newer ones within the expected range of reproducibility for the test method.

Table 2.3.1: Measured STC values for wall assemblies with a double row of wood studs[1] on separate plates with a space of 25 mm between the rows with stud cross-section of 38 mm x 89 mm (coded as DWS89). The results are numbered and organized in groups by common features within each group. All listed assemblies have sound-absorbing material in the cavities between the studs (on one side or both sides), and all have fire-rated gypsum board.

Specimen ID	Descriptive Short Code	Reference		STC
		NBCC	NRC Test	
DWS89-13a	G16_DWS89(400,600)_2MFB89_G16	W13a	TL93-263,264,266,281,292	**57**
DWS89-14a	G16_DWS89(400,600)_2MFB89_2G16	W14a	TL93-267,282	**61**
DWS89-15a	2G16_DWS89(400,600)_2MFB89_2G16	W15a	TL93-269,283	**66**
DWS89-13b	G13_DWS89(400,600)_2MFB89_G13	W13b	TL93-270, 278	**57**
DWS89-14b	G13_DWS89(400,600)_2MFB89_2G13	W14b	TL93-271,285	**61**
DWS89-15b	2G13_DWS89(400,600)_2MFB89_2G13	W15b	TL93-272,286	**65**
DWS89-13c	G16_DWS89(400,600)_MFB89_G16	W13c	TL93-265,295	**54**
DWS89-14c	G16_DWS89(400,600)_MFB89_2G16	W14c	TL93-312	**57**
DWS89-15d	2G16_DWS89(400,600)_MFB89_2G16	W15d	TL93-313	**62**
DWS89-13d	G13_DWS89(400,600)_MFB89_G13	W13d	TL93-279,296	**53**
DWS89-14d	G13_DWS89(400,600)_MFB89_2G13	W14d		**57**
DWS89-15e	2G13_DWS89(400,600)_MFB89_2G13	W15e		**60**

NOTES:

1. The listed STC values correspond to the values in Table 9.10.3.1. of the 2015 National Building Code of Canada (NBCC).
2. Entries in the table show "MFB89" (for mineral or rock fibre batt), but GFB (glass fibre batt) or CFL (blown-in cellulose fibre) of similar thickness would usually have the same STC rating.
3. Note that entries for walls in the W13x, W14x and W15x series in the NBCC are nominally for spacing of either 400 mm or 600 mm between the stud centres. The regression analysis presented below suggests that the STC rating would be higher by 1 on average with the larger spacing.
4. Results from individual NRC tests scatter around STC values in NBCC Table 9.10.3.1., typically within a range smaller than ±2 as noted below in the discussion of trends. Some NRC Test References are blank because there is no test corresponding to those specimen details.
5. For additional assemblies of this type, see NRC Report IR-761 [16.2] or NBCC Table 9.10.3.1.

Trends in the Sound Transmission for Wood-Framed Walls with 2 Rows of Studs

The effects of key parameters on the sound transmission loss of wood-framed walls with a double row of studs on separate plates were evaluated by regression analysis. This regression equation was developed as one of the algorithms for a software tool called SOCRATES (for **SO**und **C**lassification **RAT**ing **ES**timator) [16.9]. Most of the 48 double-stud walls used for the analysis used 38 mm x 89 mm wood studs. Thirteen of the walls were constructed using steel studs. There was no significant dependency on stud type. The factors varied included:

- Type, thickness, and number of layers of gypsum board
- Type and thickness of the sound-absorbing material
- Dimensions and spacing of the studs
- Cavity depth

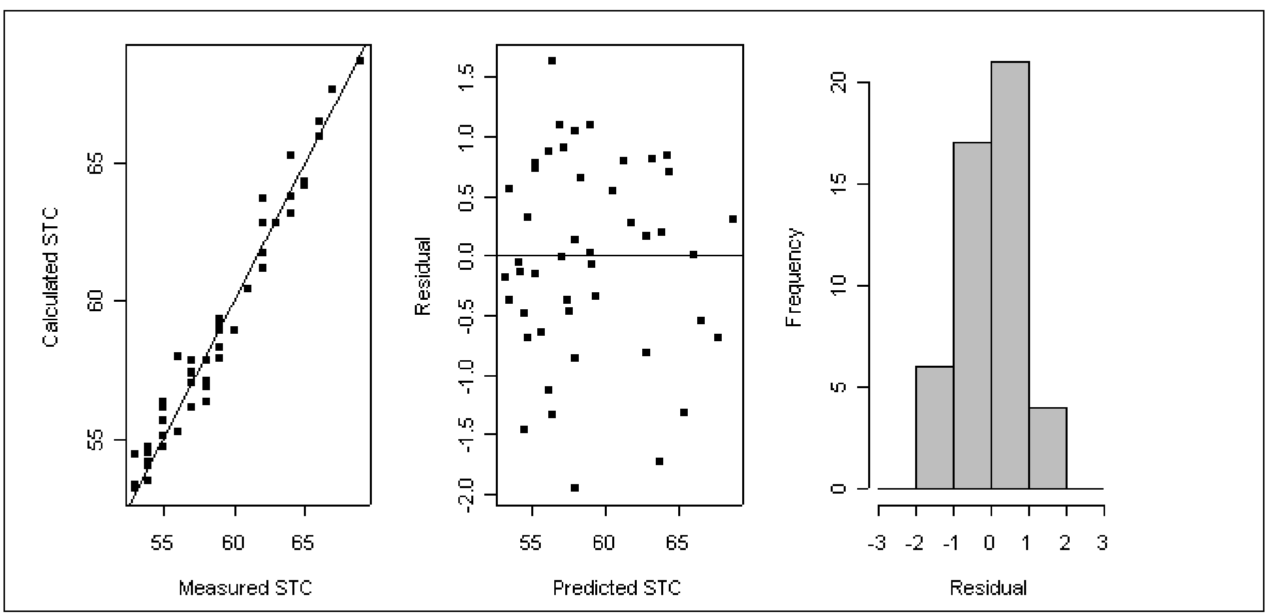
The regression analysis yields Equation 2.3.1 for estimating STC ratings:

$$STC = 9.7 + 16.1[\log m_1 + \log m_2] + 0.043[CavityDepth] + 0.018[AbsThick] + 0.0051[StudSpace] \quad \text{Eq. 2.3.1}$$

The quality of the fit is indicated in Figure 2.3.2. The significant parameters are:

- m_1 and m_2 are the masses per unit area (kg/m^2) of the gypsum boards on each face of the wall
- $CavityDepth$ is the distance between the internal faces of gypsum board in mm
- $AbsThick$ is the thickness of the sound-absorbing material in mm
- $StudSpace$ is the distance between stud centres in mm

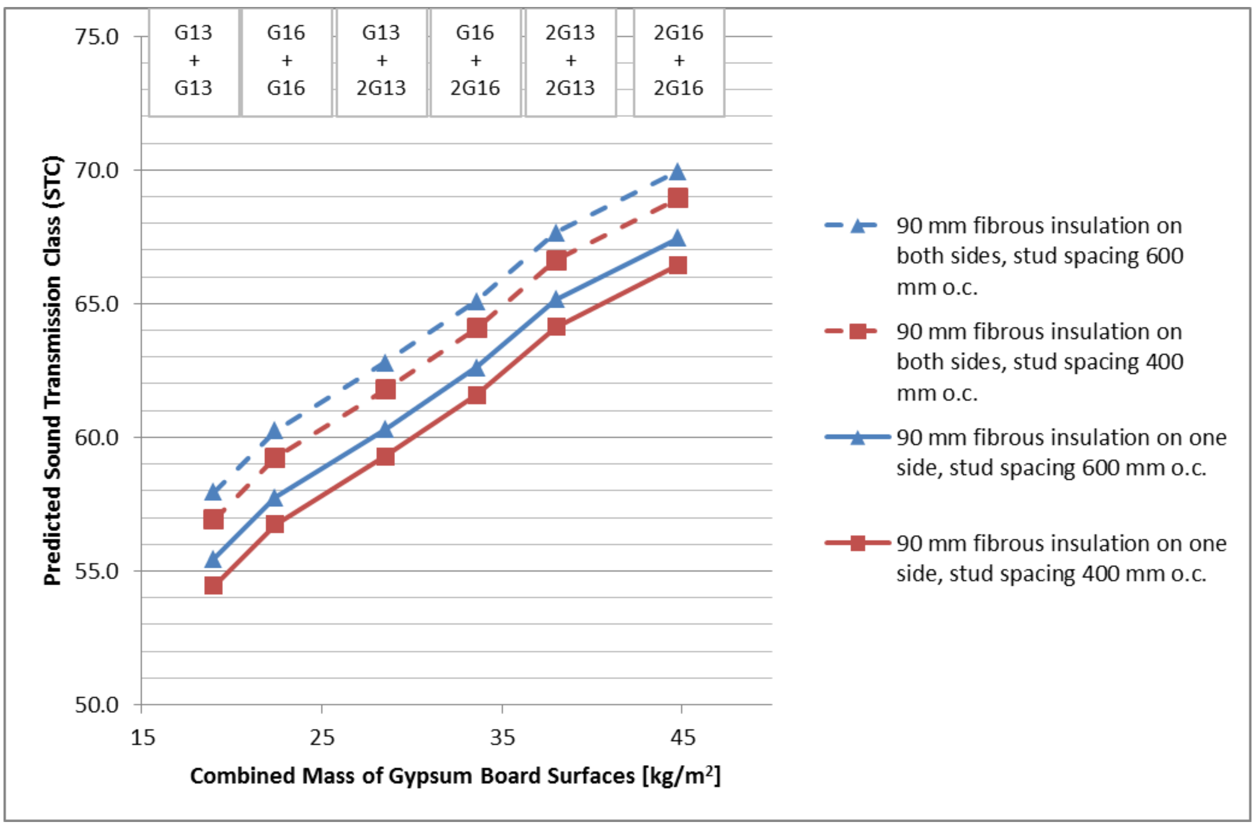
Figure 2.3.2: Plots to show how the predicted values agree with measurements and the distribution of the residuals (measured STC minus predicted STC). Summary values for the fit: Residual Standard Error = 0.85 dB, and Adjusted R^2 (quality of the fit) = 0.96.



To estimate the STC rating for a specific construction, insert parameter values from Table 2.3.2 in Equation 2.3.1, or use the calculated STC results for common cases shown in Figure 2.3.3.

Table 2.3.2: Typical values for the parameters in Equation 2.3.1. These essentially span the ranges for the data set and hence define limits for applying the equation.	m_1 or m_2:	1 or 2 layers on each side of: 9.5 (kg/m^2) for each layer of 12.7 mm fire-rated gypsum board 11.2 (kg/m^2) for each layer of 15.9 mm fire-rated gypsum board
	CavityDepth:	203 (mm) for 38 mm x 89 mm (2x4) studs with 25 mm space
	AbsThick:	89 mm for batts filling spaces between one row of studs 178 mm for batts filling spaces between both rows of studs
	StudSpace:	400 or 600 (mm) between the stud centres

Figure 2.3.3: STC values calculated using Equation 2.3.1 for a wall framed with two rows of 38 mm x 89 mm studs with each row on a separate plate (*CavityDepth* = 203 mm), with sound-absorbing material filling the inter-stud cavities of one row or both rows of studs and the other parameters as identified by the labels on the graph.



2.4 Wall Assemblies for Wood-Framed Mid-Rise Buildings

This section focusses on a series of wood stud walls particularly evaluated for use in mid-rise buildings, though the walls discussed here can be used in any context where their structural capabilities are useful to meet structural design requirements. The test series included numerous constructions, most with two staggered rows of wood studs on a common plate and many including a wood shear membrane.

The data from the study of mid-rise constructions was originally presented in Report A1-100035-02.1 [16.14], which should be consulted for additional construction details about fasteners and material properties. This Report presents only a subset of the data from Report A1-100035-02.1, including results for sound transmission through wood-framed wall assemblies in this Section, and tables of measured Flanking STC values for these walls combined with wood-framed floors in Sections 3.7 and 3.8.

For the wall designs with two rows of studs, an extended version of the coding was used where the first part (such as SWS140) gives a code indicating the stud layout and the total thickness of the wall framing, and the following code in parentheses indicates the size and spacing for the studs in each row. All of the assemblies had bottom plates and top plates matching the total depth of the wall framing. There are several variants on the coding, reflecting the different framing variants tested in the study.

Table 2.4.1 presents data for wall assemblies with two staggered rows of 38 mm x 89 mm (2x4) wood studs attached to common 38 mm x 140 mm (2x6) bottom plates and top plates. Note that wall MR-SWS-06 in Table 2.4.1 is an average of 3 cases that have PLY16 shear membrane. These results show that the orientation of the shear membrane (long axis of the sheets horizontal or vertical) had negligible effect on the STC rating, and that blocking with 38 mm x 140 mm (2x6) framing supporting the joint between the sheets of the shear membrane provides only a minimal benefit (STC +1).

Table 2.4.2 illustrates the reduction of STC values due to adding additional framing at the wall ends or by adding studs, versus the improvement for mounting gypsum board on resilient channels. It is interesting that wall MR-SWS-14 in Table 2.4.2 had an STC rating of just 50 (versus STC 49 for MR-SWS-08), despite the huge increase in weight due to added wood. For wall MR-SWS-14, the resilient channels provide a large benefit – without the resilient channels, the STC would drop to 36.

Table 2.4.3 presents the acoustical performance of walls framed with staggered 38 mm x 140 mm (2x6) studs with 38 mm x 184 mm (2x8) top plates and bottom plates, with variations demonstrating the effect of a shear layer, or adding extra framing members at the ends of the wall assembly, or supporting the gypsum board on resilient channels.

Table 2.4.4 shows the change due to replacing the 38 mm x 140 mm (2x6) studs of the assemblies in Table 2.4.3 with tripled 38 mm x 140 mm (2x6) studs at the same spacing. For the assemblies without resilient channels, adding the extra studs significantly lowers the STC value relative to the corresponding assemblies in Table 2.4.3. For assemblies that have resilient channels, the change is small.

Table 2.4.5 presents the acoustical performance of walls framed with a single row of 38 mm x 140 mm (2x6) studs with matching 140 mm bottom plates and top plates, with variations demonstrating the effect of a wood shear panel layer, or adding extra studs to the wall assembly.

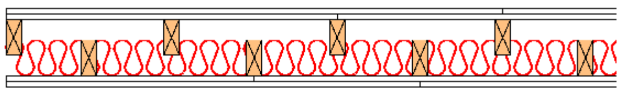
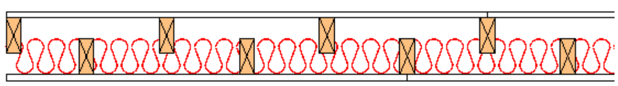
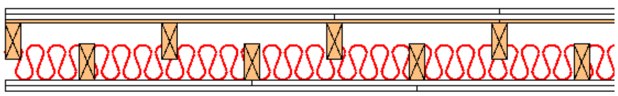
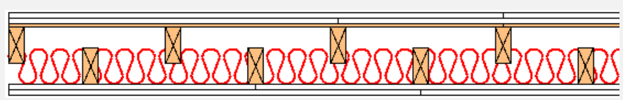
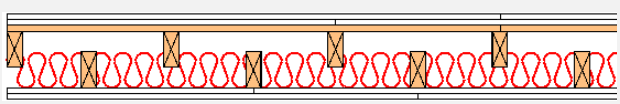
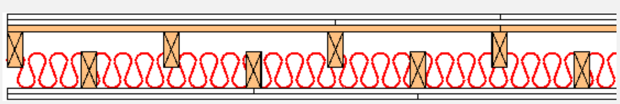
For the assemblies in Table 2.4.5, the smaller cavity depth and reduced weight of the framing (with just a single row of studs) lower the STC values by 5 or more relative to constructions with matching surface details in the preceding tables. Because of the very small 200 mm spacing between the studs, the regression expression in Section 2.2 does not properly apply, but the STC values for MR-SWS-28 and -29 seem to be about 2 points lower than that regression expression would predict.

Table 2.4.6 presents the performance of walls framed with a double row of “flatwise” wood studs (turned with their short dimension perpendicular to the wall surface) sandwiching a shear membrane on 38 mm x 89 mm (2x4) bottom plates and top plates, creating a shear-braced framing assembly just 89 mm deep.

In addition to the two rows of 38 mm x 140 mm (2x6) framing evident in the schematics in Table 2.4.6, these assemblies also had 38 mm x 140 mm (2x6) elements sandwiching the shear membrane where the plywood panels join, and had 38 mm x 89 mm (2x4) “buckling studs” fastened to both exposed 38 mm-wide faces of the 38 mm x 89 mm (2x4) “flatwise” end studs.

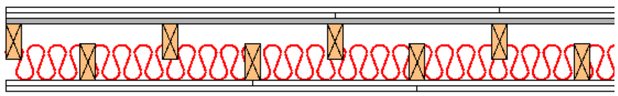
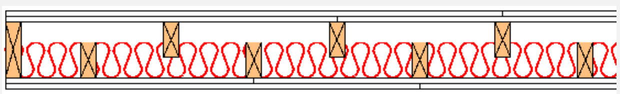
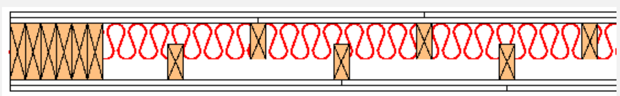
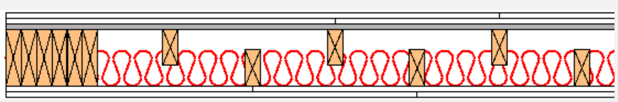
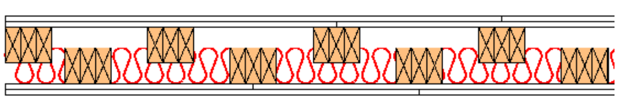
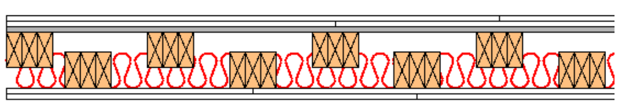
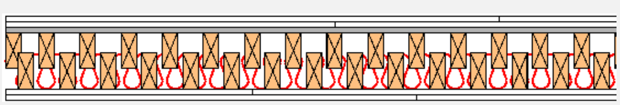
The walls in Table 2.4.6 have the designation SHWS89 (for **SH**ear **W**ood **S**tud wall with thickness 89 mm) followed by a code in parentheses such as “WS89@600” to identify details (type of framing members and spacing in mm between their centres) for the two rows of “flatwise” studs.

Table 2.4.1: Measured STC values for wall assemblies intended for mid-rise buildings, with two staggered rows of 38 mm x 89 mm (2x4) wood studs[1] attached to common 38 mm x 140 mm (2x6) bottom plates and top plates. Some of these assemblies include a shear membrane of plywood or OSB. These assemblies all have 90 mm sound-absorbing batts in the cavities between the studs on one side, and have fire-rated gypsum board fastened directly to the framing.

Specimen ID	Descriptive Short Code	Reference		STC
		Mid-Rise	NRC Test	
MR-SWS-01	2G13_SWS140(WS89@400)_GFB90_2G13 	1W, 15W	TLA-11-043, 044, 046, 048, 049, 050, 052	**50**
MR-SWS-02	G16_SWS140(WS89@400)_GFB90_G16 	2W, 16W	TLA-11-043, TLA12-004	**44**
MR-SWS-03	2G13_OSB10_SWS140(WS89@400)_GFB90_2G13 	3W	TLA-11-060	**51**
MR-SWS-04	2G13_PLY10_SWS140(WS89@400)_GFB90_2G13 	4W	TLA-11-061	**52**
MR-SWS-05	2G13_OSB16_SWS140(WS89@400)_GFB90_2G13 	5W	TLA-11-062	**52**
MR-SWS-06	2G13_PLY16_SWS140(WS89@400)_GFB90_2G13 	6W, 7W, 8W	TLA-11-063, 064, 071	**51**

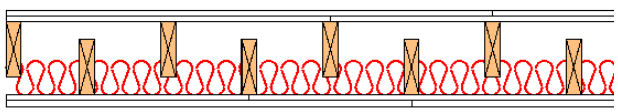
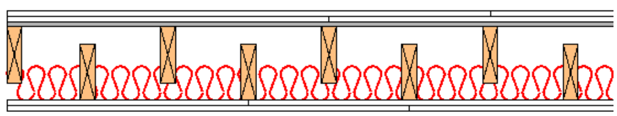
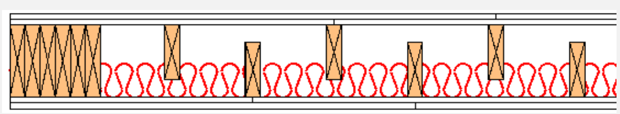
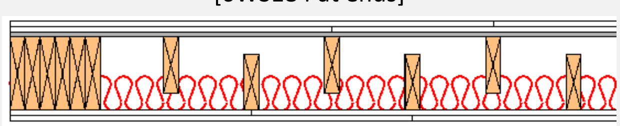
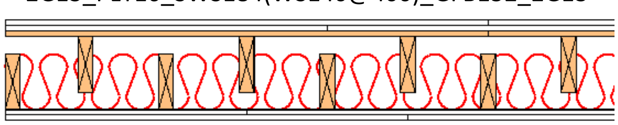
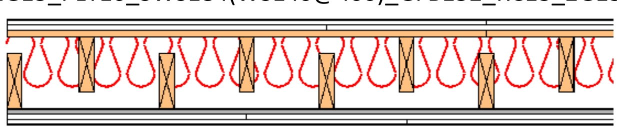
Note: Assembly numbering generally follows that in Report A1-100035-02.1 [16.14], which should be consulted for additional construction details about fasteners and material properties.

Table 2.4.2: Measured STC values for wall assemblies intended for mid-rise buildings, with two staggered rows of 38 mm x 89 mm (2x4) wood studs[1] attached to common 38 mm x 140 mm (2x6) bottom plates and top plates. Some of these assemblies include additional framing members and some have resilient metal channels supporting the gypsum board on one face of the wall. All of these walls have 90 mm sound-absorbing batts in the cavities between the studs on one side, and all have fire-rated gypsum board.

Specimen ID	Descriptive Short Code	Reference		STC
		Mid-Rise	NRC Test	
MR-SWS-07	2G13_RC13(600)_SWS140(WS89@400)_GFB90_2G13 	3WS	TLA-11-059	**59**
MR-SWS-08	2G13_SWS140(WS89@400)_GFB90_2G13, [WS140 at ends] 	1WSa	TLA-11-043, 044	**49**
MR-SWS-09	2G13_SWS140(WS89@400)_GFB90_2G13, [6WS140 at ends] 	9W	TLA-11-076	**47**
MR-SWS-10	2G13_RC13(600)_SWS140(WS89@400)_GFB90_2G13, [6WS140 at ends] 	10W	TLA-11-078	**54**
MR-SWS-11	2G13_SWS140(3WS89@400)_GFB90_2G13 	11W	TLA-11-083	**49**
MR-SWS-12	2G13_RC13(600)_SWS140(3WS89@400)_GFB90_2G13 	12W, 12Wa, 12Wb	TLA-11-084, 085, 086	**55**
MR-SWS-14	2G13_RC13(600)_SWS140(WS89@100)_GFB90_2G13 	14W	TLA-11-091	**50**

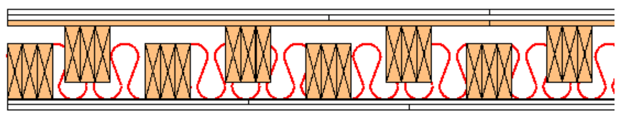
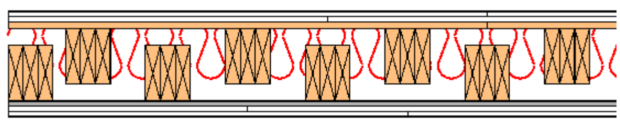
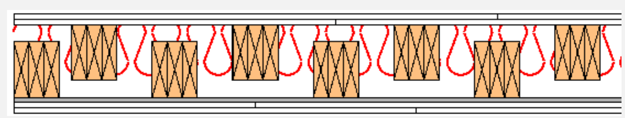
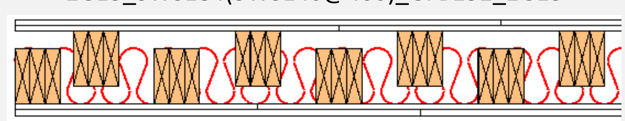
Note: Assembly numbering generally follows that in Report A1-100035-02.1 [16.14], which should be consulted for additional construction details about fasteners and material properties.

Table 2.4.3: Measured STC values for wall assemblies intended for mid-rise buildings, with two staggered rows of 38 mm x 140 mm (2x6) wood studs[1] attached to common 38 mm x 184 mm (2x8) bottom plates and top plates. Some of these assemblies include additional framing members and some have resilient metal channels supporting the gypsum board on one face of the wall. All of these walls have 152 mm sound-absorbing batts in the cavities between the studs on one side, and all have fire-rated gypsum board.

Specimen ID	Descriptive Short Code	Reference		STC
		Mid-Rise	NRC Test	
MR-SWS-18	2G13_SWS184(WS140@400)_GFB152_2G13 	18W	TLA-12-059, 060	**50**
MR-SWS-19	2G13_RC13(600)_SWS184(WS140@400)_GFB152_2G13 	19W	TLA-12-061	**59**
MR-SWS-20	2G13_SWS184(WS140@400)_GFB152_2G13, [6WS184 at ends] 	20W	TLA-12-062	**48**
MR-SWS-21	2G13_RC13(600)_SWS184(WS140@400)_GFB152_2G13, [6WS184 at ends] 	21W	TLA-12-063	**56**
MR-SWS-22	2G13_PLY16_SWS184(WS140@400)_GFB152_2G13 	22W	TLA-12-081	**51**
MR-SWS-23	2G13_PLY16_SWS184(WS140@400)_GFB152_RC13_2G13 	23W	TLA-12-082	**61**

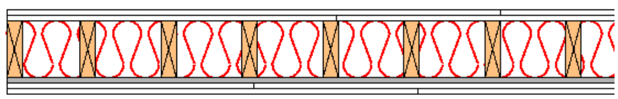
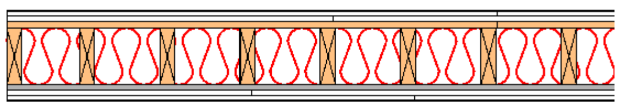
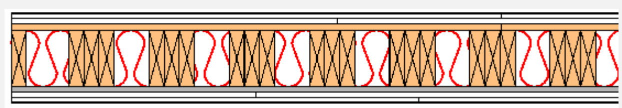
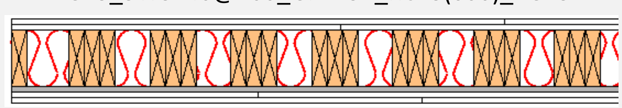
Note: Assembly numbering generally follows that in Report A1-100035-02.1 [16.14], which should be consulted for additional construction details about fasteners and material properties.

Table 2.4.4: Measured STC values for wall assemblies intended for mid-rise buildings, with two staggered rows of tripled 38 mm x 140 mm (2x6) wood studs[1] attached to common 38 mm x 184 mm (2x8) bottom plates and top plates. Some of these assemblies include shear membranes and some have resilient metal channels supporting the gypsum board on one face of the wall. All of these walls have 152 mm sound-absorbing batts in the (rather small) cavities between the studs on one side, and all have fire-rated gypsum board.

Specimen ID	Descriptive Short Code	Reference		STC
		Mid-Rise	NRC Test	
MR-SWS-24	2G13_PLY16_SWS184(3WS140@400)_GFB152_2G13 	24W	TLA-12-083	**47**
MR-SWS-25	2G13_PLY16_SWS184(3WS140@400)_GFB152_RC13(600)_2G13 	25W	TLA-12-084	**60**
MR-SWS-26	2G13_SWS184(3WS140@400)_GFB152_RC13(600)_2G13 	26W	TLA-12-089	**59**
MR-SWS-27	2G13_SWS184(3WS140@400)_GFB152_2G13 	27W	TLA-12-090	**47**

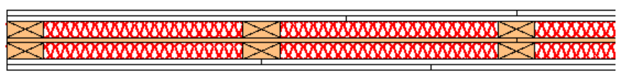
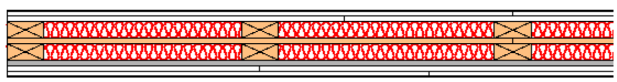
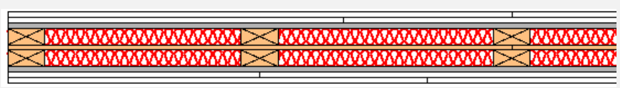
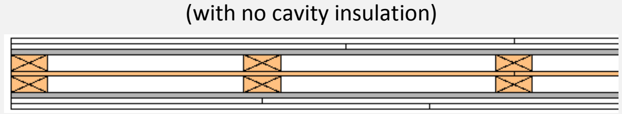
Note: Assembly numbering generally follows that in Report A1-100035-02.1 [16.14], which should be consulted for additional construction details about fasteners and material properties.

Table 2.4.5: Measured STC values for wall assemblies intended for mid-rise buildings, with one row of 38 mm x 140 mm (2x6) wood studs[1] attached to 38 mm x 140 mm (2x6) bottom plates and top plates. Some of these assemblies include shear membranes. All of these walls have 152 mm sound-absorbing batts in the cavities between the studs, and all have fire-rated gypsum board, with resilient metal channels supporting the gypsum board on one face of the wall.

Specimen ID	Descriptive Short Code	Reference		STC
		Mid-Rise	NRC Test	
MR-SWS-28	2G13_WS140@200_GFB152_RC13(600)_2G13 	28W	TLA-12-169	**51**
MR-SWS-29	2G13_PLY16_WS140@200_GFB152_RC13(600)_2G13 	29W	TLA-12-161	**51**
MR-SWS-30	2G13_PLY16_3WS140@200_GFB152_RC13(600)_2G13 	30W	TLA-12-167	**53**
MR-SWS-31	2G13_3WS140@200_GFB152_RC13(600)_2G13 	31W	TLA-12-168	**53**

Note: Assembly numbering generally follows that in Report A1-100035-02.1 [16.14], which should be consulted for additional construction details about fasteners and material properties.

Table 2.4.6: Measured STC values for wall assemblies intended for mid-rise buildings, with 89 mm thick framing comprising two rows of “flatwise” 38 mm x 89 mm (2x4) wood studs[1] sandwiching a shear membrane and framed at all 4 edges by 38 mm x 89 mm (2x4) wood members (bottom plate, double top plates, and “buckling studs”). All assemblies have a 12 mm plywood shear membrane sandwiched between the two rows of studs and all have fire-rated gypsum board on both faces. Some assemblies have resilient metal channels supporting the gypsum board on one or both faces of the wall, and most have 38 mm sound-absorbing batts in the cavities between both rows of studs.

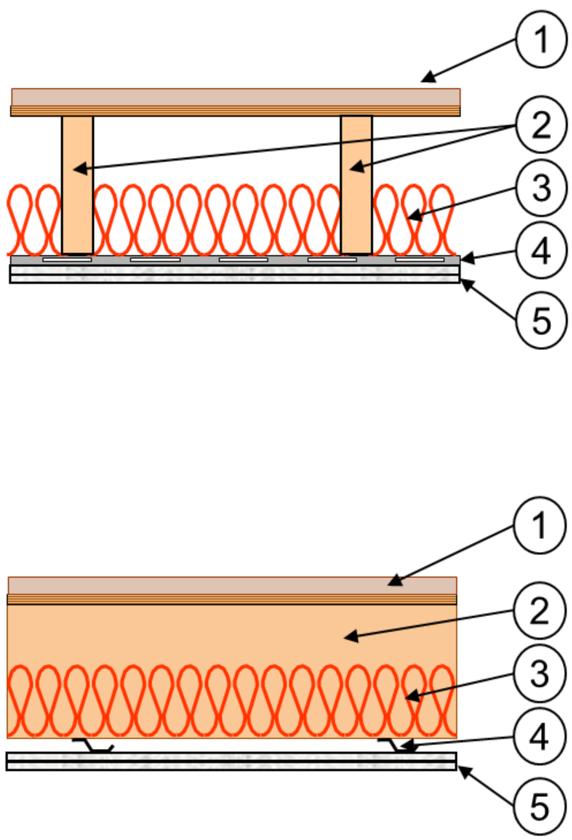
Specimen ID	Descriptive Short Code	Reference		STC
		Mid-Rise	**NRC Test**	
MR-SWS-32	2G13_SHWS89(WS38@600_GFB38_PLY12)_2G13 	32W	TLA-12-142	**48**
MR-SWS-33	2G13_SHWS89(WS38@600_GFB38_PLY12)_RC13(600)_2G13 	33W	TLA-12-144	**55**
MR-SWS-34	2G13_RC13(600)_SHWS89(WS38@600_GFB38_PLY12)_RC13(600)_2G13 	34W	TLA-12-146	**57**
MR-SWS-35	2G13_RC13(600)_SHWS89(WS38@600_PLY12)_RC13(600)_2G13 (with no cavity insulation) 	35W	TLA-12-147	**45**

Note: Assembly numbering generally follows that in Report A1-100035-02.1 [16.14], which should be consulted for additional construction details about fasteners and material properties.

2.5 Floor/Ceiling Assemblies with Wood Framing

The focus of this section is on the sound transmission loss of floor/ceiling assemblies comprised of a wood frame with a floor deck fastened directly to the top of the wood floor joists[5] and a gypsum board ceiling supported below the wood floor joists on resilient metal channels. The typical construction of the floor assemblies is shown in Figure 2.5.1.

Figure 2.5.1:
Vertical cross-section of a floor assembly with loadbearing wood floor joists[5] showing typical components. The upper drawing shows a cross-section perpendicular to the long axis of the joists. The drawing below shows a cross-section parallel to the joists. Variations and element properties are listed in more detail on the right.



Drawings are not exactly to scale

1. Floor deck comprised of a subfloor of plywood, oriented strandboard (OSB), or waferboard at least 15.5 mm thick, or tongue and groove lumber at least 17 mm thick, fastened to the top of the joists and optionally covered with a topping installed over the subfloor. The toppings tested include concrete with average thickness of 38 mm (CON38), gypsum concrete with average thickness of 25 mm (GCON25), and a topping consisting of an additional layer of OSB, plywood, or waferboard at least 11 mm thick.
2. Loadbearing wood floor joists[5] with rimboards of matching depth.
3. Sound-absorbing material[3] in the joist cavities.
4. Resilient metal channels[4] formed from light sheet steel with a suitable profile, and screwed to the faces of the joists.
5. Fire-rated gypsum board[2] screwed to resilient metal channels, with the other flange supported from the wood framing. Gypsum board may be designated either as G13 (nominal thickness of 1/2 in., 12.7 mm) or as G16 (nominal thickness of 5/8 in., 15.9 mm).

NOTE: For the notes on this page please see the corresponding endnotes on page 166.

Table 2.5.1: STC values for floor assemblies framed with wood floor joists[5].

Specimen ID	Descriptive Short Code	Reference		STC
		NBCC	NRC Test	
WJ235-8g	PLY16_WJ235(300)_CFL150_RC13(400)_G13	F8g	TLF-96-193, 01-077	**46**
WJ235-8c	PLY16_WJ235(300)_CFL150_RC13(400)_G16	F8c	TLF-97-003, 95-127	**48**
WJ235-9g	PLY16_WJ235(300)_CFL150_RC13(400)_2G13	F9g	TLF-03-033, 02-043	**51**
WJ235-9c	PLY16_WJ235(300)_CFL150_RC13(400)_2G16	F9c		**52**
WJ235-8h	PLY16_WJ235(300)_CFL150_RC13(600)_G13	F8h	TLF-96-165	**48**
WJ235-8d	PLY16_WJ235(300)_CFL150_RC13(600)_G16	F8d	TLF-97-007	**50**
WJ235-9h	PLY16_WJ235(300)_CFL150_RC13(600)_2G13	F9h	TLF-95-115, 04-001	**53**
WJ235-9d	PLY16_WJ235(300)_CFL150_RC13(600)_2G16	F9d	TLF-95-107	**54**
WJ235-10i	2PLY16_WJ235(300)_CFL150_RC13(400)_G13	F10i	TLF-01-061	**49**
WJ235-10c	2PLY16_WJ235(300)_CFL150_RC13(400)_G16	F10c	TLF-03-061, 063	**51**
WJ235-11i	2PLY16_WJ235(300)_CFL150_RC13(400)_2G13	F11i	TLF-96-187, 02-017, 023	**54**
WJ235-11c	2PLY16_WJ235(300)_CFL150_RC13(400)_2G16	F11c	TLF-96-197, 01-021	**55**
WJ235-10j	2PLY16_WJ235(300)_CFL150_RC13(600)_G13	F10j		**51**
WJ235-10d	2PLY16_WJ235(300)_CFL150_RC13(600)_G16	F10d	TLF-95-123	**53**
WJ235-11j	2PLY16_WJ235(300)_CFL150_RC13(600)_2G13	F11j	TLF-96-177	**56**
WJ235-11d	2PLY16_WJ235(300)_CFL150_RC13(600)_2G16	F11d	TLF-96-181	**57**

See notes on this table on page 34.

Table 2.5.2: STC values for floor assemblies framed with wood floor joists[5] and with a floor topping of 25 mm thick gypsum concrete or 38 mm thick concrete.

Specimen ID	Descriptive Short Code	Reference		STC
		NBCC	NRC Test	
WJ235-14i	GCON25_PLY16_WJ235(300)_CFL150_RC13(400)_G13	F14i		**58**
WJ235-14c	GCON25_PLY16_WJ235(300)_CFL150_RC13(400)_G16	F14c		**60**
WJ235-15i	GCON25_PLY16_WJ235(300)_CFL150_RC13(400)_2G13	F15i	TLF-04-007	**63**
WJ235-15c	GCON25_PLY16_WJ235(300)_CFL150_RC13(400)_2G16	F15c		**64**
WJ235-14j	GCON25_PLY16_WJ235(300)_CFL150_RC13(600)_G13	F14j		**60**
WJ235-14d	GCON25_PLY16_WJ235(300)_CFL150_RC13(600)_G16	F14d	TLF-97-040	**62**
WJ235-15j	GCON25_PLY16_WJ235(300)_CFL150_RC13(600)_2G13	F15j	TLF-04-003	**65**
WJ235-15d	GCON25_PLY16_WJ235(300)_CFL150_RC13(600)_2G16	F15d		**66**
WJ235-20i	CON38_PLY16_WJ235(300)_CFL150_RC13(400)_G13	F20i		**62**
WJ235-20c	CON38_PLY16_WJ235(300)_CFL150_RC13(400)_G16	F20c		**63**
WJ235-21i	CON38_PLY16_WJ235(300)_CFL150_RC13(400)_2G13	F21i	TLF-02-045	**66**
WJ235-21c	CON38_PLY16_WJ235(300)_CFL150_RC13(400)_2G16	F21c		**67**
WJ235-20j	CON38_PLY16_WJ235(300)_CFL150_RC13(600)_G13	F20j		**64**
WJ235-20d	CON38_PLY16_WJ235(300)_CFL150_RC13(600)_G16	F20d	TLF-96-143	**65**
WJ235-21j	CON38_PLY16_WJ235(300)_CFL150_RC13(600)_2G13	F21j		**68**
WJ235-21d	CON38_PLY16_WJ235(300)_CFL150_RC13(600)_2G16	F21d	TLF-96-147	**69**

See notes on this table on page 34.

NOTES on Tables 2.5.1 and 2.5.2:

1. The listed STC values correspond to the values in Table 9.10.3.1. of the 2015 National Building Code of Canada (NBCC). Specimen details must conform to all pertinent criteria in the notes to that table.
2. Following the notes to Table 9.10.3.1. in the 2015 NBCC, the sound transmission loss values in Tables 2.5.1. and 2.5.2 apply for solid-sawn wood joists with minimum member size of 38 mm x 235 mm and for wood I-joists with a minimum flange size of 38 mm x 38 mm, a minimum plywood or OSB web thickness of 9.5 mm, and a minimum joist depth of 241 mm.
3. The STC values for specimens 9c/d/g/h and 11c/d/g/h and 15c/d/g/h and 21c/d/g/h also apply for solid-sawn wood joists with member size of 38 mm x 184 mm.
4. Specimen description codes in Tables 2.5.1 and 2.5.2 all show "PLY16" (for 15.5 mm plywood). Substituting 15.5 mm thick OSB or waferboard or 17 mm tongue and groove lumber for the subfloor is listed with the same STC rating in the NBCC. The floor topping for specimens 10c/d/i/j and 11c/d/i/j may be of plywood, OSB, or waferboard at least 11 mm thick.
5. The 25 mm gypsum concrete topping must have a mass per area of at least 44 kg/m^2. The 38 mm concrete topping must have a mass per area of at least 70 kg/m^2.
6. The joist spacing in the table is given as 300 mm o.c. following Table 9.10.3.1. in the 2015 NBCC, but the same STC ratings can be expected for the same floors with joist spacing of 400 mm o.c. For joist spacing of 600 mm o.c. the STC rating can be expected to be 1 STC point higher than listed in Tables 2.5.1 and 2.5.2.
7. Specimen description codes in Tables 2.5.1 and 2.5.2 all show "CFL150" (for blown-in or loose fill cellulose fibre) sound-absorbing material. Substituting GFB150 (glass fibre batt) or MFB150 (mineral or rock fibre batt) does not change the STC rating.
8. Note that most entries in Tables 2.5.1 and 2.5.2 and in the NBCC Table 9.10.3.1. are for a thickness of 150 mm for the sound-absorbing material, but (as the notes in the NBCC acknowledge) the regression analysis presented below suggests that the STC rating would on average be higher by 1 point with each 50 mm increase in thickness of the sound-absorbing material.
9. The NBCC provides STC ratings for floors with trusses of various types in series F22 to F38, but the minimum rated depth is larger than 235 mm. For a truss depth of 400 mm, the STC would on average be higher by 1 point than the corresponding joist floors listed in Tables 2.5.1 and 2.5.2.
10. Results from individual NRC tests scatter around STC values in the NBCC Table 9.10.3.1., typically within a range of ±2 points as noted below in the discussion of trends. Some NRC Test References are blank because there is no test corresponding to those specific specimen details.
11. For additional assemblies of this type, see the NRC Reports IR-766 [16.3], IR-811 [16.4] and RR-169 [16.7], or the NBCC Table 9.10.3.1.

Trends in the Sound Transmission for Wood-Framed Floors

The effects of key parameters on the sound transmission loss of wood-framed floor assemblies were evaluated by regression analysis. This regression equation was developed for the NRC report RR-169 [16.7] and subsequently repeated as one of the estimator equations for a software tool called SOCRATES (for **SO**und **C**lassification **RAT**ing **ES**timator) [16.9]. Since Equation 2.5.1 is based on the same set of test results used to develop Table 9.10.3.1. in the National Building Code of Canada, it should be quite consistent with the tabulated values in that table.

The dataset used for the analysis included 174 floors. This set comprised floors with 4 types of framing: 68 solid-sawn wood joist floors, 43 wood I-joist floors, 34 cold-formed steel-framed joists, and 28 wood truss floors. All floors had resilient metal channels supporting the gypsum board ceiling, and all had sound-absorbing material between the framing members.

No individual type of joists or trusses gave significantly different STC from the average result for the four types of framing. The factors varied included:

- Joist type, joist depth, and spacing between the centres of adjacent joists
- Type and thickness of the subfloor
- Topping (no topping, or added layer of plywood or OSB, or concrete, or gypsum concrete)
- Type, thickness and number of layers of gypsum board on the ceiling
- Type and thickness of the sound-absorbing material
- Space between the centres of the resilient metal channels

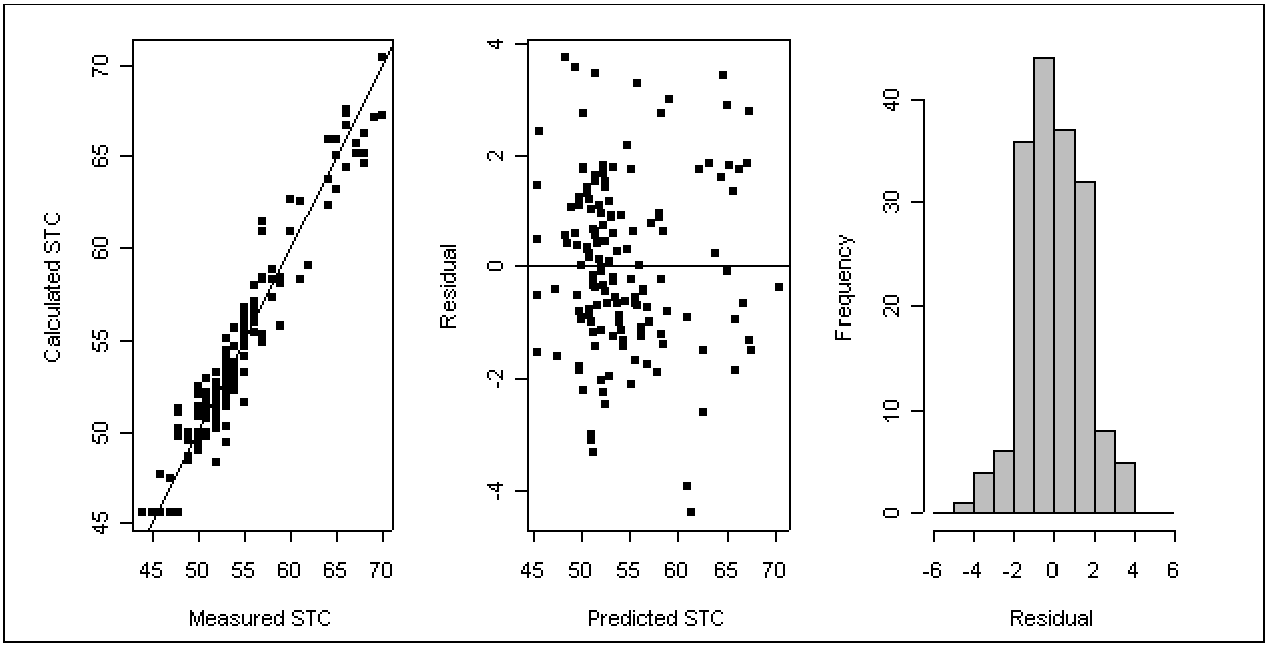
The regression analysis yields Equation 2.5.1 for estimating STC ratings:

$$STC = 8.6 + 14.2[\log m_{floor}] + 15.5[\log m_{ceil}] + 0.006[CavityDepth] + 0.019[AbsThick] + 0.005[JoistSpace] + 0.011[RCSpace] \qquad \text{Eq. 2.5.1}$$

The quality of the fit is indicated in Figure 2.5.2. The significant parameters are:

- m_{floor} is the mass per area (kg/m^2) of the subfloor and topping that comprise the top surface
- m_{ceil} is the mass per area (kg/m^2) of gypsum board layers on the ceiling
- $CavityDepth$ is the distance between the internal faces of gypsum board in mm
- $AbsThick$ is the thickness of the sound-absorbing material in mm
- $JoistSpace$ and $RCSpace$ are the distance in mm between centres of joists or resilient channels

Figure 2.5.2: Plots to show how the predicted values agree with measurements and the distribution of the residuals (measured STC minus predicted STC). Summary values for the fit: Residual Standard Error = 1.6 dB, and Adjusted R^2 (quality of the fit) = 0.92.



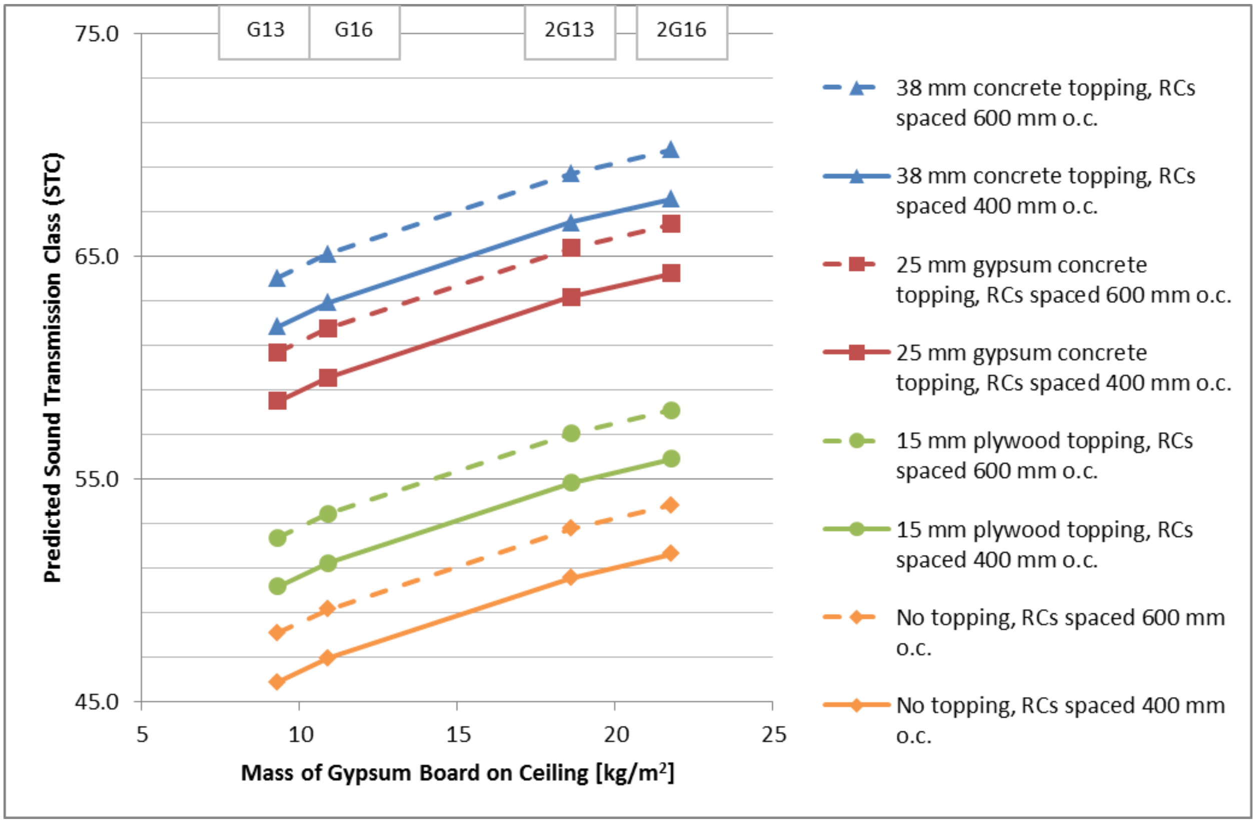
To estimate the STC rating for a specific construction, insert parameter values (e.g. from Table 2.5.2) in Equation 2.5.1, or use the calculated STC results for common cases shown in Figure 2.5.3.

Table 2.5.2: Typical values for the parameters in Equation 2.5.1. The values shown here essentially span the ranges for the data set and hence define the limits for applying the Equation 2.5.1.

$m_{floor} =$ $m_{subfloor} +$ $m_{topping} =$	Weight of the (optional) topping plus subfloor: 93 (kg/m^2) for 38 mm thick concrete topping incl. plywood subfloor 54 (kg/m^2) for 25 mm thick gypsum concrete topping incl. plywood subfloor 14 (kg/m^2) for 15 mm oriented strandboard (OSB) topping incl. plywood subfloor 7 (kg/m^2) for 15 mm plywood subfloor
$m_{ceil} =$	1 or 2 layers on the ceiling of 9.3 (kg/m^2) for each layer of 12.7 mm fire-rated gypsum board 10.9 (kg/m^2) for each layer of 15.9 mm fire-rated gypsum board
$CavityDepth =$	13 (mm) plus depth of the wood floor joist in mm (within the dataset range from 197 mm to 500 mm)
$AbsThick =$	Thickness in mm of sound-absorbing material between joists (within the dataset range from 59 mm to *CavityDepth*)
$JoistSpace =$	300 or 400 or 600 (mm)
$RCSpace =$	300 or 400 or 600 (mm)

Note that the permitted range for Equation 2.5.1 is limited by the cases in the dataset, which restricts the floors to designs with resilient metal channels supporting the gypsum board ceiling, and at least 59 mm of sound-absorbing material between the framing.

Figure 2.5.3: STC values estimated using Equation 2.5.1 for a floor framed with wood floor joists[5] 242 mm deep (*CavityDepth* = 255 mm) and spaced 300 mm o.c., with a subfloor of 15.5 mm thick plywood (which corresponds to the minimum values specified for these parameters in the notes to Table 9.10.3.1. in the NBCC). The topping installed over the subfloor and the spacing between resilient channels is indicated by the caption for each curve. The horizontal axis shows ceiling mass, and the layer(s) comprising the ceiling are indicated in the boxes at the top of the plot area.



2.6 Summary for Chapter 2: Sound Transmission through Wood-Framed Walls and Floors

For the results of individual tests, the dependence of the STC rating on specimen details are partially masked by the uncertainty in individual test results, and only a limited set of constructions have been tested. However, the regression expressions and the corresponding tables of STC values from Section 9.10.3. of the National Building Code provide a clear indication of the dependence of the STC rating on parameters such as spacing of framing members and mass per unit area of the assembly surfaces, for each category of common wood-framed constructions.

The STC test results in the tables of Section 2.4 do not provide such a clear picture of trends, but in general these wall assemblies for mid-rise buildings exhibit rather similar dependence of the STC rating on changing surface weight or adding resilient channels. Overall, despite the large weight of additional framing in some specimens, the walls in Section 2.4 do not achieve STC values much over 50 unless the gypsum board on one side is on resilient channels.

In general, the constructions listed in the tables in Sections 2.2, 2.3, and 2.5 were selected to provide an indication of the STC ratings that can be expected in the worst common cases. Trends in the data provide a reliable basis for assigning conservative lower limits for the STC rating for many assembly designs not listed in the tables.

Some key considerations for STC ratings are:

- Heavier surfaces give higher STC ratings if other variables are constant, i.e. adding layers of plywood or gypsum board to a listed wall or adding a heavier topping on a floor will usually give an STC rating at least as high as an otherwise comparable listed value.
- For joist depth (or cavity depth) greater than the listed case, the STC rating will usually be at least as high as an otherwise comparable listed value.
- Floors with solid-sawn wood joists or I-joists of similar depth are equivalent.
- All types of fibrous sound-absorbing material (glass fibre, rock fibre, cellulose fibre) usually yield the same STC rating (also see Endnote 3 on page 166).
- Filling a cavity completely with sound-absorbing material will give STC ratings at least as high as comparable assemblies with thinner sound-absorbing layers that are listed in the tables.
- For resiliently mounted gypsum board with fewer connections per m^2 than the listed cases, the STC will usually be at least as high as for a comparable listed assembly.

Together with the similar approach to assigning minimum values presented for Flanking STC at the end of Chapter 3, these conservative estimates can greatly extend the range of constructions for which ASTC calculations can establish compliance with a required minimum performance such as the ASTC 47 requirement in the NBCC.

3 Flanking Sound Transmission in Wood-Framed Constructions

The focus of this chapter is the flanking sound transmission in buildings comprising wood-framed walls connected to wood-framed floors. ISO 15712-1 [8] provides a procedure for predicting sound transmission in buildings where the structure is composed of connected homogeneous wall and floor assemblies. Wood-framed constructions do not fall within this scope.

The same basic concept of combining the sound power transmitted via direct and flanking paths does apply to wood-framed assemblies, but different test methods are required to evaluate flanking paths. Instead of using the procedures of ISO 15712-1, which are appropriate only for heavy homogeneous constructions, experimental data from measurements following the procedures of ISO 10848 [7] are used to characterize the flanking sound transmission for wood-framed constructions.

3.1 Test Facilities and Test Procedures for Wood-Framed Assemblies

This introduction provides a brief description of the setup and standardized test methods used to measure flanking sound transmission loss values for individual transmission paths in framed assemblies.

Most of the measurements reported here were conducted in the fully-automated 8-room flanking sound transmission facility at the NRC, depicted in Figure 3.1.1. Each room in the facility is equipped with four loudspeakers with independent/incoherent sources and one microphone that can be positioned by a robot at a set of selected positions for each test sequence. The test specimen consists of eight walls, four floors, and six junctions. The permanent shell of the facility (upper ceiling/roof, perimeter walls, and foundation floor) is constructed of highly sound insulating elements that are resiliently isolated from each other and from the test specimens, with vibration breaks in the permanent surfaces where the specimens are installed. The upper rooms have a ceiling height of 2.7 m while the lower rooms have a ceiling height of 2.4 m. The volume of the rooms used to assess flanking sound transmission ranges between approximately 30 m^3 and approximately 50 m^3.

In addition to the measurements conducted in the 8-room flanking sound transmission facility, an earlier set of measurements was conducted in the older 4-room flanking sound transmission facility (2 upper and 2 lower rooms), with similar room sizes and basically equivalent instrumentation and test procedures. Comparison tests from the time when the 8-room facility was commissioned showed good agreement between the two facilities (for nominally equivalent constructions, the measured Flanking STC for junctions agreed within 2 dB or better.)

The individual flanking paths between adjacent rooms (side-by-side or one-above-the-other) were determined following the indirect method described in ISO 10848. Sound transmission loss measurements were conducted in both directions and the average was used as the final result. This procedure reduces errors associated with the microphone calibration and local variations in the sound field. For each room pair, the source room was excited with pink noise using the four loudspeakers in that room, driven with incoherent source signals. The sound pressure levels were recorded in the source room and the other seven rooms at nine positions each, using a microphone that was moved by a computer-controlled robot in each room. The reverberation times were measured using the interrupted noise method as specified in ASTM E2235 [4]. Background noise levels were measured in each room as part of the transmission loss measurements.

Figure 3.1.1(a): Schematic representation of a specimen installed in the 8-room flanking facility

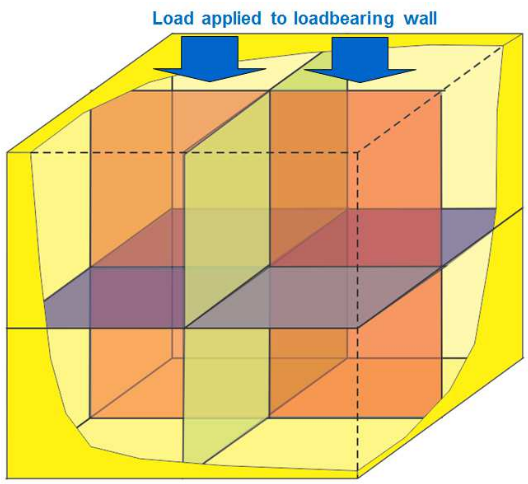


Figure 3.1.1(b): The interior of the flanking facility before construction of the specimen.

Determining Flanking TL for Individual Transmission Paths

In many cases, the flanking path of interest could be measured directly by shielding all other paths between the rooms. The wall shielding consisted of two layers of 15.9 mm gypsum board that were installed in front of the specimen surface without any structural connection (i.e. the shielding was supported by the permanent facility floor or ceiling instead of being attached to the test specimen). The 120 mm deep cavity between the shielding layers and the specimen surface was filled with fibrous insulation, and the perimeter was sealed with tape. Tests showed that this type of wall shielding provided an additional transmission loss between 15 dB and 25 dB over most of the frequency range of interest when installed on both sides of the wall.

In some cases, it was necessary to extract the flanking path of interest from a set of measurements with different shielding conditions. For example, the ceiling surfaces in the lower rooms could not be shielded due to the practical difficulties of suspending the shielding layers without structurally connecting them to the specimen. As a consequence, the ceiling-ceiling path is always included in any measurement between horizontally adjacent lower rooms. In order to determine the direct path through a separating wall in the lower rooms, it was therefore necessary to first determine the ceiling-ceiling path and the wall-ceiling and ceiling-wall paths. The sound power of these three paths was then removed from the apparent transmission, yielding the direct path through the separating wall. Throughout this procedure it was important to take proper account of flanking limits and background noise.

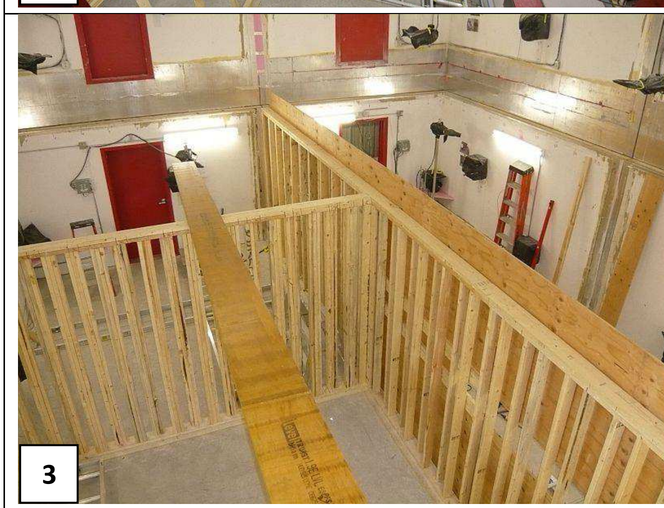
Figure 3.1.2 shows some images of a wood-framed specimen during construction.

Figure 3.1.2: Some images of the wood-framed assemblies under construction.

The flanking test specimen in the 8-room flanking sound transmission facility consisted of four loadbearing walls, four non-loadbearing walls, four floors, and six junctions, which divide the space into 8 rooms.

To take advantage of symmetries and to allow for redundant measurements, the four loadbearing walls are usually nominally identical, as are the four non-loadbearing walls and the four floors.

1. View of the upper four rooms of the flanking facility, during construction of the upper wall framing.
2. View from above of the test specimen for low-rise wood-framed buildings under construction.
3. View from above of the test specimen for mid-rise wood-framed buildings under construction. The triple staggered wood studs on the loadbearing wall and the shear membrane on the non-loadbearing wall are visible in the image.



Presentation and Organization of the Flanking Sound Transmission Data

Chapter 3 presents single-number results for the flanking sound transmission as was done for the presentation of the STC results in Chapter 2. In this case, the results are values of flanking sound transmission class (Flanking STC_{ij}), where the subscript i denotes the source room (surface D or F), and the subscript j denotes the connected receiving room (surface d or f) for the transmission path through the junction.

The flanking sound transmission class values are used to calculate the ASTC rating in the examples in Chapter 4, using the Simplified Method of ISO 15712-1.

Each of the tables in this Chapter shows Flanking STC_{ij} values for a set of paths through a junction, either a wall/floor junction or a wall/wall junction. In total, there are almost 70 tables of Flanking STC data. They are organized and numbered as follows:

Section 3.2: Wall/Floor Junctions for Low-Rise Buildings

- Walls with one row of 38 mm x 89 mm (2x4) wood studs
- Floors with wood floor joists
- Loadbearing (continuous/discontinuous joists) and non-loadbearing junctions

Section 3.3: Wall/Floor Junctions for Low-Rise Buildings

- Walls with two rows of 38 mm x 89 mm (2x4) wood studs on separate plates
- Floors with wood floor joists
- Loadbearing and non-loadbearing junctions

Section 3.4: Wall/Wall Junctions for Low-Rise Buildings

- Walls with one row of 38 mm x 89 mm (2x4) wood studs

Section 3.5: Wall/Wall Junctions for Low-Rise Buildings

- Separating walls with two rows of 38 mm x 89 mm (2x4) studs on separate plates
- Flanking walls with one row of 38 mm x 89 mm (2x4) wood studs

Section 3.6: Wall/Floor Junctions for Mid-Rise Buildings

- Walls with two rows of staggered 38 mm x 89 mm (2x4) wood studs on common plate, with shear layers
- Floors with wood floor joists
- Loadbearing and non-loadbearing junctions

Section 3.7: Wall/Wall Junctions for Mid-Rise Buildings

- Walls with two rows of staggered 38 mm x 89 mm (2x4) wood studs on common plate, with shear layers

The Flanking STC values presented in the following sections were determined from measurements as described in Section 3.1, or from calculations based on the measured data. Due to the large number of possible configurations and the significant effort required to measure individual flanking paths, it is usually not feasible to determine every single flanking path by measurement.

In some cases, the Flanking STC values were derived from the Flanking STC values of other, similar paths. For example, if a flanking path involving a wall with gypsum board was only measured with one layer of gypsum board on the wall but not with two layers of gypsum board, then the Flanking STC value for the wall with two layers of gypsum board was assumed to be at least as high as the Flanking STC value for the wall with one layer. This is indicated in the tables by a "≥" sign. The tabulated value therefore presents a lower limit of the flanking sound transmission loss that can be expected for that assembly.

On the other hand, if the determination of the laboratory Flanking STC rating for a transmission path yielded a value of 90 or higher, the Flanking STC value in the tables was set to 90 to allow for the inevitable effect of higher order flanking paths. A value of 90 therefore constitutes an upper limit.

In other cases, the flanking sound transmission at a junction was not measured for each individual transmission path, and only the combined transmission for the entire junction was available. This is indicated in the tables by "Ff+Fd+Df". The worked examples in Chapter 4 demonstrate how to use such data (see e.g. the examples in Section 4.3).

In some cases, not enough measurement data was available for a given construction detail to determine the Flanking STC value for a given path. In those cases, the respective table entry was left empty.

More information on the measurement procedures and the determination of individual flanking paths is available in the research reports that form the basis of this Chapter [16.1, 16.5, 16.6, 16.8, 16.10, 16.11].

NOTE:

All Flanking STC results in this Report have been normalized to room dimensions consistent with the Standard Scenario presented in Chapter 1.

The test results presented in the tables in this Chapter include:

- Values of Flanking STC measured following the procedures of ISO 10848-3 for rooms that are side-by-side (i.e. a wall is the separating assembly), normalized to:
  - $S = 12.5\ m^2$ and $l = 5.0$ m for the wall/floor or wall/ceiling junction
  - $S = 12.5\ m^2$ and $l = 2.5$ m for the wall/wall junction
- Values of Flanking STC measured following the procedures of ISO 10848-3 for rooms that are one-above-the-other (i.e. a floor/ceiling is the separating assembly), normalized to:
  - $S = 20.0\ m^2$ and $l = 5.0$ m
- Values of STC measured according to ASTM E90 (as tabulated in Chapter 2) for path Dd

3.2 Wall/Floor Junctions for Low-Rise Buildings – Wall Assemblies with 1 Row of Wood Studs

The following tables present flanking sound transmission class values of specific flanking sound transmission paths that were determined from measurements following the procedures of ISO 10848 on a series of mock-up constructions. The facilities and test procedures are described in Section 3.1.

All of the wall assemblies in this Section were framed with one row of 38 mm x 89 mm wood studs.

Each table of Flanking STC_{ij} results consists of several parts:

1. Brief generic descriptions of the wall and floor/ceiling assemblies and their junction
2. A drawing showing the main features of the assemblies and their junction. Wood floor joists are shown as I-joists because most of the experimental studies at NRC used I-joists. However, the Flanking STC_{ij} values reported in the tables also apply to solid-sawn wood joists of similar depth.
3. Each wall/floor junction can be viewed in several ways:
    - As the wall/floor junction between two side-by-side rooms above the floor
    - As the wall/ceiling junction between two side-by-side rooms below the ceiling
    - As the junction of a flanking wall with the floor/ceiling assembly separating two rooms that are one-above-the-other

    The different junction cases are presented in the rows underneath the descriptions, with stylized drawings to identify the paths and the Flanking STC values for each flanking path ij.
4. The naming for the wall/floor junctions follows a simple coding system in four segments:
    - The first segment of the code indicates that the junction consist of wood-framed assemblies and identifies the basic wall framing.
    - The second 2-letter segment of the code indicates the junction type (where the first letter identifies the separating assembly and the second letter identifies the flanking assemblies):
        - WF = wall/floor, WC = wall/ceiling, FW = floor/wall
    - The third segment of the code indicates a loadbearing or non-loadbearing junction.
    - The final segment of the code is the unique number for that junction detail and is determined by the assembly surfaces.

NOTE:

The tables in this section present data for floors constructed with 305 mm wood I-joists spaced 400 mm o.c., with 150 mm sound-absorbing material in the cavities and with a 19 mm oriented strandboard (OSB) subfloor. Equal or higher Flanking STC values can be expected for floors constructed with solid-sawn wood joists of similar depth or deeper, for joists that are spaced 600 mm o.c., and for floors with a subfloor of plywood at least 19 mm thick. The flanking sound transmission for wood trusses has not been established yet; hence the Flanking STC values should not be used for floors with trusses.

Section 3.2 contains 42 tables, divided into three main groups based on junction details:

1. The first group includes wall/floor junctions where the wood floor joists are perpendicular to the loadbearing separating wall and both the floor joists and the subfloor are continuous across the junction. This set of junctions is designated as loadbearing continuous (LBC) and the table numbers begin with “3.2.LBC”.
2. The second group includes wall/floor junctions where the subfloor is continuous across the junction and the wood floor joists are perpendicular to the loadbearing separating wall but not continuous across the junction. This set of junctions is designated as loadbearing (LB) and the table numbers begin with “3.2.LB”.
3. The third group includes wall/floor junctions where the subfloor is continuous across the junction and the wood floor joists are parallel to the non-loadbearing separating wall. This set of junctions is designated as non-loadbearing (NLB) and the table numbers begin with “3.2.NLB”.

Within each group, the tables are numbered by two indices:

1. The second-last index indicates the floor surface, beginning with “1” for the case with a bare subfloor of OSB or plywood, and higher values for junctions where a topping is added over the subfloor.
2. The final index indicates a variant on the gypsum board surfaces of the ceilings and the walls above and below the floor/ceiling. The tables cycle through these cases for each topping case. These begin with cases where the ceiling has 2 layers of gypsum board supported on resilient channels, followed by cases where the ceiling has 1 layer of gypsum board (in the few cases where such ceilings were evaluated).

The following 14 pages present the group of junctions designated as LBC.

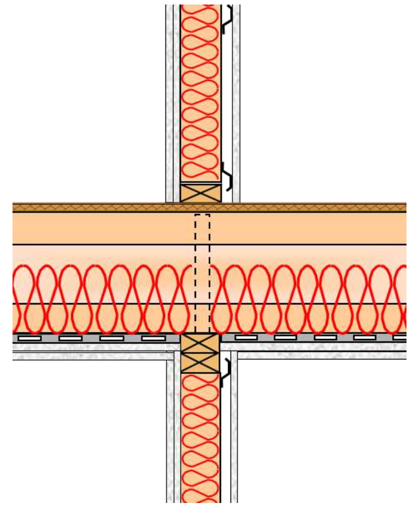
Table 3.2.LBC.1.1: Floor-Wall Transmission Paths

- Continuous joists and (bare) subfloor across the junction

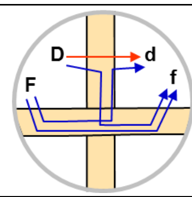
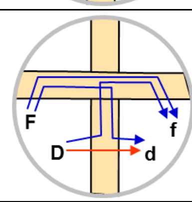
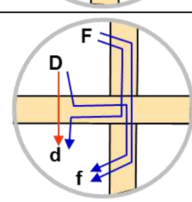
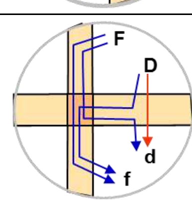
Loadbearing wall assembly:
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

Floor/ceiling assembly:
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- No topping
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:
- Floor joists oriented perpendicular to the wall
- Joists and subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC$_{ij}$
WS89-WF-LBC-11 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	51 38 45 45
WS89-WC-LBC-11 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	51 77 78 65
WI305-FW-LBC-11 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	55 70 90 60
WI305-FW-LBC-11R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff Fd Df	55 ≥72

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.LBC.1.2: Floor-Wall Transmission Paths

- As 3.2.LBC.1.1, but with different wall surfaces

Loadbearing wall assembly:

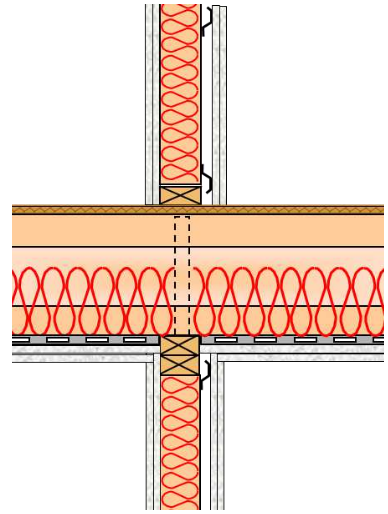
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 2 layers on resilient channels[4] on the other side

Floor/ceiling assembly:

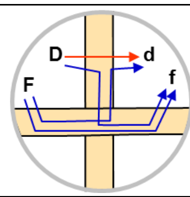
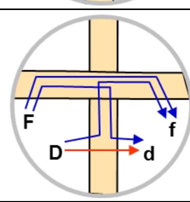
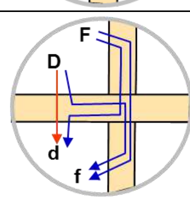
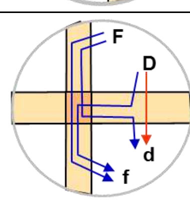
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- No topping
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented perpendicular to the wall
- Joists and subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-LBC-12 Wall-Floor Loadbearing Junction		Dd	58
		Ff	38
		Fd	47
		Df	45
WS89-WC-LBC-12 Wall-Ceiling Loadbearing Junction		Dd	58
		Ff	77
		Fd	80
		Df	65
WI305-FW-LBC-12 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd	55
		Ff	70
		Fd	90
		Df	60
WI305-FW-LBC-12R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd	55
		Ff+Fd+Df	≥74

(For the notes in this table please see the corresponding endnotes on page 166.)

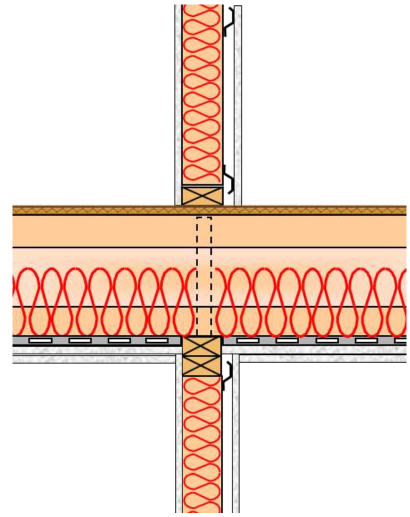
Table 3.2.LBC.1.3: Floor-Wall Transmission Paths

- As 3.2.LBC.1.1, but with different wall surfaces

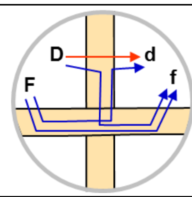
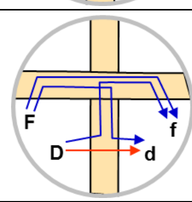
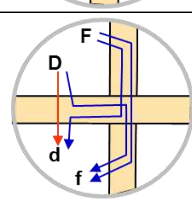
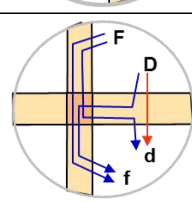
Loadbearing wall assembly:
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 1 layer of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

Floor/ceiling assembly:
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- No topping
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:
- Floor joists oriented perpendicular to the wall
- Joists and subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-LBC-13 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	45 38 45 ≥41
WS89-WC-LBC-13 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	45 77 78 ≥61
WI305-FW-LBC-13 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	55 64 90 57
WI305-FW-LBC-13R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	55 ≥72

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.LBC.1.4: Floor-Wall Transmission Paths

- As 3.2.LBC.1.1, but with different ceiling surfaces

Loadbearing wall assembly:

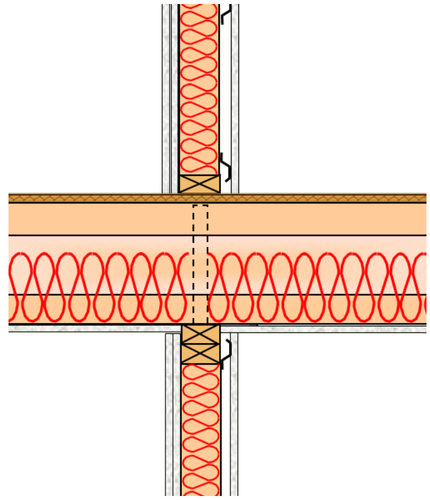
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

Floor/ceiling assembly:

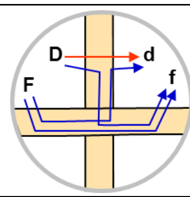
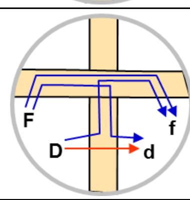
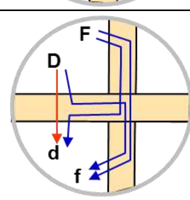
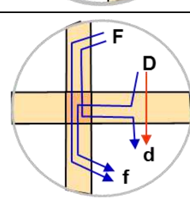
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- No topping
- Ceiling of 1 layer of 13 mm fire-rated gypsum board[2] directly attached to floor joists

Junction:

- Floor joists oriented perpendicular to the wall
- Joists and subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-LBC-14 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	51 38 45 45
WS89-WC-LBC-14 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	51 58 75 63
WI305-FW-LBC-14 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	29 70 58 60
WI305-FW-LBC-14R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff Fd Df	29 70 61 62

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.LBC.1.5: Floor-Wall Transmission Paths

- As 3.2.LBC.1.2, but with different ceiling surfaces

Loadbearing wall assembly:

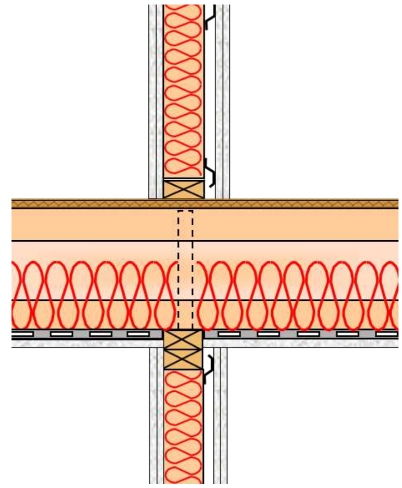
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 2 layers on resilient channels[4] on the other side

Floor/ceiling assembly:

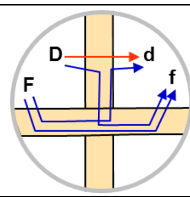
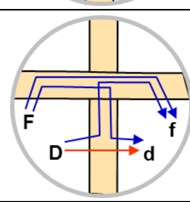
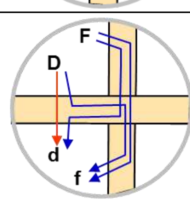
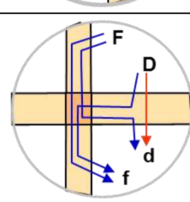
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- No topping
- Ceiling of 1 layer of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented perpendicular to the wall
- Joists and subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction		Path	Flanking STC_{ij}
WS89-WF-LBC-15 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	58 38 45 45
WS89-WC-LBC-15 Wall-Ceiling Loadbearing Junction		Dd Ff+Fd+Df	58 ≥57
WI305-FW-LBC-15 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff+Fd+Df	51 ≥60
WI305-FW-LBC-15R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	51 ≥74

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.LBC.1.6: Floor-Wall Transmission Paths

- As 3.2.LBC.1.3, but with different ceiling surfaces

Loadbearing wall assembly:

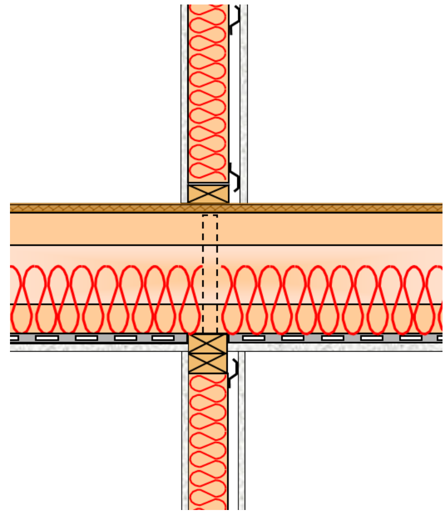
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 1 layer of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

Floor/ceiling assembly:

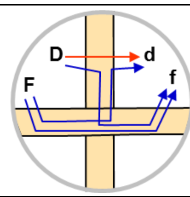
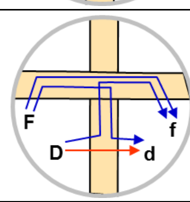
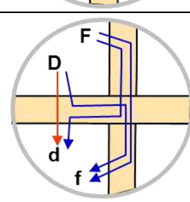
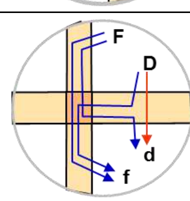
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- No topping
- Ceiling of 1 layer of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented perpendicular to the wall
- Joists and subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-LBC-16 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	45 38 45 ≥41
WS89-WC-LBC-16 Wall-Ceiling Loadbearing Junction		Dd Ff+Fd+Df	45 ≥55
WI305-FW-LBC-16 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff+Fd+Df	51 ≥56
WI305-FW-LBC-16R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	51 ≥72

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.LBC.2.1: Floor-Wall Transmission Paths

- As 3.2.LBC.1.1, but with 19 mm OSB floor topping

Loadbearing wall assembly:

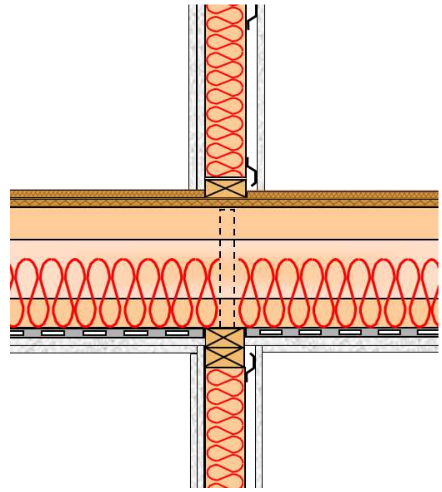
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

Floor/ceiling assembly:

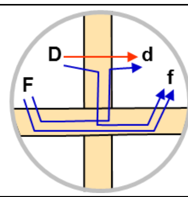
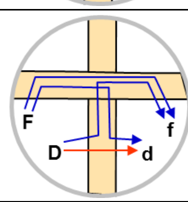
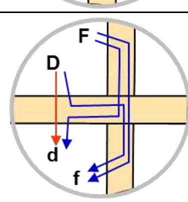
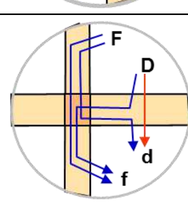
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 19 mm OSB mechanically fastened over subfloor
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented perpendicular to the wall
- Joists and subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

		Path	Flanking STC_{ij}
WS89-WF-LBC-21 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	51 45 49 49
WS89-WC-LBC-21 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	51 77 78 65
WI305-FW-LBC-21 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	60 70 90 64
WI305-FW-LBC-21R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	60 ≥72

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.LBC.2.2: Floor-Wall Transmission Paths

- As 3.2.LBC.1.2, but with 19 mm OSB floor topping

Loadbearing wall assembly:

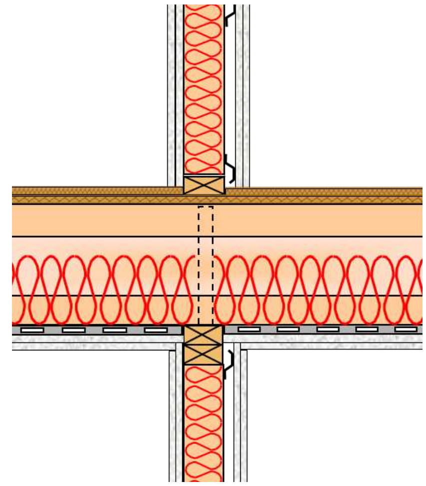
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 2 layers on resilient channels[4] on the other side

Floor/ceiling assembly:

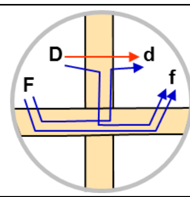
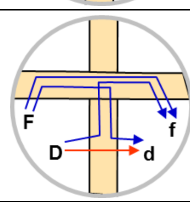
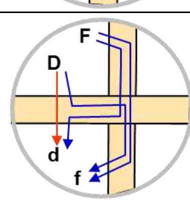
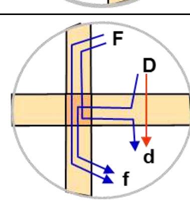
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 19 mm OSB mechanically fastened over subfloor
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented perpendicular to the wall
- Joists and subfloor continuous across the junction



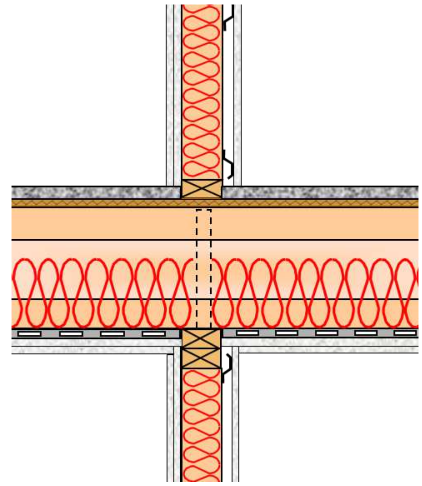
Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-LBC-22 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	58 45 51 49
WS89-WC-LBC-22 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	58 77 80 65
WI305-FW-LBC-22 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	60 70 90 64
WI305-FW-LBC-22R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	60 ≥74

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.LBC.3.1: Floor-Wall Transmission Paths

- As 3.2.LBC.1.1, but with 25 mm gypsum concrete topping

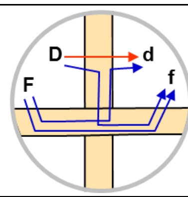
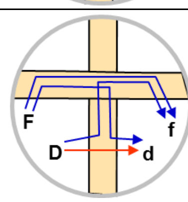
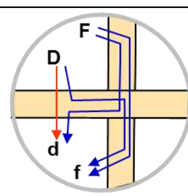
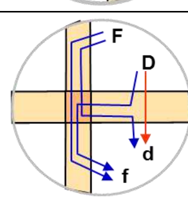


Floor-Wall Junction: Vertical section, approximately to scale

Loadbearing wall assembly:
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

Floor/ceiling assembly:
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 25 mm gypsum concrete bonded to subfloor
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:
- Floor joists oriented perpendicular to the wall
- Joists and subfloor continuous across the junction

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-LBC-31 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	51 61 58 57
WS89-WC-LBC-31 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	51 77 78 65
WI305-FW-LBC-31 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	66 70 90 71
WI305-FW-LBC-31R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	66 ≥72

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.LBC.3.2: Floor-Wall Transmission Paths

- As 3.2.LBC.1.2, but with 25 mm gypsum concrete topping

Loadbearing wall assembly:

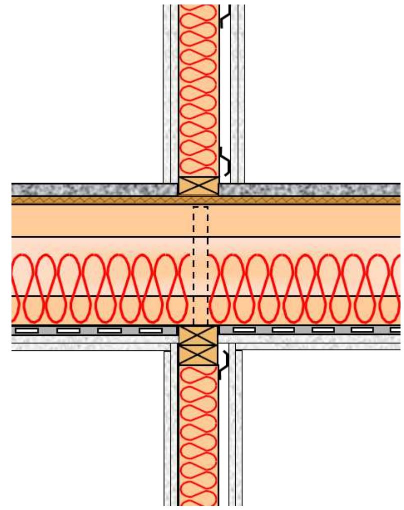
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 2 layers on resilient channels[4] on the other side

Floor/ceiling assembly:

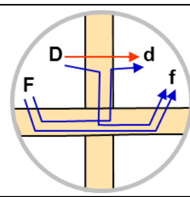
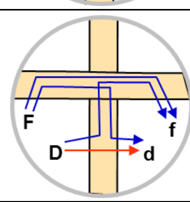
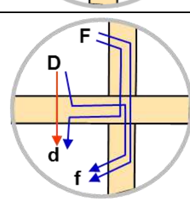
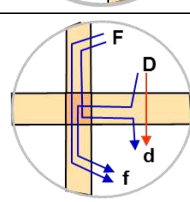
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 25 mm gypsum concrete bonded to subfloor
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented perpendicular to the wall
- Joists and subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction		Path	Flanking STC_{ij}
WS89-WF-LBC-32 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	58 61 60 57
WS89-WC-LBC-32 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	58 77 80 65
WI305-FW-LBC-32 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	66 70 90 71
WI305-FW-LBC-32R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	66 ≥74

(For the notes in this table please see the corresponding endnotes on page 166.)

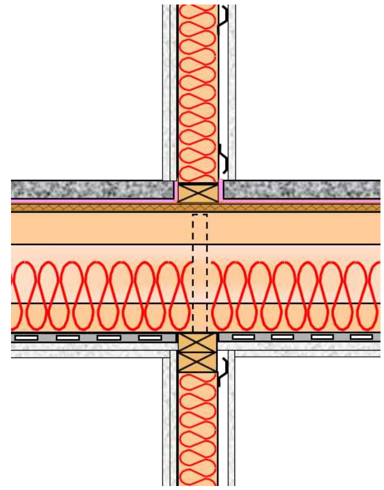
Table 3.2.LBC.5.1: Floor-Wall Transmission Paths

- As 3.2.LBC.1.1, but with 38 mm floating gypsum concrete

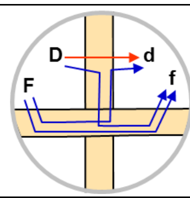
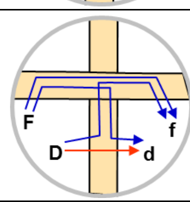
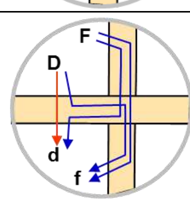
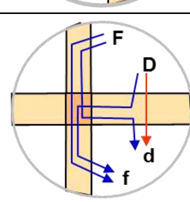
Loadbearing wall assembly:
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

Floor/ceiling assembly:
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 38 mm gypsum concrete on a resilient foam underlay
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:
- Floor joists oriented perpendicular to the wall
- Joists and subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-LBC-51 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	51 64 59 59
WS89-WC-LBC-51 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	51 77 78 65
WI305-FW-LBC-51 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	70 70 90 73
WI305-FW-LBC-51R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	70 ≥72

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.LBC.5.2: Floor-Wall Transmission Paths

- As 3.2.LBC.1.2, but with 38 mm floating gypsum concrete

Loadbearing wall assembly:

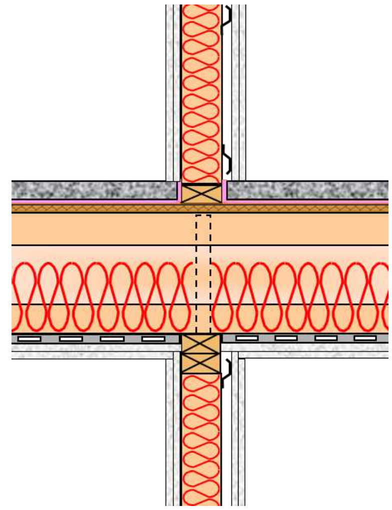
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 2 layers on resilient channels[4] on the other side

Floor/ceiling assembly:

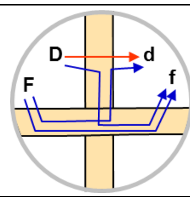
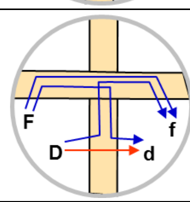
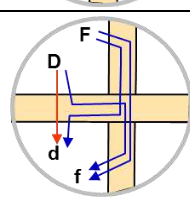
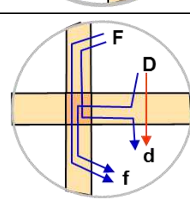
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 38 mm gypsum concrete on a resilient foam underlay
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented perpendicular to the wall
- Joists and subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-LBC-52 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	58 64 61 59
WS89-WC-LBC-52 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	58 77 80 65
WI305-FW-LBC-52 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	70 70 90 73
WI305-FW-LBC-52R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	70 ≥74

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.LBC.6.1: Floor-Wall Transmission Paths

- As 3.2.LBC.1.1, but with wood raft topping

Loadbearing wall assembly:

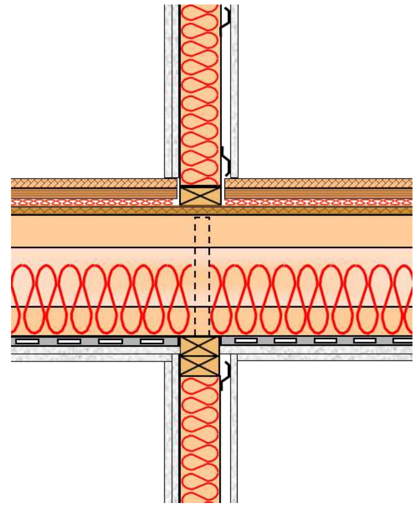
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

Floor/ceiling assembly:

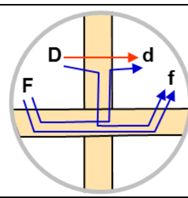
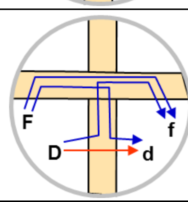
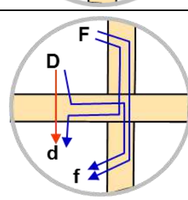
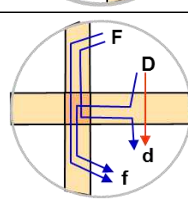
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- 19 mm plywood and 19 mm oriented strandboard (OSB) topping on 9 mm resilient interlayer
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented perpendicular to the wall
- Joists and subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction		Path	Flanking STC_{ij}
WS89-WF-LBC-62 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	51 53 54 54
WS89-WC-LBC-62 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	51 77 78 65
WI305-FW-LBC-62 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	65 70 90 72
WI305-FW-LBC-62R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	65 ≥72

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.LBC.6.2: Floor-Wall Transmission Paths

- As 3.2.LBC.1.2, but with wood raft topping

Loadbearing wall assembly:

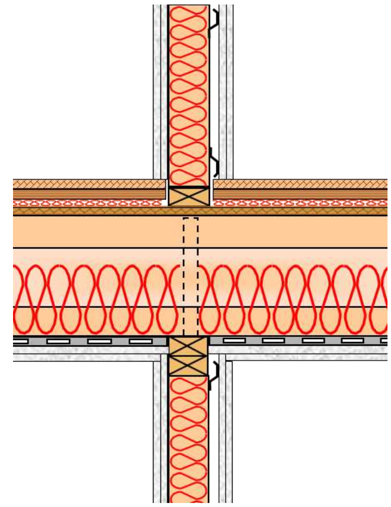
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 2 layers on resilient channels[4] on the other side

Floor/ceiling assembly:

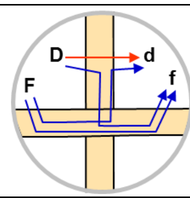
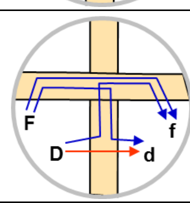
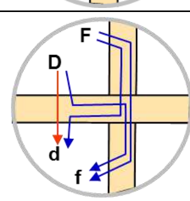
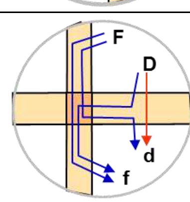
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- 19 mm plywood and 19 mm oriented strandboard (OSB) topping on 9 mm resilient interlayer
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented perpendicular to the wall
- Joists and subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-LBC-62 Wall-Floor Loadbearing Junction		Dd	58
		Ff	53
		Fd	56
		Df	54
WS89-WC-LBC-62 Wall-Ceiling Loadbearing Junction		Dd	58
		Ff	77
		Fd	80
		Df	65
WI305-FW-LBC-62 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd	65
		Ff	70
		Fd	90
		Df	72
WI305-FW-LBC-62R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd	65
		Ff+Fd+Df	≥74

(For the notes in this table please see the corresponding endnotes on page 166.)

Section 3.2 contains 42 tables, divided into three main groups based on junction details:

1. The first group includes wall/floor junctions where the wood floor joists are perpendicular to the loadbearing separating wall and both the floor joists and the subfloor are continuous across the junction. This set of junctions is designated as loadbearing continuous (LBC) and the table numbers begin with “3.2.LBC”.
2. The second group includes wall/floor junctions where the subfloor is continuous across the junction and the wood floor joists are perpendicular to the loadbearing separating wall but not continuous across the junction. This set of junctions is designated as loadbearing (LB) and the table numbers begin with “3.2.LB”.
3. The third group includes wall/floor junctions where the subfloor is continuous across the junction and the wood floor joists are parallel to the non-loadbearing separating wall. This set of junctions is designated as non-loadbearing (NLB) and the table numbers begin with “3.2.NLB”.

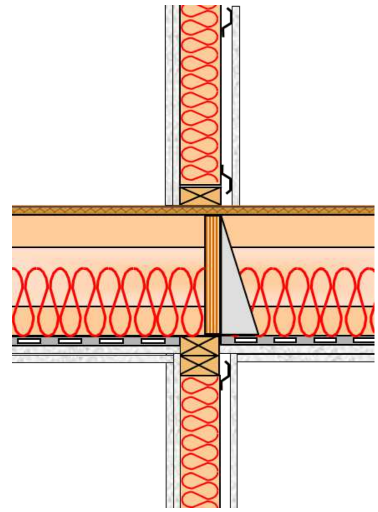
Within each group, the tables are numbered by two indices:

1. The second-last index indicates the floor surface, beginning with “1” for the case with a bare subfloor of OSB or plywood, and higher values for junctions where a topping is added over the subfloor.
2. The final index indicates a variant on the gypsum board surfaces of the ceilings and the walls above and below the floor/ceiling. The tables cycle through these cases for each topping case. These begin with cases where the ceiling has 2 layers of gypsum board supported on resilient channels, followed by cases where the ceiling has 1 layer of gypsum board (in the few cases where such ceilings were evaluated).

The following 13 pages present the group of junctions designated as LB.

Table 3.2.LB.1.1: Floor-Wall Transmission Paths

- As 3.2.LBC.1.1, but with joists discontinuous



Floor-Wall Junction: Vertical section, approximately to scale

Loadbearing wall assembly:

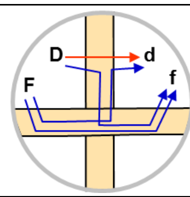
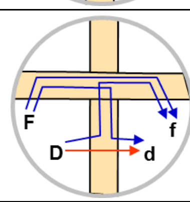
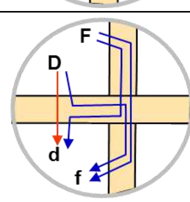
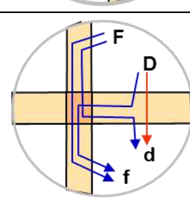
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

Floor/ceiling assembly:

- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- No topping over subfloor
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

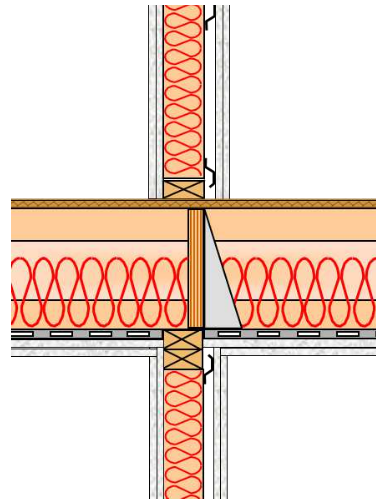
- Floor joists oriented perpendicular to the wall but not continuous across the junction. Second side supported from joist hangers fastened to the rimboard
- Subfloor continuous across the junction

Junction		Path	Flanking STC_{ij}
WS89-WF-LB-11 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	51 45 53 51
WS89-WC-LB-11 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	51 82 88 74
WI305-FW-LB-11 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	55 70 90 60
WI305-FW-LB-11R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	55 ≥72

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.LB.1.2: Floor-Wall Transmission Paths

- As 3.2.LB.1.1, but different wall assembly



Floor-Wall Junction: Vertical section, approximately to scale

Loadbearing wall assembly:

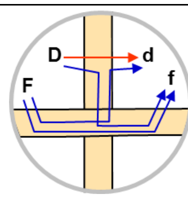
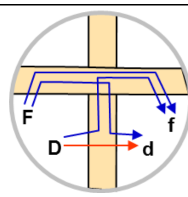
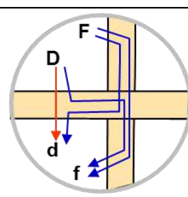
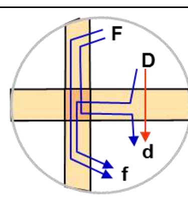
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 2 layers on resilient channels[4] on the other side

Floor/ceiling assembly:

- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- No topping over subfloor
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

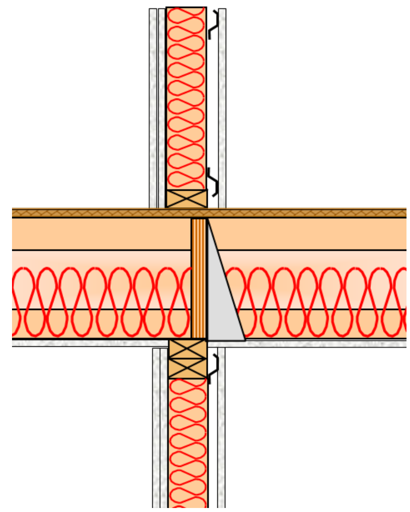
- Floor joists oriented perpendicular to the wall but not continuous across the junction. Second side supported from joist hangers fastened to the rimboard
- Subfloor continuous across the junction

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-LB-12 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	58 45 55 51
WS89-WC-LB-12 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	58 82 90 74
WI305-FW-LB-12 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	55 70 90 60
WI305-FW-LB-12R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	55 ≥74

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.LB.1.4: Floor-Wall Transmission Paths

- As 3.2.LB.1.1, but with different ceiling assembly



Floor-Wall Junction: Vertical section, approximately to scale

Loadbearing wall assembly:

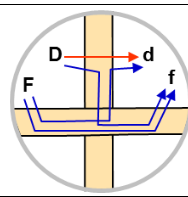
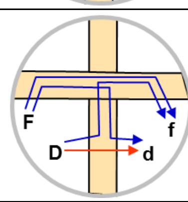
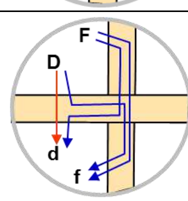
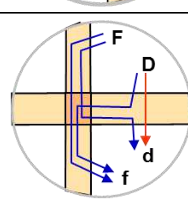
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

Floor/ceiling assembly:

- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- No topping over subfloor
- Ceiling of 1 layer of 13 mm fire-rated gypsum board[2] directly attached to floor joists

Junction:

- Floor joists oriented perpendicular to the wall but not continuous across the junction. Second side supported from joist hangers fastened to the rimboard
- Subfloor continuous across the junction

Junction		Path	Flanking STC_{ij}
WS89-WF-LB-14 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	51 45 53 51
WS89-WC-LB-14 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	51 79 65 65
WI305-FW-LB-14 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	29 70 58 60
WI305-FW-LB-14R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff Fd Df	29 70 61 62

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.LB.2.1: Floor-Wall Transmission Paths

- As 3.2.LB.1.1, but with 19 mm OSB floor topping

Loadbearing wall assembly:

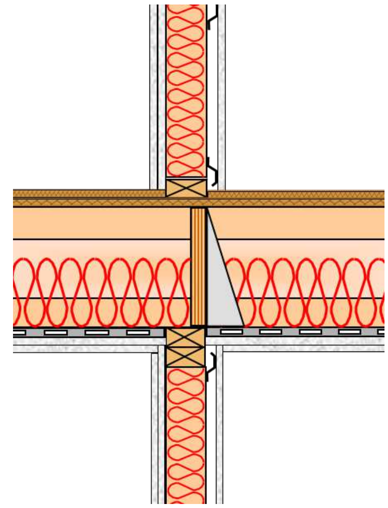
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

Floor/ceiling assembly:

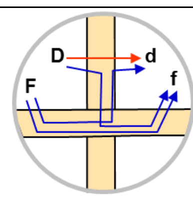
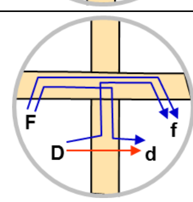
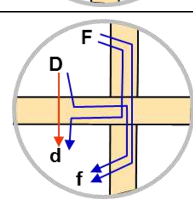
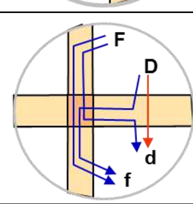
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 19 mm OSB mechanically fastened over subfloor
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented perpendicular to the wall but not continuous across the junction. Second side supported from joist hangers fastened to the rimboard
- Subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-LB-21 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	51 53 57 56
WS89-WC-LB-21 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	51 82 88 74
WI305-FW-LB-21 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	60 70 90 64
WI305-FW-LB-21R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	60 ≥72

(For the notes in this table please see the corresponding endnotes on page 166.)

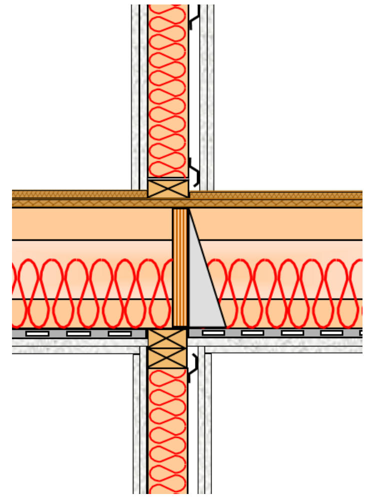
Table 3.2.LB.2.2: Floor-Wall Transmission Paths

- As 3.2.LB.2.1, but with different wall assembly

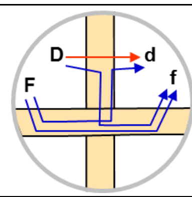
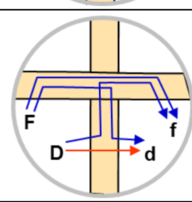
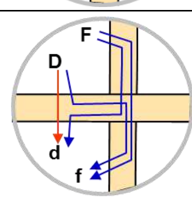
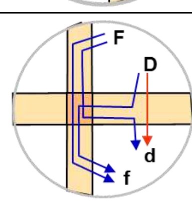
Loadbearing wall assembly:
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 2 layers on resilient channels[4] on the other side

Floor/ceiling assembly:
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 19 mm OSB mechanically fastened over subfloor
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:
- Floor joists oriented perpendicular to the wall but not continuous across the junction. Second side supported from joist hangers fastened to the rimboard
- Subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction		Path	Flanking STC_{ij}
WS89-WF-LB-22 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	58 53 59 56
WS89-WC-LB-22 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	58 82 90 74
WI305-FW-LB-22 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	60 70 90 64
WI305-FW-LB-22R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	60 ≥74

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.LB.3.1: Floor-Wall Transmission Paths

- As 3.2.LB.1.1, but with 25 mm gypsum concrete topping

Loadbearing wall assembly:

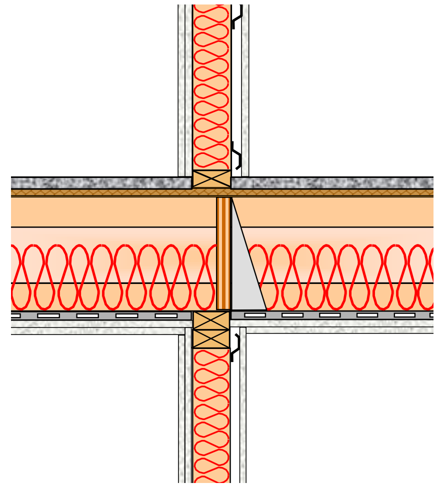
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

Floor/ceiling assembly:

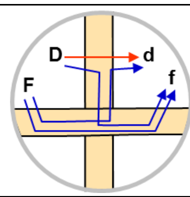
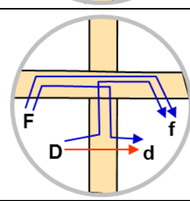
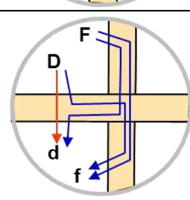
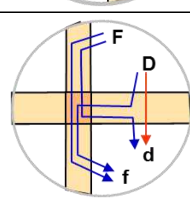
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 25 mm gypsum concrete bonded to subfloor
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented perpendicular to the wall but not continuous across the junction. Second side supported from joist hangers fastened to the rimboard
- Subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-LB-31 Wall-Floor Loadbearing Junction		Dd	51
		Ff	66
		Fd	65
		Df	64
WS89-WC-LB-31 Wall-Ceiling Loadbearing Junction		Dd	51
		Ff	82
		Fd	88
		Df	74
WI305-FW-LB-31 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd	66
		Ff	70
		Fd	90
		Df	71
WI305-FW-LB-31R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd	66
		Ff+Fd+Df	≥72

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.LB.3.2: Floor-Wall Transmission Paths

- As 3.2.LB.3.1, but with different wall assembly

Loadbearing wall assembly:

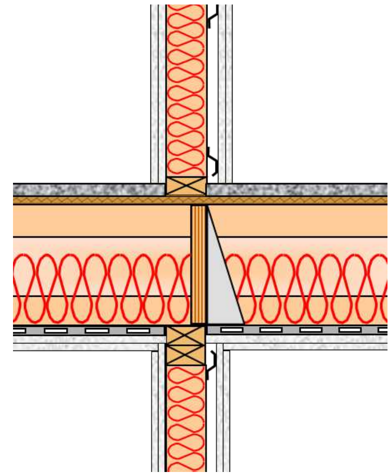
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 2 layers on resilient channels[4] on the other side

Floor/ceiling assembly:

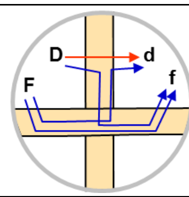
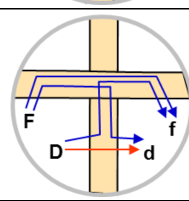
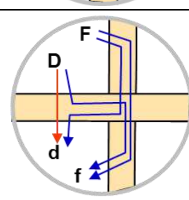
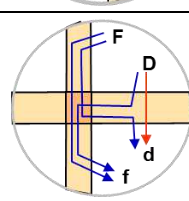
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 25 mm gypsum concrete bonded to subfloor
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented perpendicular to the wall but not continuous across the junction. Second side supported from joist hangers fastened to the rimboard
- Subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-LB-32 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	58 66 67 64
WS89-WC-LB-32 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	58 82 90 74
WI305-FW-LB-32 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	66 70 90 71
WI305-FW-LB-32R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	66 ≥74

(For the notes in this table please see the corresponding endnotes on page 166.)

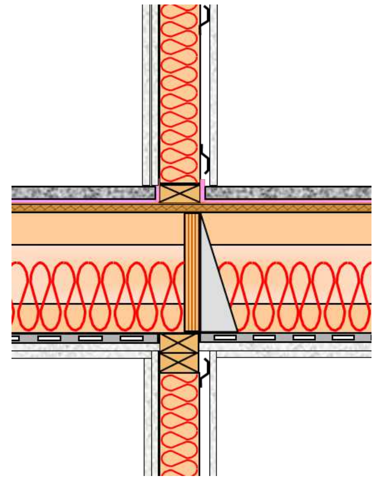
Table 3.2.LB.4.1: Floor-Wall Transmission Paths

- As 3.2.LB.1.1, but with 25 mm floating gypsum concrete

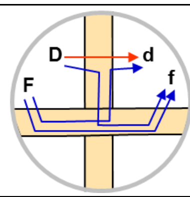
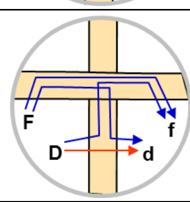
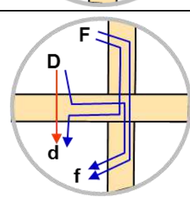
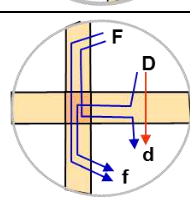
Loadbearing wall assembly:
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

Floor/ceiling assembly:
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 25 mm gypsum concrete on a resilient foam underlay
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:
- Floor joists oriented perpendicular to the wall but not continuous across the junction. Second side supported from joist hangers fastened to the rimboard
- Subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-LB-41 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	51 ≥66 ≥65 ≥64
WS89-WC-LB-41 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	51 82 88 74
WI305-FW-LB-41 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff+Fd+Df	68 ≥70
WI305-FW-LB-41R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	68 ≥72

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.LB.4.2: Floor-Wall Transmission Paths

- As 3.2.LB.4.1, but with different wall assembly

Loadbearing wall assembly:

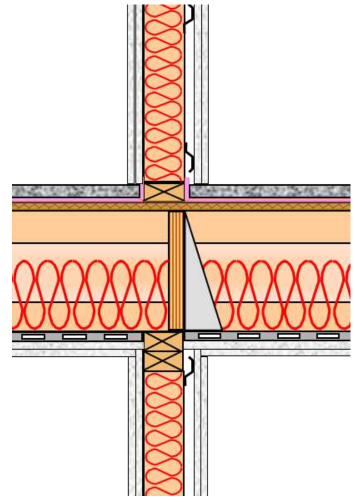
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 2 layers on resilient channels[4] on the other side

Floor/ceiling assembly:

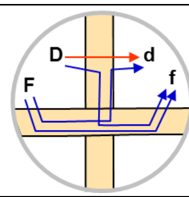
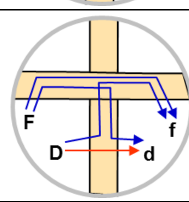
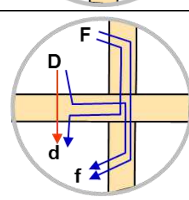
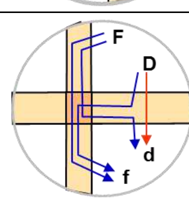
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 25 mm gypsum concrete on a resilient foam underlay
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented perpendicular to the wall but not continuous across the junction. Second side supported from joist hangers fastened to the rimboard
- Subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-LB-42 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	58 61 ≥59 56
WS89-WC-LB-42 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	58 82 90 74
WI305-FW-LB-42 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff+Fd+Df	68 ≥70
WI305-FW-LB-42R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	68 ≥74

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.LB.5.1: Floor-Wall Transmission Paths

- As 3.2.LB.1.1, but with 38 mm floating gypsum concrete

<u>**Loadbearing wall assembly:**</u>

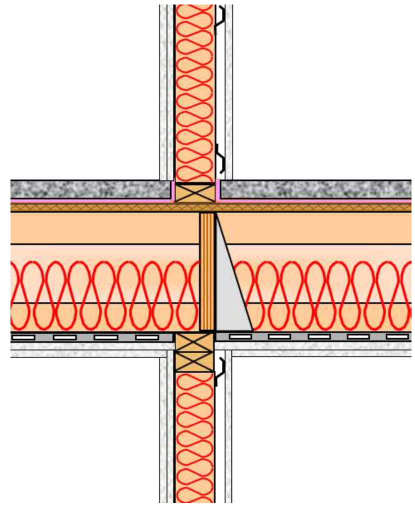
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

<u>**Floor/ceiling assembly:**</u>

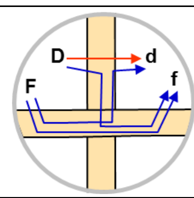
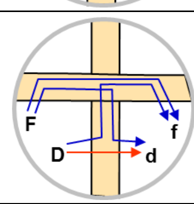
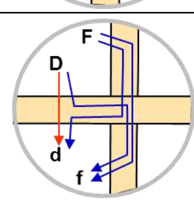
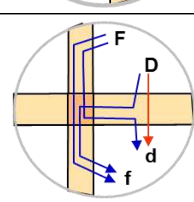
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 38 mm gypsum concrete on a resilient foam underlay
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

<u>**Junction:**</u>

- Floor joists oriented perpendicular to the wall but not continuous across the junction. Second side supported from joist hangers fastened to the rimboard
- Subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction		Path	Flanking STC_{ij}
WS89-WF-LB-51 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	51 72 66 65
WS89-WC-LB-51 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	51 82 88 74
WI305-FW-LB-51 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	70 70 90 73
WI305-FW-LB-51R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	70 ≥72

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.LB.5.2: Floor-Wall Transmission Paths

- As 3.2.LB.5.1, but with different wall assembly

Loadbearing wall assembly:

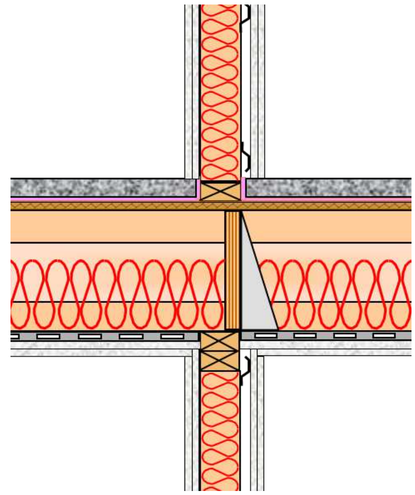
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 2 layers on resilient channels[4] on the other side

Floor/ceiling assembly:

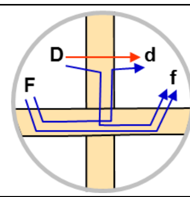
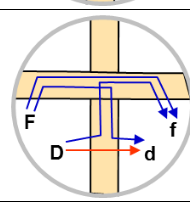
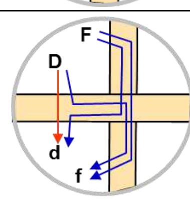
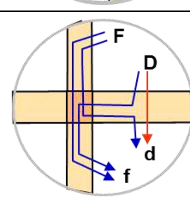
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 38 mm gypsum concrete on a resilient foam underlay
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented perpendicular to the wall but not continuous across the junction. Second side supported from joist hangers fastened to the rimboard
- Subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-LB-52 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	58 72 69 65
WS89-WC-LB-52 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	58 82 90 74
WI305-FW-LB-52 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	70 70 90 73
WI305-FW-LB-52R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	70 ≥74

(For the notes in this table please see the corresponding endnotes on page 166.)

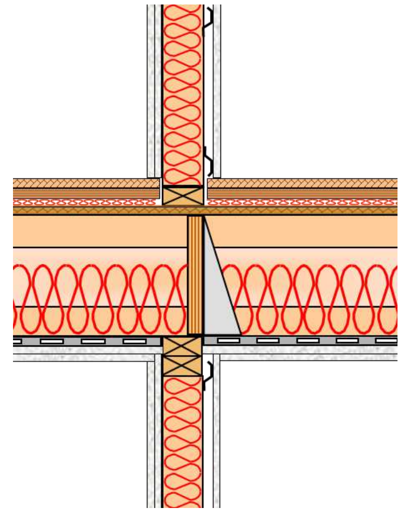
Table 3.2.LB.6.1: Floor-Wall Transmission Paths

- As 3.2.LB.1.1, but with wood raft topping

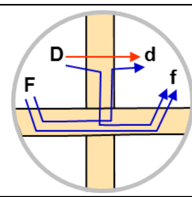
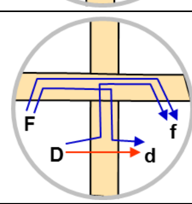
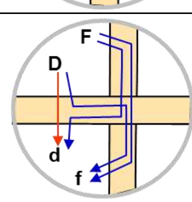
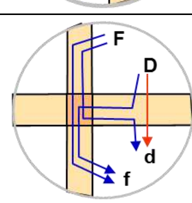
Loadbearing wall assembly:
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

Floor/ceiling assembly:
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- 19 mm plywood and 19 mm oriented strandboard (OSB) topping on 9 mm resilient interlayer on both sides
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:
- Floor joists oriented perpendicular to the wall but not continuous across the junction. Second side supported from joist hangers fastened to the rimboard
- Subfloor continuous across the junction



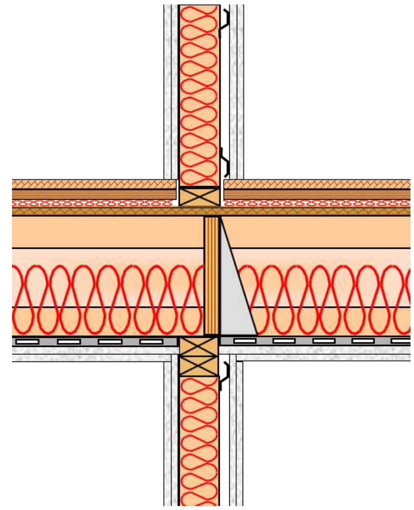
Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-LB-61 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	51 61 64 63
WS89-WC-LB-61 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	51 82 88 74
WI305-FW-LB-61 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	65 70 90 72
WI305-FW-LB-61R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	65 ≥72

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.LB.6.2: Floor-Wall Transmission Paths

- As 3.2.LB.6.1, but with different wall assembly



Floor-Wall Junction: Vertical section, approximately to scale

Loadbearing wall assembly:

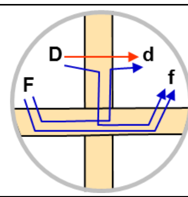
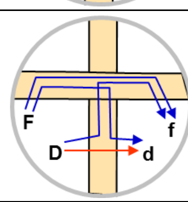
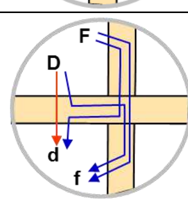
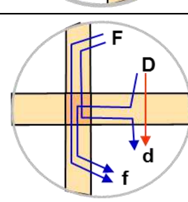
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 2 layers on resilient channels[4] on the other side

Floor/ceiling assembly:

- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- 19 mm plywood and 19 mm oriented strandboard (OSB) topping on 9 mm resilient interlayer on both sides
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented perpendicular to the wall but not continuous across the junction. Second side supported from joist hangers fastened to the rimboard
- Subfloor continuous across the junction

Junction		Path	Flanking STC_{ij}
WS89-WF-LB-62 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	58 61 66 63
WS89-WC-LB-62 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	58 82 90 74
WI305-FW-LB-62 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	65 70 90 72
WI305-FW-LB-62R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	65 ≥74

(For the notes in this table please see the corresponding endnotes on page 166.)

Section 3.2 contains 42 tables, divided into three main groups based on junction details:

1. The first group includes wall/floor junctions where the wood floor joists are perpendicular to the loadbearing separating wall and both the floor joists and the subfloor are continuous across the junction. This set of junctions is designated as loadbearing continuous (LBC) and the table numbers begin with “3.2.LBC”.
2. The second group includes wall/floor junctions where the subfloor is continuous across the junction and the wood floor joists are perpendicular to the loadbearing separating wall but not continuous across the junction. This set of junctions is designated as loadbearing (LB) and the table numbers begin with “3.2.LB”.
3. The third group includes wall/floor junctions where the subfloor is continuous across the junction and the wood floor joists are parallel to the non-loadbearing separating wall. This set of junctions is designated as non-loadbearing (NLB) and the table numbers begin with “3.2.NLB”.

Within each group, the tables are numbered by two indices:

1. The second-last index indicates the floor surface, beginning with “1” for the case with a bare subfloor of OSB or plywood, and higher values for junctions where a topping is added over the subfloor.
2. The final index indicates a variant on the gypsum board surfaces of the ceilings and the walls above and below the floor/ceiling. The tables cycle through these cases for each topping case. These begin with cases where the ceiling has 2 layers of gypsum board supported on resilient channels, followed by cases where the ceiling has 1 layer of gypsum board (in the few cases where such ceilings were evaluated).

The following 15 pages present the group of junctions designated as NLB.

Table 3.2.NLB.1.1: Floor-Wall Transmission Paths

Non-loadbearing wall assembly:

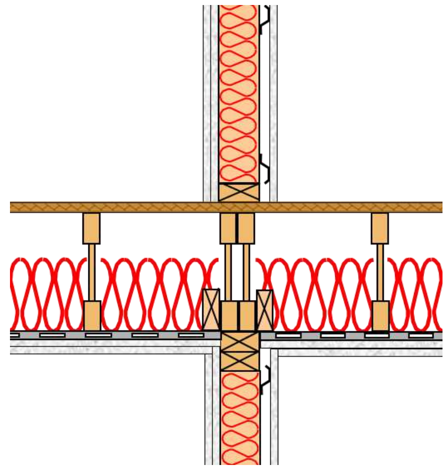
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

Floor/ceiling assembly:

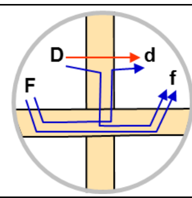
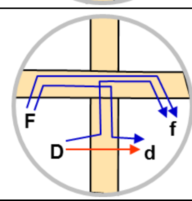
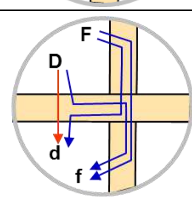
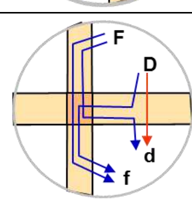
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- No topping over subfloor
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented parallel to wall, double joist at junction
- Subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-NLB-11 Wall-Floor Non-Loadbearing Junction		Dd	51
		Ff	48
		Fd	54
		Df	52
WS89-WC-NLB-11 Wall-Ceiling Non-Loadbearing Junction		Dd	51
		Ff	80
		Fd	85
		Df	70
WI305-FW-NLB-11 Floor-Wall Non-Loadbearing Junction (Wall gypsum board attached directly)		Dd	55
		Ff	70
		Fd	90
		Df	64
WI305-FW-NLB-11R Floor-Wall Non-Loadbearing Junction (Wall gypsum board on resilient channels)		Dd	55
		Ff+Fd+Df	≥64

(For the notes in this table please see the corresponding endnotes on page 166.)

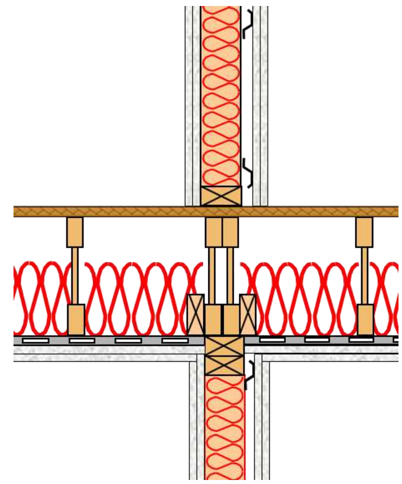
Table 3.2.NLB.1.2: Floor-Wall Transmission Paths

- As 3.2.NLB.1.1, but with different wall assembly

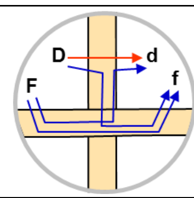
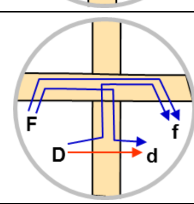
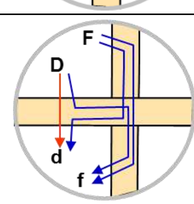
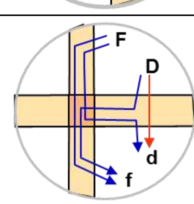
Non-loadbearing wall assembly:
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 2 layers on resilient channels[4] on the other side

Floor/ceiling assembly:
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- No topping over subfloor
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:
- Floor joists oriented parallel to wall, double joist at junction
- Subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-NLB-12 Wall-Floor Non-Loadbearing Junction		Dd	58
		Ff	48
		Fd	56
		Df	52
WS89-WC-NLB-12 Wall-Ceiling Non-Loadbearing Junction		Dd	58
		Ff	80
		Fd	87
		Df	70
WI305-FW-NLB-12 Floor-Wall Non-Loadbearing Junction (Wall gypsum board attached directly)		Dd	55
		Ff	70
		Fd	90
		Df	64
WI305-FW-NLB-12R Floor-Wall Non-Loadbearing Junction (Wall gypsum board on resilient channels)		Dd	55
		Ff+Fd+Df	≥64

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.NLB.1.4: Floor-Wall Transmission Paths

- As 3.2.NLB.1.1, but with different ceiling assembly

Non-loadbearing wall assembly:

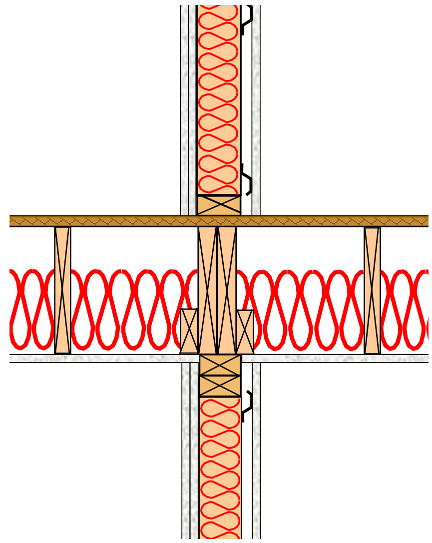
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

Floor/ceiling assembly:

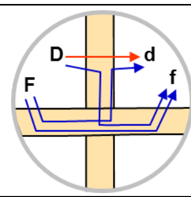
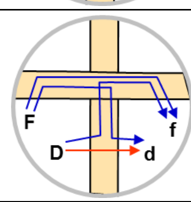
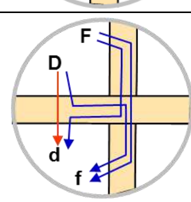
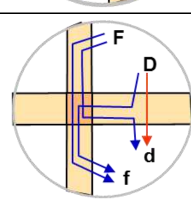
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- No topping over subfloor
- Ceiling of 1 layer of 13 mm fire-rated gypsum board[2] directly attached to floor joists

Junction:

- Floor joists oriented parallel to wall, double joist at junction
- Subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-NLB-14 Wall-Floor Non-Loadbearing Junction		Dd Ff Fd Df	51 48 54 52
WS89-WC-NLB-14 Wall-Ceiling Non-Loadbearing Junction		Dd Ff Fd Df	51 65 79 64
WI305-FW-NLB-14 Floor-Wall Non-Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	29
WI305-FW-NLB-14R Floor-Wall Non-Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff Fd Df	29

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.NLB.1.5: Floor-Wall Transmission Paths

- As 3.2.NLB.1.2, but with different ceiling assembly

Non-loadbearing wall assembly:

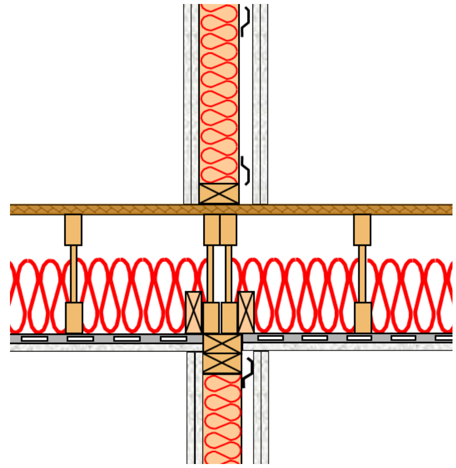
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 2 layers on resilient channels[4] on the other side

Floor/ceiling assembly:

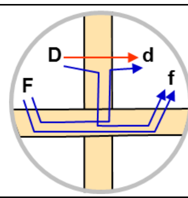
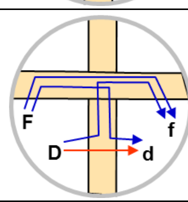
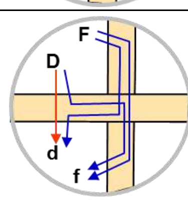
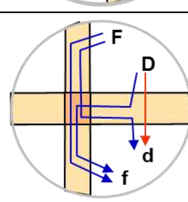
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- No topping over subfloor
- Ceiling of 1 layer of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented parallel to wall, double joist at junction
- Subfloor continuous across the junction



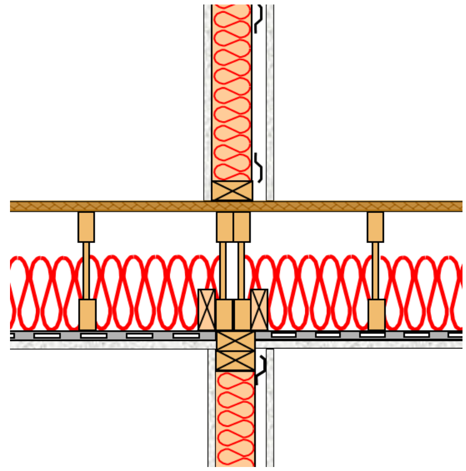
Floor-Wall Junction: Vertical section, approximately to scale

Junction		Path	Flanking STC_{ij}
WS89-WF-NLB-15 Wall-Floor Non-Loadbearing Junction		Dd Ff Fd Df	58 48 56 52
WS89-WC-NLB-15 Wall-Ceiling Non-Loadbearing Junction		Dd Ff Fd Df	58
WI305-FW-NLB-15 Floor-Wall Non-Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	51 70 90 64
WI305-FW-NLB-15R Floor-Wall Non-Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	51 ≥64

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.NLB.1.6: Floor-Wall Transmission Paths

- As 3.2.NLB.1.1, but different ceiling and different walls



Floor-Wall Junction: Vertical section, approximately to scale

Non-loadbearing wall assembly:

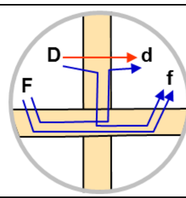
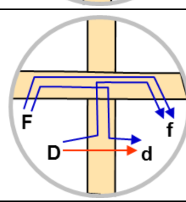
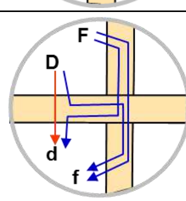
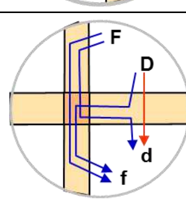
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 1 layer of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

Floor/ceiling assembly:

- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- No topping over subfloor
- Ceiling of 1 layer of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented parallel to wall, double joist at junction
- Subfloor continuous across the junction

Junction		Path	Flanking STC_{ij}
WS89-WF-NLB-16 Wall-Floor Non-Loadbearing Junction		Dd Ff Fd Df	45 48 54 ≥48
WS89-WC-NLB-16 Wall-Ceiling Non-Loadbearing Junction		Dd Ff Fd Df	45
WI305-FW-NLB-16 Floor-Wall Non-Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	51 64 90 61
WI305-FW-NLB-16R Floor-Wall Non-Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	51 ≥64

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.NLB.2.1: Floor-Wall Transmission Paths

- As 3.2.NLB.1.1, but with 19 mm OSB floor topping

Non-loadbearing wall assembly:

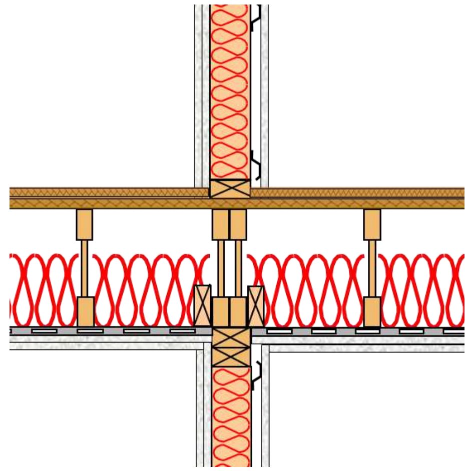
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

Floor/ceiling assembly:

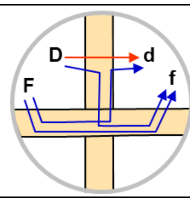
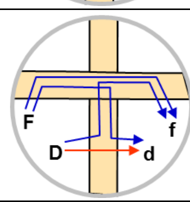
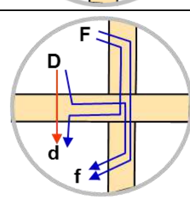
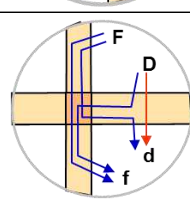
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 19 mm OSB mechanically fastened over subfloor
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented parallel to wall, double joist at junction
- Subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-NLB-21 Wall-Floor Non-Loadbearing Junction		Dd Ff Fd Df	51 59 59 57
WS89-WC-NLB-21 Wall-Ceiling Non-Loadbearing Junction		Dd Ff Fd Df	51 80 85 70
WI305-FW-NLB-21 Floor-Wall Non-Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff+Fd+Df	60 ≥64
WI305-FW-NLB-21R Floor-Wall Non-Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	60 ≥64

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.NLB.2.2: Floor-Wall Transmission Paths

- As 3.2.NLB.2.1, but with different wall assembly

Non-loadbearing wall assembly:

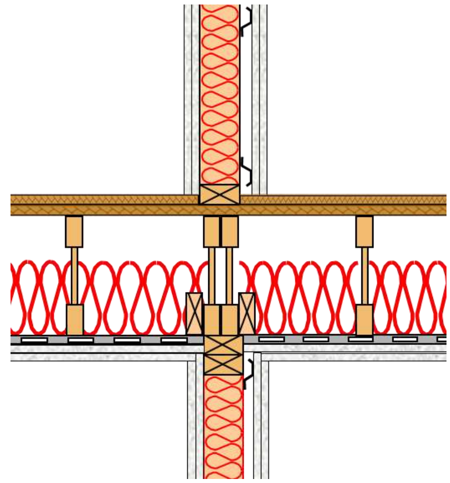
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 2 layers on resilient channels[4] on the other side

Floor/ceiling assembly:

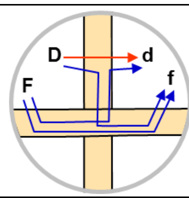
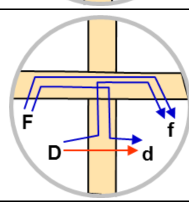
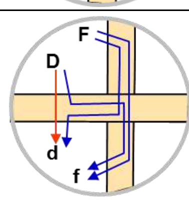
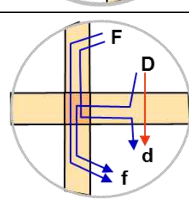
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 19 mm OSB mechanically fastened over subfloor
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented parallel to wall, double joist at junction
- Subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-NLB-22 Wall-Floor Non-Loadbearing Junction		Dd Ff Fd Df	58 59 62 57
WS89-WC-NLB-22 Wall-Ceiling Non-Loadbearing Junction		Dd Ff Fd Df	58 80 87 70
WI305-FW-NLB-22 Floor-Wall Non-Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff+Fd+Df	60 ≥64
WI305-FW-NLB-22R Floor-Wall Non-Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	60 ≥64

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.NLB.3.1: Floor-Wall Transmission Paths

- As 3.2.NLB.1.1, but with 25 mm gypsum concrete topping

Non-loadbearing wall assembly:

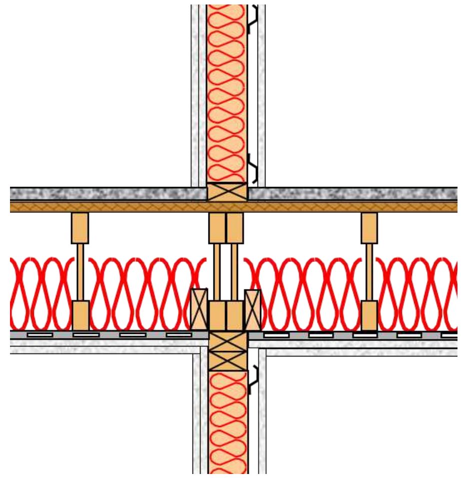
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

Floor/ceiling assembly:

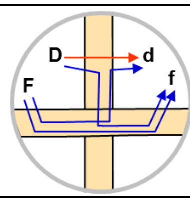
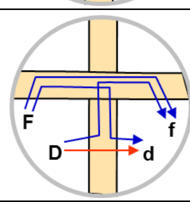
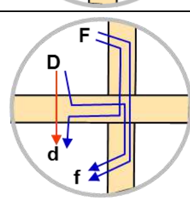
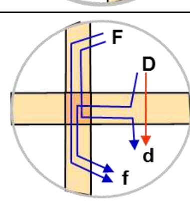
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 25 mm gypsum concrete bonded to subfloor
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented parallel to wall, double joist at junction
- Subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-NLB-31 Wall-Floor Non-Loadbearing Junction		Dd Ff Fd Df	51 61 61 59
WS89-WC-NLB-31 Wall-Ceiling Non-Loadbearing Junction		Dd Ff Fd Df	51 80 85 70
WI305-FW-NLB-31 Floor-Wall Non-Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff+Fd+Df	66 ≥64
WI305-FW-NLB-31R Floor-Wall Non-Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	66 ≥64

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.NLB.3.2: Floor-Wall Transmission Paths

- As 3.2.NLB.3.1, but with different wall assembly

Non-loadbearing wall assembly:

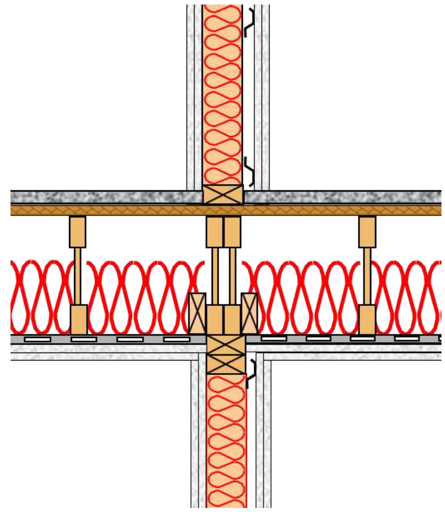
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 2 layers on resilient channels[4] on the other side

Floor/ceiling assembly:

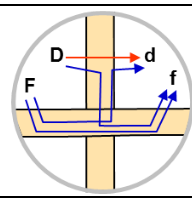
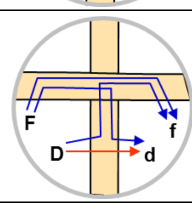
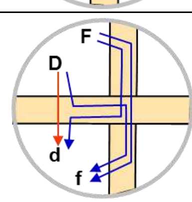
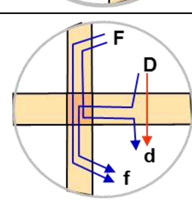
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 25 mm gypsum concrete bonded to subfloor
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented parallel to wall, double joist at junction
- Subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
WS89-WF-NLB-32 Wall-Floor Non-Loadbearing Junction		Dd Ff Fd Df	58 61 64 59
WS89-WC-NLB-32 Wall-Ceiling Non-Loadbearing Junction		Dd Ff Fd Df	58 80 87 70
WI305-FW-NLB-32 Floor-Wall Non-Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff+Fd+Df	66 ≥64
WI305-FW-NLB-32R Floor-Wall Non-Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	66 ≥64

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.NLB.4.1: Floor-Wall Transmission Paths

- As 3.2.NLB.1.1, but with 25 mm floating gypsum concrete

Non-loadbearing wall assembly:

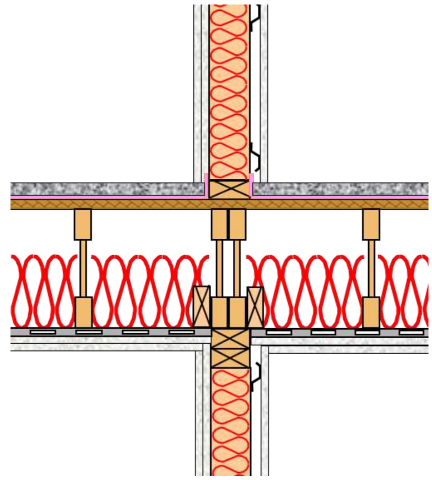
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

Floor/ceiling assembly:

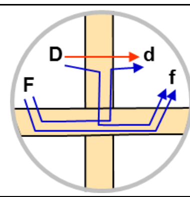
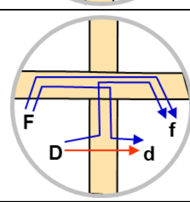
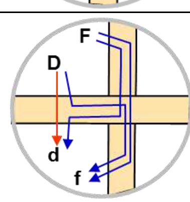
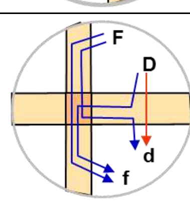
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 25 mm concrete on a resilient foam underlay
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented parallel to wall, double joist at junction
- Subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction		Path	Flanking STC_{ij}
WS89-WF-NLB-41 Wall-Floor Non-Loadbearing Junction		Dd Ff Fd Df	51
WS89-WC-NLB-41 Wall-Ceiling Non-Loadbearing Junction		Dd Ff Fd Df	51 80 85 70
WI305-FW-NLB-41 Floor-Wall Non-Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff+Fd+Df	68 ≥73
WI305-FW-NLB-41R Floor-Wall Non-Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	68 ≥73

(For the notes in this table please see the corresponding endnotes on page 166.)

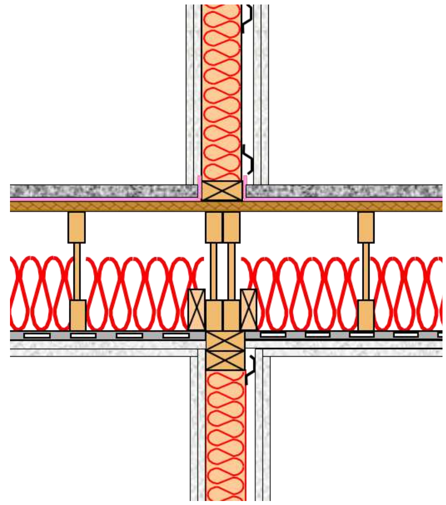
Table 3.2.NLB.4.2: Floor-Wall Transmission Paths

- As 3.2.NLB.4.1, but with different wall assembly

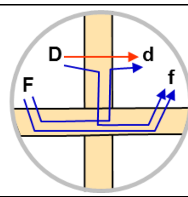
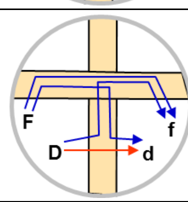
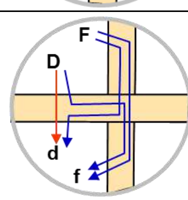
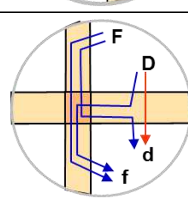
Non-loadbearing wall assembly:
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 2 layers on resilient channels[4] on the other side

Floor/ceiling assembly:
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 25 mm concrete on a resilient foam underlay
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:
- Floor joists oriented parallel to wall, double joist at junction
- Subfloor continuous across the junction



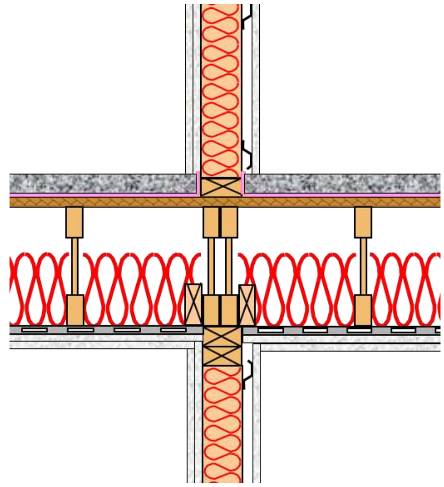
Floor-Wall Junction: Vertical section, approximately to scale

Junction		Path	Flanking STC_{ij}
WS89-WF-NLB-42 Wall-Floor Non-Loadbearing Junction		Dd Ff Fd Df	58
WS89-WC-NLB-42 Wall-Ceiling Non-Loadbearing Junction		Dd Ff Fd Df	58 80 87 70
WI305-FW-NLB-42 Floor-Wall Non-Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff+Fd+Df	68 ≥73
WI305-FW-NLB-42R Floor-Wall Non-Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	68 ≥73

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.NLB.5.1: Floor-Wall Transmission Paths

- As 3.2.NLB.1.1, but with 38 mm floating gypsum concrete

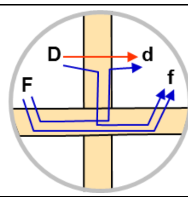
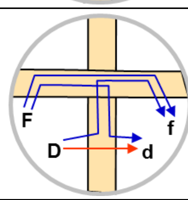
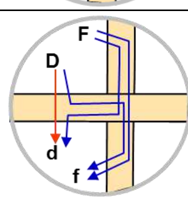
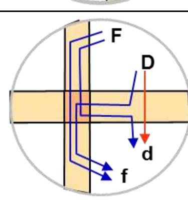


Floor-Wall Junction: Vertical section, approximately to scale

Non-loadbearing wall assembly:
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

Floor/ceiling assembly:
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 38 mm concrete on a resilient foam underlay
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:
- Floor joists oriented parallel to wall, double joist at junction
- Subfloor continuous across the junction

Junction		Path	Flanking STC_{ij}
WS89-WF-NLB-51 Wall-Floor Non-Loadbearing Junction		Dd Ff Fd Df	51 69 64 63
WS89-WC-NLB-51 Wall-Ceiling Non-Loadbearing Junction		Dd Ff Fd Df	51 80 85 70
WI305-FW-NLB-51 Floor-Wall Non-Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff+Fd+Df	70 ≥73
WI305-FW-NLB-51R Floor-Wall Non-Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	70 ≥73

(For the notes in this table please see the corresponding endnotes on page 166.)

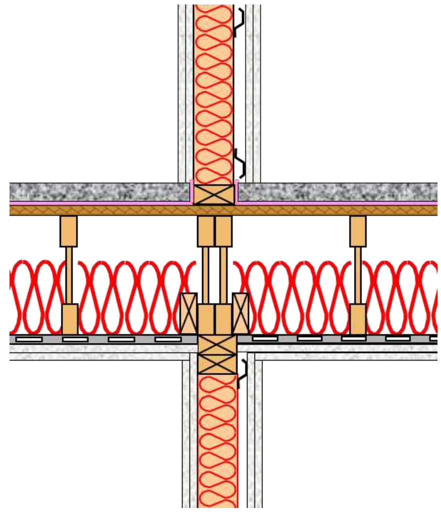
Table 3.2.NLB.5.2: Floor-Wall Transmission Paths

- As 3.2.NLB.5.1, but with different wall assembly

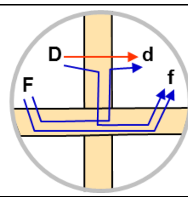
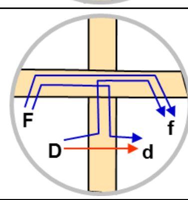
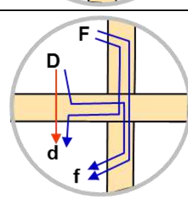
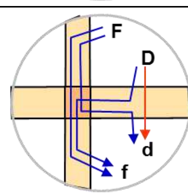
Non-loadbearing wall assembly:
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 2 layers on resilient channels[4] on the other side

Floor/ceiling assembly:
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 38 mm concrete on a resilient foam underlay
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:
- Floor joists oriented parallel to wall, double joist at junction
- Subfloor continuous across the junction



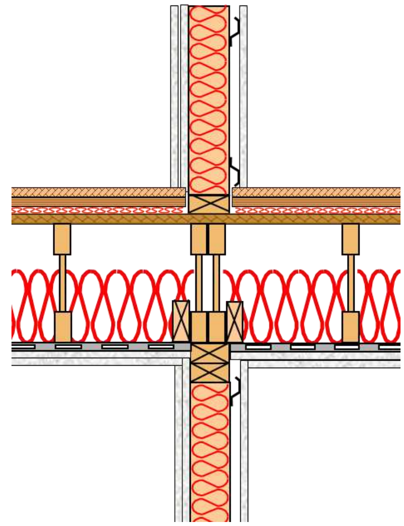
Floor-Wall Junction: Vertical section, approximately to scale

Junction	Path	Flanking STC_{ij}
WS89-WF-NLB-52 Wall-Floor Non-Loadbearing Junction 	Dd Ff Fd Df	58 69 66 63
WS89-WC-NLB-52 Wall-Ceiling Non-Loadbearing Junction 	Dd Ff Fd Df	58 80 87 70
WI305-FW-NLB-52 Floor-Wall Non-Loadbearing Junction (Wall gypsum board attached directly) 	Dd Ff+Fd+Df	70 ≥73
WI305-FW-NLB-52R Floor-Wall Non-Loadbearing Junction (Wall gypsum board on resilient channels) 	Dd Ff+Fd+Df	70 ≥73

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.2.NLB.6.1: Floor-Wall Transmission Paths

- As 3.2.NLB.1.1, but with wood raft topping



Floor-Wall Junction: Vertical section, approximately to scale

Non-loadbearing wall assembly:

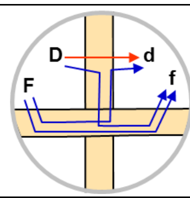
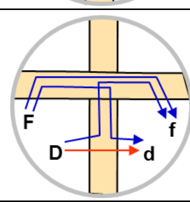
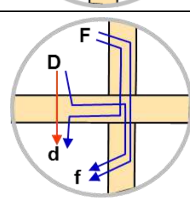
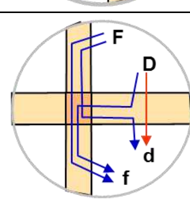
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 1 layer on resilient channels[4] on the other side

Floor/ceiling assembly:

- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- 19 mm plywood and 19 mm oriented strandboard (OSB) topping on 9 mm resilient interlayer on both sides
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented parallel to wall, double joist at junction
- Subfloor continuous across the junction

Junction		Path	Flanking STC_{ij}
WS89-WF-LB-61 Wall-Floor Non-Loadbearing Junction		Dd Ff Fd Df	51 65 65 63
WS89-WC-LB-61 Wall-Ceiling Non-Loadbearing Junction		Dd Ff Fd Df	51 80 85 70
WI305-FW-NLB-61 Floor-Wall Non-Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff+Fd+Df	65 ≥64
WI305-FW-NLB-61R Floor-Wall Non-Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	65 ≥64

(For the notes in this table please see the corresponding endnotes on page 166.)

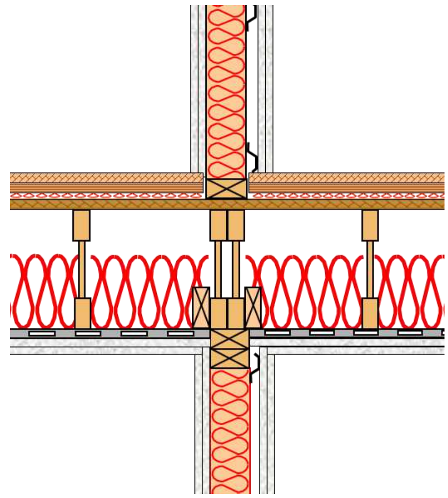
Table 3.2.NLB.6.2: Floor-Wall Transmission Paths

- As 3.2.NLB.6.1, but with different wall assembly

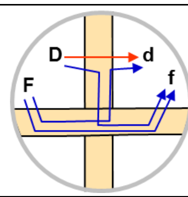
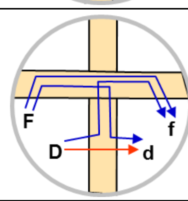
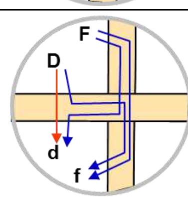
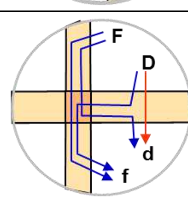
Non-loadbearing wall assembly:
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached on one side, 2 layers on resilient channels[4] on the other side

Floor/ceiling assembly:
- Floor with 305 mm wood I-joists spaced 400 mm o.c. with 150 mm sound-absorbing material[3] in the cavities
- 19 mm oriented strandboard (OSB) subfloor on both sides
- 19 mm plywood and 19 mm oriented strandboard (OSB) topping on 9 mm resilient interlayer on both sides
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:
- Floor joists oriented parallel to wall, double joist at junction
- Subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction		Path	Flanking STC_{ij}
WS89-WF-NLB-62 Wall-Floor Non-Loadbearing Junction		Dd Ff Fd Df	58 65 67 63
WS89-WC-NLB-62 Wall-Ceiling Non-Loadbearing Junction		Dd Ff Fd Df	58 80 87 70
WI305-FW-NLB-62 Floor-Wall Non-Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff+Fd+Df	65 ≥64
WI305-FW-NLB-62R Floor-Wall Non-Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff+Fd+Df	65 ≥64

(For the notes in this table please see the corresponding endnotes on page 166.)

3.3 Wall/Floor Junctions for Low-Rise Buildings – Wall Assemblies with 2 Rows of Wood Studs

The following tables present flanking sound transmission class values of specific flanking sound transmission paths that were determined from measurements following the procedures of ISO 10848 on a series of mock-up constructions. The facilities and test procedures are described in Section 3.1.

All of the wall assemblies in this Section were framed with two rows of 38 mm x 89 mm wood studs.

Each table of Flanking STC_{ij} results consists of several parts:

1. Brief generic descriptions of the wall and floor/ceiling assemblies and their junction
2. A drawing showing the main features of the assemblies and their junction. Wood floor joists are shown as I-joists because most of the experimental studies at NRC used I-joists. However, the Flanking STC_{ij} values reported in the tables also apply to solid-sawn wood joists of similar depth.
3. Each wall/floor junction can be viewed in several ways:
   - As the wall/floor junction between two side-by-side rooms above the floor
   - As the wall/ceiling junction between two side-by-side rooms below the ceiling
   - As the junction of a flanking wall with the floor/ceiling assembly separating two rooms that are one-above-the-other

   The different junction cases are presented in the rows underneath the descriptions, with stylized drawings to identify the paths and the Flanking STC values for each flanking path ij.
4. The naming for the wall/floor junctions follows a simple coding system in four segments:
   - The first segment of the code indicates that the junction consist of wood-framed assemblies and identifies the basic wall framing.
   - The second 2-letter segment of the code indicates the junction type (where the first letter identifies the separating assembly and the second letter identifies the flanking assemblies):
     - WF = wall/floor, WC = wall/ceiling, FW = floor/wall
   - The third segment of the code indicates a loadbearing or non-loadbearing junction.
   - The final segment of the code is the unique number for that junction detail and is determined by the assembly surfaces.

This Section contains 6 tables:

- 1 table for loadbearing walls (with floor joists perpendicular to the wall)
- 5 tables for non-loadbearing walls (with floor joists parallel to the wall)

Numbering of the tables has a consistent sequence of codes:

- The first 2 digits match the Section number.
- “LB” or “NLB” identifies the orientation of the floor joists.
- The final 3 values identify the fire block at the floor/wall junction, the surfaces of the floor/ceiling assemblies, and the surfaces of the wall, respectively.

NOTE:

The tables in this section present data for floors constructed with 38 mm x 235 mm solid-sawn wood joists spaced 400 mm o.c., with 150 mm sound-absorbing material in the cavities and with a 19 mm oriented strandboard (OSB) subfloor. Equal or higher Flanking STC values can be expected for floors constructed with wood I-joists of similar depth or deeper, for joists that are spaced 600 mm o.c., and for floors with a subfloor of plywood at least 19 mm thick. The flanking sound transmission for wood trusses has not been established yet; hence the Flanking STC values should not be used for floors with trusses.

Table 3.3.LB.1.1.1: Floor-Wall Transmission Paths

Loadbearing wall assembly:

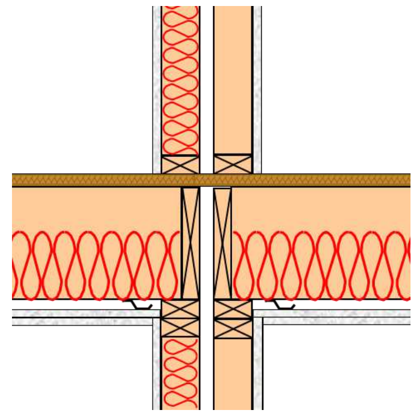
- Double row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 25 mm space between rows and with 90 mm-thick sound-absorbing material[3] filling the cavities between studs of one row
- 1 layer of 16 mm fire-rated gypsum board[2] directly attached on each side

Floor/ceiling assembly:

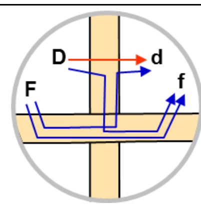
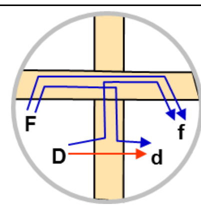
- Floor with 38 mm x 235 mm solid-sawn wood joists spaced 400 mm o.c. and oriented perpendicular to the wall, with 150 mm sound-absorbing material[3] in cavities between joists
- 19 mm oriented strandboard (OSB) subfloor on both sides
- No topping over subfloor
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented perpendicular to wall and supported on one row of studs
- Subfloor continuous across junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Path	Flanking STC_{ij}
DWS89-WF-LB-1-1-1 Wall-Floor Loadbearing Junction 	Dd	54
	Ff+Fd+Df	49
DWS89-WC-LB-1-1-1 Wall-Ceiling Loadbearing Junction 	Dd	54
	Ff+Fd+Df	≥68

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.3.NLB.1.1.1: Floor-Wall Transmission Paths

Non-loadbearing wall assembly:

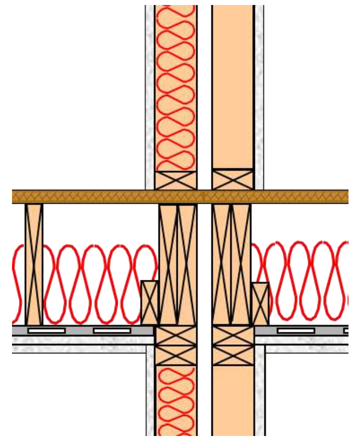
- Double row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 25 mm space between rows and with 90 mm-thick sound-absorbing material[3] filling the cavities between studs of one row
- 1 layer of 16 mm fire-rated gypsum board[2] directly attached on each side

Floor/ceiling assembly:

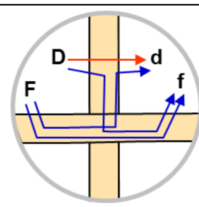
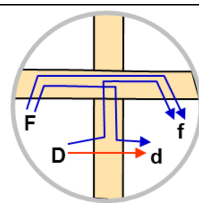
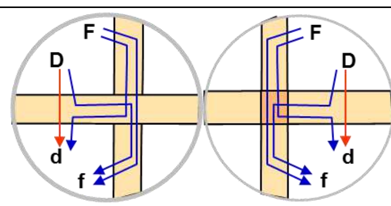
- Floor with 38 mm x 235 mm solid-sawn wood joists spaced 400 mm o.c. and oriented parallel to the wall, with 150 mm sound-absorbing material[3] in cavities between joists
- 19 mm oriented strandboard (OSB) subfloor on both sides
- No topping over subfloor
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented parallel to the wall
- Subfloor continuous across junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Path	Flanking STC_{ij}
DWS89-WF-NLB-1-1-1 Wall-Floor Non-Loadbearing Junction 	Dd	54
	Ff+Fd+Df	47
DWS89-WC-NLB-1-1-1 Wall-Ceiling Non-Loadbearing Junction 	Dd	54
	Ff+Fd+Df	≥62
DWS89-FW-NLB-1-1-1 Floor-Wall Non-Loadbearing Junction 	Dd	55
	Ff+Fd+Df	≥61

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.3.NLB.1.1.2: Floor-Wall Transmission Paths

Non-loadbearing wall assembly:

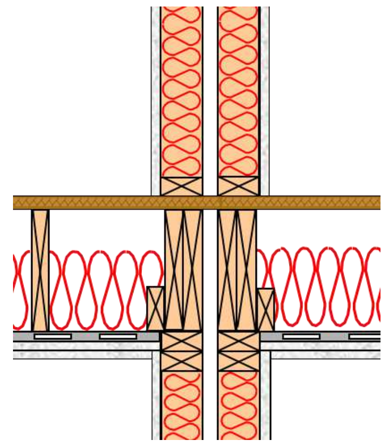
- Double row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 25 mm space between rows and with 90 mm-thick sound-absorbing material[3] filling the cavities between the studs on each side
- 1 layer of 16 mm fire-rated gypsum board[2] directly attached on each side

Floor/ceiling assembly:

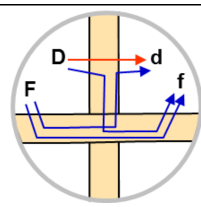
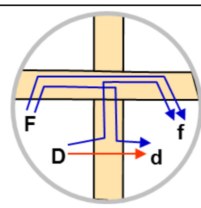
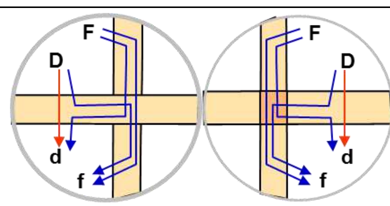
- Floor with 38 mm x 235 mm solid-sawn wood joists spaced 400 mm o.c. and oriented parallel to the wall, with 150 mm sound-absorbing material[3] in cavities between joists
- 19 mm oriented strandboard (OSB) subfloor on both sides
- No topping over subfloor
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented parallel to the wall
- Subfloor continuous across junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction		Path	Flanking STC_{ij}
DWS89-WF-NLB-1-1-2 Wall-Floor Non-Loadbearing Junction		Dd Ff+Fd+Df	57 47
DWS89-WC-NLB-1-1-2 Wall-Ceiling Non-Loadbearing Junction		Dd Ff+Fd+Df	57 ≥62
DWS89-FW-NLB-1-1-2 Floor-Wall Non-Loadbearing Junction		Dd Ff+Fd+Df	55 ≥61

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.3.NLB.1.2.2: Floor-Wall Transmission Paths

Non-loadbearing wall assembly:

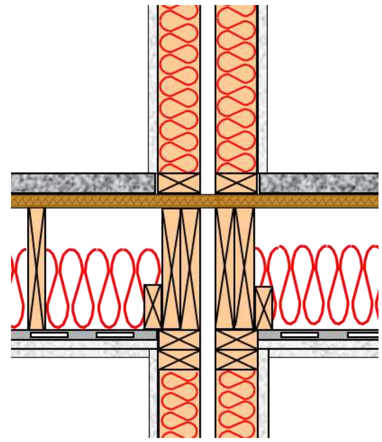
- Double row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 25 mm space between rows and with 90 mm-thick sound-absorbing material[3] filling the cavities between the studs on each side
- 1 layer of 16 mm fire-rated gypsum board[2] directly attached on each side

Floor/ceiling assembly:

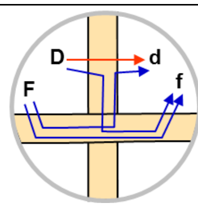
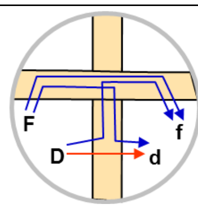
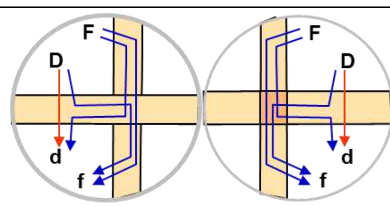
- Floor with 38 mm x 235 mm solid-sawn wood joists spaced 400 mm o.c. and oriented parallel to the wall, with 150 mm sound-absorbing material[3] in cavities between joists
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 38 mm concrete
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented parallel to the wall
- Subfloor continuous across junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
DWS89-WF-NLB-1-2-2 Wall-Floor Non-Loadbearing Junction		Dd Ff+Fd+Df	57 ≥65
DWS89-WC-NLB-1-2-2 Wall-Ceiling Non-Loadbearing Junction		Dd Ff+Fd+Df	57 ≥66
DWS89-FW-NLB-1-2-2 Floor-Wall Non-Loadbearing Junction		Dd Ff+Fd+Df	67 ≥73

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.3.NLB.2.1.2: Floor-Wall Transmission Paths

Non-loadbearing wall assembly:

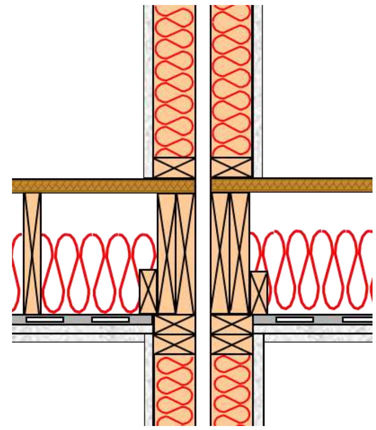
- Double row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 25 mm space between rows and with 90 mm-thick sound-absorbing material[3] filling the cavities between the studs on each side
- 1 layer of 16 mm fire-rated gypsum board[2] directly attached on each side

Floor/ceiling assembly:

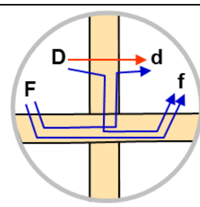
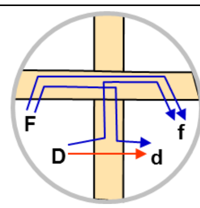
- Floor with 38 mm x 235 mm solid-sawn wood joists spaced 400 mm o.c. and oriented parallel to the wall, with 150 mm sound-absorbing material[3] in cavities between joists
- 19 mm oriented strandboard (OSB) subfloor on both sides
- No topping over subfloor
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented parallel to the wall
- Subfloor NOT continuous across junction (no solid fire block)

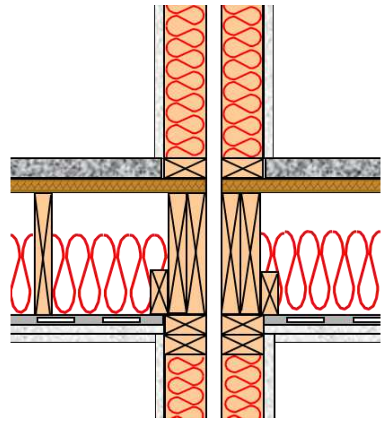


Floor-Wall Junction: Vertical section, approximately to scale

Junction	Path	Flanking STC_{ij}
DWS89-WF-NLB-2-1-2 Wall-Floor Non-Loadbearing Junction 	Dd	57
	Ff+Fd+Df	≥85
DWS89-WC-NLB-2-1-2 Wall-Ceiling Non-Loadbearing Junction 	Dd	57
	Ff+Fd+Df	≥85

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.3.NLB.2.2.2: Floor-Wall Transmission Paths



Floor-Wall Junction: Vertical section, approximately to scale

Non-loadbearing wall assembly:

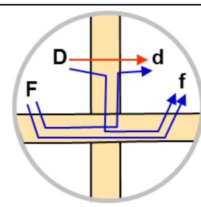
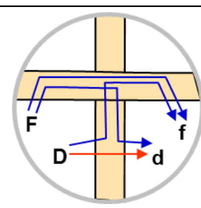
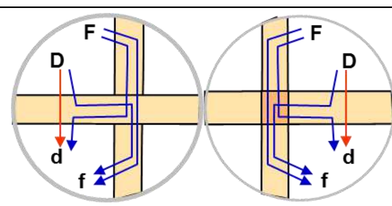
- Double row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 25 mm space between rows and with 90 mm-thick sound-absorbing material[3] filling the cavities between the studs on each side
- 1 layer of 16 mm fire-rated gypsum board[2] directly attached on each side

Floor/ceiling assembly:

- Floor with 38 mm x 235 mm solid-sawn wood joists spaced 400 mm o.c. and oriented parallel to the wall, with 150 mm sound-absorbing material[3] in cavities between joists
- 19 mm oriented strandboard (OSB) subfloor on both sides
- Topping of 38 mm concrete
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented parallel to the wall
- Subfloor NOT continuous across junction (no solid fire block)

Junction	Diagram	Path	Flanking STC_{ij}
DWS89-WF-NLB-2-2-2 Wall-Floor Non-Loadbearing Junction		Dd Ff+Fd+Df	57 ≥85
DWS89-WC-NLB-2-2-2 Wall-Ceiling Non-Loadbearing Junction		Dd Ff+Fd+Df	57 ≥85
DWS89-FW-NLB-2-2-2 Floor-Wall Non-Loadbearing Junction		Dd Ff+Fd+Df	67 ≥73

(For the notes in this table please see the corresponding endnotes on page 166.)

3.4 Wall/Wall Junctions for Low-Rise Buildings – Wall Assemblies with 1 Row of Wood Studs

The following tables present flanking sound transmission class values of specific flanking sound transmission paths that were determined from measurements following the procedures of ISO 10848 on a series of mock-up constructions. The facilities and test procedures are described in Section 3.1.

All of the wall assemblies in this Section were framed with one row of 38 mm x 89 mm wood studs.

Each table of Flanking STC results consists of several parts:

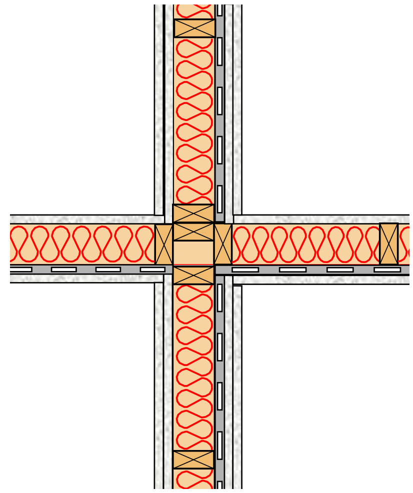
1. Brief generic descriptions of the intersecting wall assemblies and their junction
2. A drawing showing the main features of the assemblies and their junction
3. Each wall/wall junction can be viewed as a set of T-junctions. The T-Junction cases are presented in the rows underneath the descriptions, with stylized drawings to identify the paths and the Flanking STC values for each flanking path ij.
4. The naming for the wall/wall junctions follows a simple coding system in four segments:
    - The first segment of the code indicates that the junction consists of wood-framed assemblies and identifies the basic framing of the separating wall.
    - The second 2-letter segment of the code indicates the junction type: WW = wall/wall
    - The third segment of the code indicates the surfaces of the separating assembly.
    - The fourth segment of the code indicates the surfaces of the flanking assembly.

This Section contains 4 tables, for different configurations of wall/wall junctions.

Numbering of the tables has a consistent sequence of codes:

- The first 2 digits match the Section number.
- The final 2 values identify the surfaces for the separating and flanking walls, respectively.

Table 3.4.1.1: Wall-Wall Transmission Paths



Wall-Wall Junction for wood-framed construction, with flanking wall going left to right. Horizontal section viewed from above, approximately to scale.

Separating wall assembly:

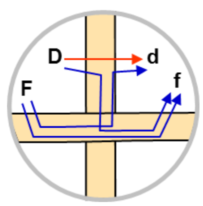
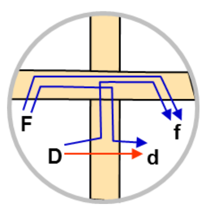
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] attached directly to the framing on one side and 2 layers on resilient channels[4] on the other side

Flanking wall assembly:

- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 1 layer of 16 mm fire-rated gypsum board[2] attached directly to the framing on one side and 1 layer on resilient channels[4] on the other side

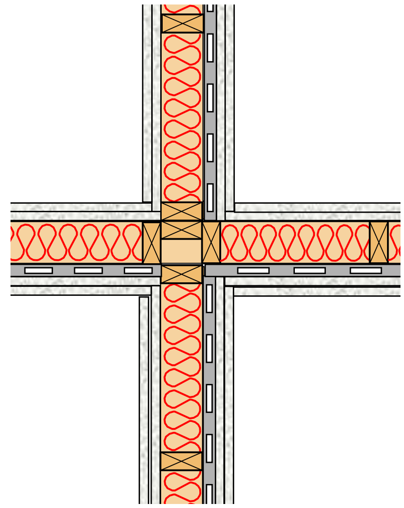
Junction:

- End studs of flanking walls fastened to the separating wall
- Bottom plate and double top plate of separating wall continuous across the junction, with extra studs to support the gypsum board edges or resilient channels next to the framing of the flanking wall

	Path	Flanking STC_{ij}
WS89-WW-1-1 Wall-Wall Junction 	Dd	58
	Ff	70
	Fd	71
	Df	68
WS89-WW-1-1R Wall-Wall Junction 	Dd	58
	Ff	90
	Fd	86
	Df	84

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.4.1.2: Wall-Wall Transmission Paths



Wall-Wall Junction for wood-framed construction, with flanking wall going left to right. Horizontal section viewed from above, approximately to scale.

Separating wall assembly:

- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] attached directly to the framing on one side and 2 layers on resilient channels[4] on the other side

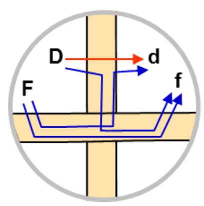
Flanking wall assembly:

- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] attached directly to the framing on one side and 2 layers on resilient channels[4] on the other side

Junction:

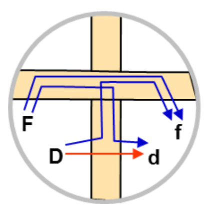
- End studs of flanking walls fastened to the separating wall
- Bottom plate and double top plate of separating wall continuous across the junction, with extra studs to support the gypsum board edges or resilient channels next to the framing of the flanking wall

WS89-WW-1-2
Wall-Wall Junction



Path	Flanking STC_{ij}
Dd	58
Ff	74
Fd	73
Df	70

WS89-WW-1-2R
Wall-Wall Junction



Path	Flanking STC_{ij}
Dd	58
Ff	90
Fd	90
Df	90

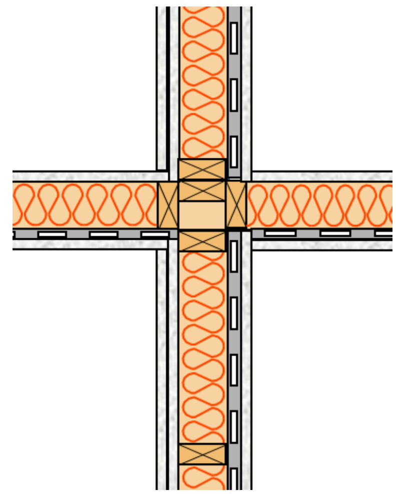
(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.4.2.1: Wall-Wall Transmission Paths

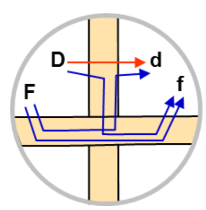
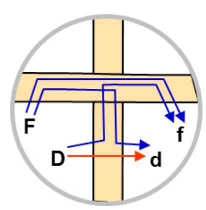
<u>**Separating wall assembly:**</u>
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] attached directly to the framing on one side and 1 layer on resilient channels[4] on the other side

<u>**Flanking wall assembly:**</u>
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 1 layer of 16 mm fire-rated gypsum board[2] attached directly to the framing on one side and 1 layer on resilient channels[4] on the other side

<u>**Junction:**</u>
- End studs of flanking walls fastened to the separating wall
- Bottom plate and double top plate of separating wall continuous across the junction, with extra studs to support the gypsum board edges or resilient channels next to the framing of the flanking wall



Wall-Wall Junction for wood-framed construction, with flanking wall going left to right. Horizontal section viewed from above, approximately to scale.

Assembly	Path	Flanking STC_{ij}
WS89-WW-2-1 Wall-Wall Junction 	Dd	51
	Ff	70
	Fd	69
	Df	68
WS89-WW-2-1R Wall-Wall Junction 	Dd	51
	Ff	90
	Fd	84
	Df	84

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.4.2.2: Wall-Wall Transmission Paths

Separating wall assembly:

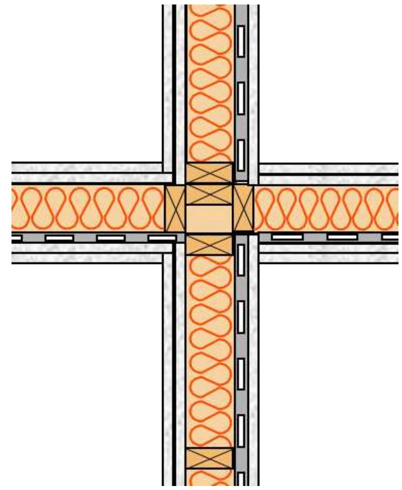
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] attached directly to the framing on one side and 1 layer on resilient channels[4] on the other side

Flanking wall assembly:

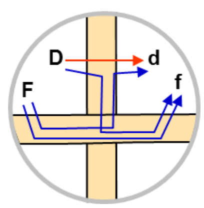
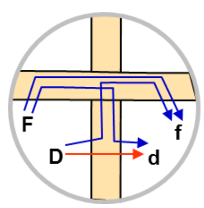
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] attached directly to the framing on one side and 2 layers on resilient channels[4] on the other side

Junction:

- End studs of flanking walls fastened to the separating wall
- Bottom plate and double top plate of separating wall continuous across the junction, with extra studs to support the gypsum board edges or resilient channels next to the framing of the flanking wall



Wall-Wall Junction for wood-framed construction, with flanking wall going left to right. Horizontal section viewed from above, approximately to scale.

Assembly	Diagram	Path	Flanking STC_{ij}
WS89-WW-2-2 Wall-Wall Junction		Dd Ff Fd Df	51 74 72 70
WS89-WW-2-2R Wall-Wall Junction		Dd Ff Fd Df	51 90 90 90

(For the notes in this table please see the corresponding endnotes on page 166.)

3.5 Wall/Wall Junctions for Low-Rise Buildings – Wall Assemblies with 2 Rows of Wood Studs

The following tables present flanking sound transmission class values of specific flanking sound transmission paths that were determined from measurements following the procedures of ISO 10848 on a series of mock-up constructions. The facilities and test procedures are described in Section 3.1.

The separating wall assemblies in this Section have two rows of 38 mm x 89 mm wood studs, and the flanking wall assemblies have one row of 38 mm x 89 mm wood studs.

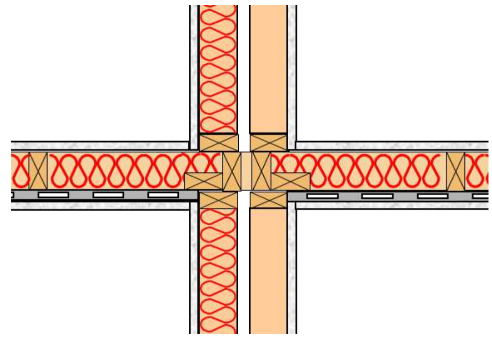
Each table of Flanking STC results consists of several parts:

5. Brief generic descriptions of the intersecting wall assemblies and their junction
6. A drawing showing the main features of the assemblies and their junction
7. Each wall/wall junction can be viewed as a set of T-junctions. The T-Junction cases are presented in the rows underneath the descriptions, with stylized drawings to identify the paths and the Flanking STC values for each flanking path ij.
8. The naming for the wall/wall junctions follows a simple coding system in four segments:
    - The first segment of the code indicates that the junction consists of wood-framed assemblies and identifies the basic framing of the separating wall.
    - The second 2-letter segment of the code indicates the junction type: WW = wall/wall
    - The third segment of the code indicates the surfaces of the separating assembly.
    - The fourth segment of the code indicates the surfaces of the flanking assembly.

This Section contains 2 tables, for different configurations of wall/wall junctions.

Numbering of the tables has a consistent sequence of codes:

- The first 2 digits match the Section number.
- The final 2 values identify the surfaces for the separating and flanking walls, respectively.

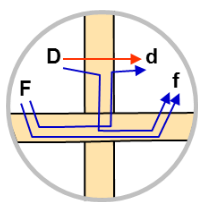
<table>
<tr><td colspan="2">Table 3.5.1.1: Wall-Wall Transmission Paths</td><td colspan="2" rowspan="2">
Wall-Wall Junction for wood-framed construction, with flanking wall going left to right. Horizontal section viewed from above, approximately to scale.</td></tr>
<tr><td colspan="2" rowspan="2"><u>Separating wall assembly:</u>

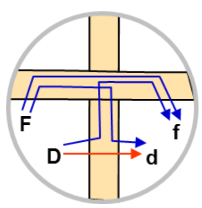
Double row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 25 mm space between rows and with 90 mm-thick sound-absorbing material[3] filling the cavities between the studs on one side
1 layer of 16 mm fire-rated gypsum board[2] directly attached on each side

<u>Flanking wall assembly:</u>

Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
Resilient metal channels[4] on one side spaced 600 mm o.c.
1 layer of 16 mm fire-rated gypsum board[2] attached directly to the framing on one side and on resilient channels[4] on the other side

<u>Junction:</u>

End studs of flanking walls fastened to loadbearing wall
Bottom plate and top plate of flanking wall continuous across the junction
</td></tr>
<tr><td>Path</td><td>Flanking STC_{ij}</td></tr>
<tr><td>DWS89-WW-1-1
Wall-Wall Junction
with DWS89
separating wall</td><td>
</td><td>Dd

Ff+Fd+Df</td><td>54</td></tr>
<tr><td>DWS89-WW-1-1R
Wall-Wall Junction
with DWS89
separating wall</td><td>
</td><td>Dd

Ff+Fd+Df</td><td>54

≥68</td></tr>
</table>

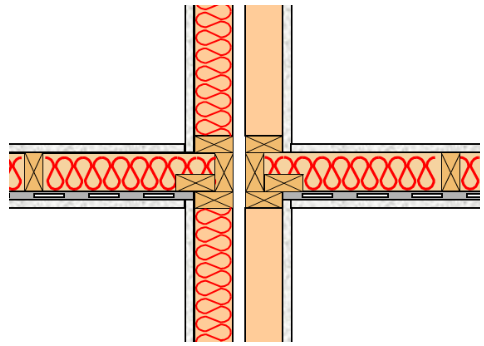
(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.5.2.1: Wall-Wall Transmission Paths

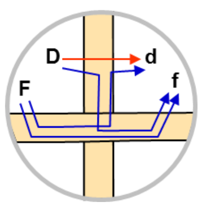
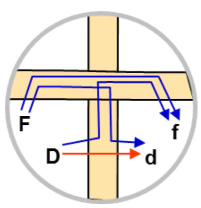
Separating wall assembly:
- Double row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 25 mm space between rows and with 90 mm-thick sound-absorbing material[3] filling the cavities between the studs on one side
- 1 layer of 16 mm fire-rated gypsum board[2] directly attached on each side

Flanking wall assembly:
- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities
- Resilient metal channels[4] on one side spaced 600 mm o.c.
- 1 layer of 16 mm fire-rated gypsum board[2] attached directly to the framing on one side and on resilient channels[4] on the other side

Junction:
- End studs of flanking walls fastened to loadbearing wall
- Bottom plate and top plate of flanking wall NOT continuous across the junction (no structural connection)



Wall-Wall Junction for wood-framed construction, with flanking wall going left to right. Horizontal section viewed from above, approximately to scale.

Junction		Path	Flanking STC_{ij}
DWS89-WW-2-1 Wall-Wall Junction with DWS89 separating wall		Dd	54
		Ff+Fd+Df	≥85
DWS89-WW-2-1R Wall-Wall Junction with DWS89 separating wall		Dd	54
		Ff+Fd+Df	≥85

(For the notes in this table please see the corresponding endnotes on page 166.)

3.6 Wall/Floor Junctions for Mid-Rise Buildings – Wall Assemblies with Staggered Wood Studs

The following tables present flanking sound transmission class values of specific flanking sound transmission paths that were determined from measurements following the procedures of ISO 10848 on a series of mock-up constructions. The facilities and test procedures are described in Section 3.1.

All of the wall assemblies in this Section were framed with two staggered rows of single or triple 38 mm x 89 mm wood studs fastened to common 38 mm x 140 mm bottom plates and top plates.

Each table of Flanking STC_{ij} results consists of several parts:

1. Brief generic descriptions of the wall and floor/ceiling assemblies and their junction
2. A drawing showing the main features of the assemblies and their junction. Wood floor joists are shown as I-joists because most of the experimental studies at NRC used I-joists. However, the Flanking STC_{ij} values reported in the tables also apply to solid-sawn wood joists of similar depth.
3. Each wall/floor junction can be viewed in several ways:
   - As the wall/floor junction between two side-by-side rooms above the floor
   - As the wall/ceiling junction between two side-by-side rooms below the ceiling
   - As the junction of a flanking wall with the floor/ceiling assembly separating two rooms that are one-above-the-other

   The different junction cases are presented in the rows underneath the descriptions, with stylized drawings to identify the paths and the Flanking STC values for each flanking path ij.
4. The naming for the wall/floor junctions follows a simple coding system in four segments:
   - The first segment of the code indicates that the junction consist of wood-framed assemblies and identifies the basic wall framing.
   - The second 2-letter segment of the code indicates the junction type (where the first letter identifies the separating assembly and the second letter identifies the flanking assemblies):
     - WF = wall/floor, WC = wall/ceiling, FW = floor/wall
   - The third segment of the code indicates a loadbearing or non-loadbearing junction.
   - The final segment of the code is the unique number for that junction detail and is determined by the assembly surfaces.

This Section contains 12 tables:

- 6 tables for loadbearing walls (with floor joists perpendicular to the wall)
- 6 tables for non-loadbearing walls (with floor joists parallel to the wall)

Numbering of the tables has a consistent sequence of codes:

- The first 2 digits match the Section number.
- “LB” or “NLB” identifies the orientation of the floor joists.
- The final 2 values identify the surfaces of the floor and the surfaces of the wall, respectively.

The Flanking STC values presented in this Section were adapted from the data presented in the NRC Report A1-100035-02.1 [16.14] by normalizing the Flanking STC values to the dimensions of the Standard Scenario described in Section 1.2 of this Report. In addition, averaging of comparable cases and conservative lower-limit values were employed to fill gaps where test data were not available:

- For cases where wall surfaces were mounted on resilient channels, a subset of the flanking specimens were tested with 2 layers of 13 mm fire-rated gypsum board while others had one layer of 16 mm fire-rated gypsum board; neither set included all the pertinent configurations. The tables in this Section present the data for walls with 2 layers of 13 mm fire-rated gypsum board. For additional cases with 1 layer of 16 mm fire-rated gypsum board, please see [16.14].
- None of the wall/floor paths were evaluated with gypsum board surfaces on the wall above the floor mounted on resilient channels. In the tables in this Section, the Flanking STC values for Fd or Df paths with gypsum board on resilient channels were assumed to be greater than the corresponding measured values with 2 layers of 13 mm fire-rated gypsum board fastened directly to the framing (which is consistently observed in measured cases).
- For vertical wall/wall paths with both gypsum board surfaces on resilient channels, the Flanking STC values were taken as greater than the measured result with one of the wall surfaces on resilient channels and the other directly fastened to the framing.
- The effect of floor toppings was evaluated with a topping added on one of the four floor surfaces in the flanking sound transmission facility, and only a subset of wall surfaces was evaluated with each topping. The Flanking STC value for the floor-floor path Ff with topping on both sides of a separating wall was assumed to be greater than the measured result with topping on one side only (which has been consistently demonstrated in measurements). For paths that combined the floor surface and a wall surface, missing cases were assigned lower limits using the same procedures outlined above.

Measured values were available for a majority of the flanking paths in the tables in Sections 3.6 and 3.7. The procedures described above provided conservative values for Flanking STC values for the remaining configurations in those tables, to permit evaluation for a wide range of designs.

NOTE:

The tables in this section present data for floors constructed with 305 mm wood I-joists spaced 400 mm o.c., with 150 mm sound-absorbing material in the cavities and with a 16 mm oriented strandboard (OSB) subfloor. Equal or higher Flanking STC values can be expected for floors constructed with solid-sawn wood joists of similar depth or deeper, for joists that are spaced 600 mm o.c., and for floors with a subfloor of plywood at least 16 mm thick. The flanking sound transmission for wood trusses has not been established yet; hence the Flanking STC values should not be used for floors with trusses.

Table 3.6.LB.1.1: Floor-Wall Transmission Paths

Loadbearing wall assembly:

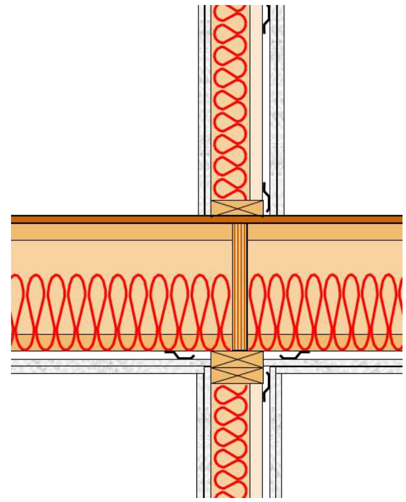
- Two rows of staggered triple 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side (MR-SWS-12 in Table 2.4.2)
- 2 layers of 13 mm fire-rated gypsum board[2] on each side, one side directly attached, other side on resilient channels[4] spaced 600 mm o.c.

Floor/ceiling assembly:

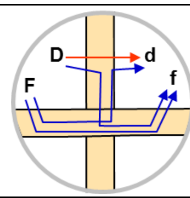
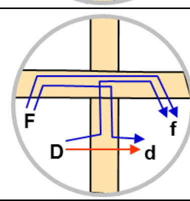
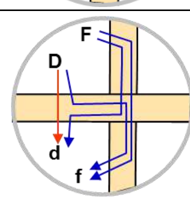
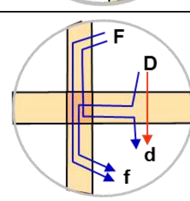
- Floor with 305 mm wood I-joists spaced 400 mm o.c., with 150 mm sound-absorbing material[3] in the cavities
- 16 mm oriented strandboard (OSB) subfloor on each side
- Ceilings with 2 layers of 13 mm fire-rated gypsum board on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented perpendicular to separating wall but not continuous across junction, attached to rimboard at junction
- Subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction		Path	Flanking STC_{ij}
SWS89-WF-LB-1-1 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	55 52 ≥58 58
SWS89-WC-LB-1-1 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	55 80 77 67
WI305-FW-LB-1-1 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	53 ≥75 ≥70 ≥60
WI305-FW-LB-1-1R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff Fd Df	53 ≥75 ≥70 ≥60

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.6.LB.1.2: Floor-Wall Transmission Paths

Loadbearing wall assembly:

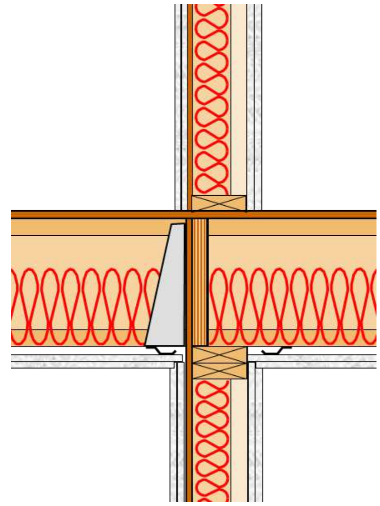
- Two rows of staggered triple 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side
- 2 layers of 13 mm fire-rated gypsum board[2], one side fastened over 16 mm plywood, other side fastened directly to framing

Floor/ceiling assembly:

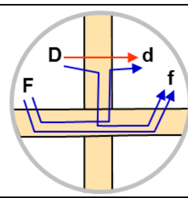
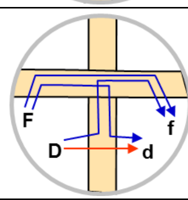
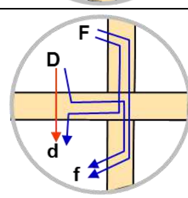
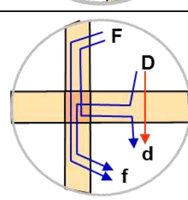
- Floor with 305 mm wood I-joists spaced 400 mm o.c., with 150 mm sound-absorbing material[3] in the cavities
- 16 mm oriented strandboard (OSB) subfloor on each side
- Ceilings with 2 layers of 13 mm fire-rated gypsum board on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented perpendicular to separating wall but not continuous across junction, attached to rimboard or joist hangers
- Subfloor continuous across the junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
SWS89-WF-LB-1-2 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	51 52 58 54
SWS89-WC-LB-1-2 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	51 80 67 69
WI305-FW-LB-1-2SH Floor-Wall Loadbearing Junction (Wall gypsum board over plywood shear membrane)		Dd Ff Fd Df	53 ≥75 ≥70 ≥60
WI305-FW-LB-1-2 Floor-Wall Loadbearing Junction (Wall gypsum board same as case 1-1)		Dd Ff Fd Df	53 ≥75 ≥70 ≥60

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.6.LB.2.1: Floor-Wall Transmission Paths

Loadbearing wall assembly:

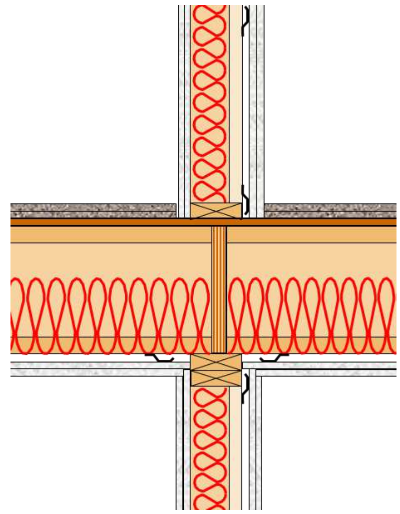
- Two rows of staggered triple 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side (MR-SWS-12 in Table 2.4.2)
- 2 layers of 13 mm fire-rated gypsum board[2] on each side, one side directly attached, other side on resilient channels[4] spaced 600 mm o.c.

Floor/ceiling assembly:

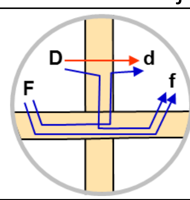
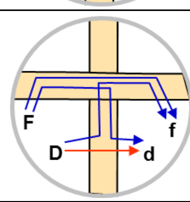
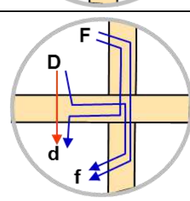
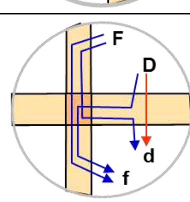
- Floor with 305 mm wood I-joists spaced 400 mm o.c., with 150 mm sound-absorbing material[3] in the cavities
- 16 mm oriented strandboard (OSB) subfloor on each side
- Floor topping of 2 layers of 13 mm fibre-reinforced cement board screwed to OSB subfloor
- Ceilings with 2 layers of 13 mm fire-rated gypsum board on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented perpendicular to separating wall but not continuous across junction, attached to rimboard at junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
SWS89-WF-LB-2-1 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	55 ≥63 ≥65 ≥65
SWS89-WC-LB-2-1 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	55 80 77 67
WI305-FW-LB-2-1 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	57 ≥75 ≥70 ≥65
WI305-FW-LB-2-1R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff Fd Df	57 ≥75 ≥70 ≥65

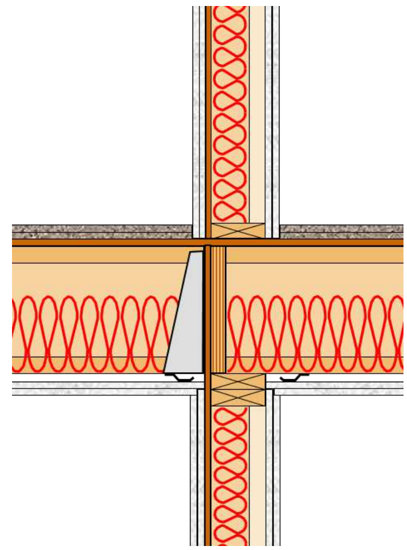
(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.6.LB.2.2: Floor-Wall Transmission Paths

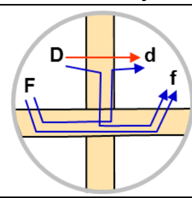
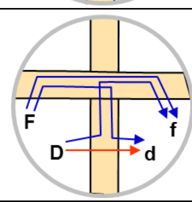
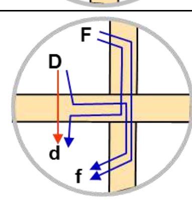
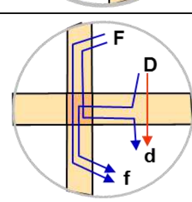
Loadbearing wall assembly:
- Two rows of staggered triple 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side
- 2 layers of 13 mm fire-rated gypsum board[2], one side fastened over 16 mm plywood, other side fastened directly to framing

Floor/ceiling assembly:
- Floor with 305 mm wood I-joists spaced 400 mm o.c., with 150 mm sound-absorbing material[3] in the cavities
- 16 mm oriented strandboard (OSB) subfloor on each side
- Floor topping of 2 layers of 13 mm fibre-reinforced cement board screwed to OSB subfloor
- Ceilings with 2 layers of 13 mm fire-rated gypsum board on resilient channels[4] spaced 400 mm o.c.

Junction:
- Floor joists oriented perpendicular to separating wall but not continuous across junction, attached to rimboard or joist hangers



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
SWS89-WF-LB-2-2 Wall-Floor Loadbearing Junction		Dd	51
		Ff	≥63
		Fd	≥65
		Df	65
SWS89-WC-LB-2-2 Wall-Ceiling Loadbearing Junction		Dd	51
		Ff	80
		Fd	67
		Df	69
WI305-FW-LB-2-2SH Floor-Wall Loadbearing Junction (Wall gypsum board over plywood shear membrane)		Dd	57
		Ff	≥75
		Fd	≥70
		Df	≥65
WI305-FW-LB-2-2 Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd	57
		Ff	≥75
		Fd	≥70
		Df	≥65

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.6.LB.3.1: Floor-Wall Transmission Paths

Loadbearing wall assembly:

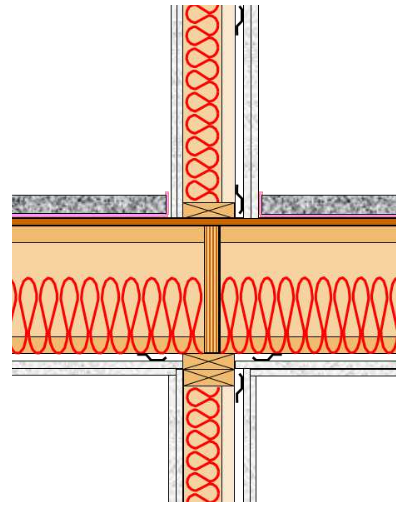
- Two rows of staggered triple 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side (MR-SWS-12 in Table 2.4.2)
- 2 layers of 13 mm fire-rated gypsum board[2] on each side, one side directly attached, other side on resilient channels[4] spaced 600 mm o.c.

Floor/ceiling assembly:

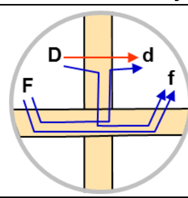
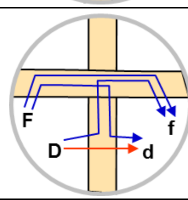
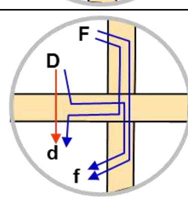
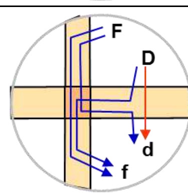
- Floor with 305 mm wood I-joists spaced 400 mm o.c., with 150 mm sound-absorbing material[3] in the cavities
- 16 mm oriented strandboard (OSB) subfloor on each side
- Floor topping of 38 mm gypsum concrete on 9 mm resilient layer
- Ceilings with 2 layers of 13 mm fire-rated gypsum board on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented perpendicular to separating wall but not continuous across junction, attached to rimboard at junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
SWS89-WF-LB-3-1 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	55 ≥65 ≥68 68
SWS89-WC-LB-3-1 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	55 80 77 67
WI305-FW-LB-3-1 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	68 ≥75 ≥70 ≥70
WI305-FW-LB-3-1R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff Fd Df	68 ≥75 ≥70 ≥70

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.6.LB.3.2: Floor-Wall Transmission Paths

Loadbearing wall assembly:

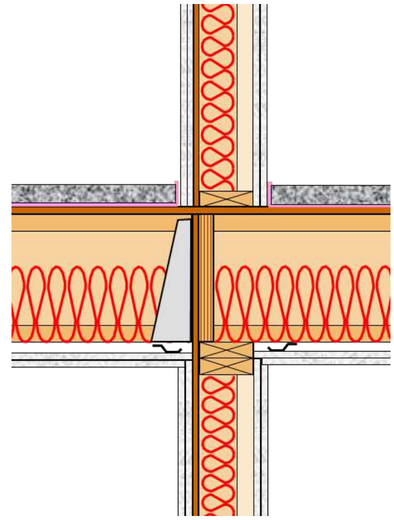
- Two rows of staggered triple 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side
- 2 layers of 13 mm fire-rated gypsum board[2], one side fastened over 16 mm plywood, other side fastened directly to framing

Floor/ceiling assembly:

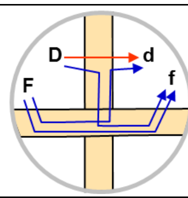
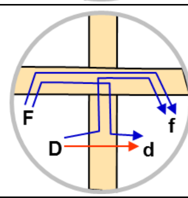
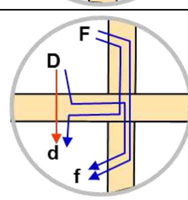
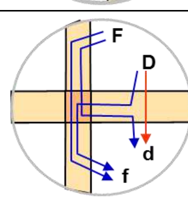
- Floor with 305 mm wood I-joists spaced 400 mm o.c., with 150 mm sound-absorbing material[3] in the cavities
- 16 mm oriented strandboard (OSB) subfloor on each side
- Floor topping of 38 mm gypsum concrete on 9 mm resilient layer
- Ceilings with 2 layers of 13 mm fire-rated gypsum board on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented perpendicular to separating wall but not continuous across junction, attached to rimboard or joist hangers



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
SWS89-WF-LB-3-2 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	51 ≥65 68 ≥64
SWS89-WC-LB-3-2 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	51 80 67 69
WI305-FW-LB-3-2SH Floor-Wall Loadbearing Junction (Wall gypsum board over plywood shear membrane)		Dd Ff Fd Df	68 ≥75 ≥70 ≥70
WI305-FW-LB-3-2 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	68 ≥75 ≥70 ≥70

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.6.NLB.1.1: Floor-Wall Transmission Paths

Non-loadbearing wall assembly:

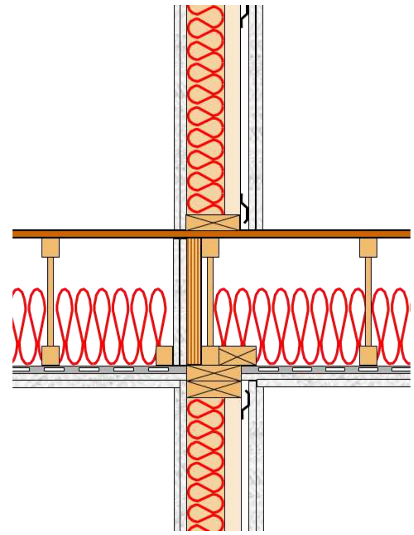
- Two rows of staggered 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side (MR-SWS-7 in Table 2.4.2)
- 2 layers of 13 mm fire-rated gypsum board[2] on each side, one side directly attached, other side on resilient channels[4] spaced 600 mm o.c.

Floor/ceiling assembly:

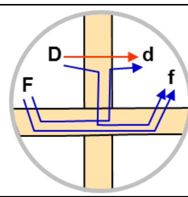
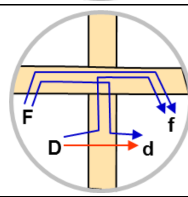
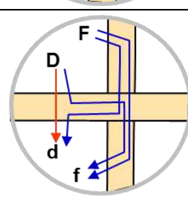
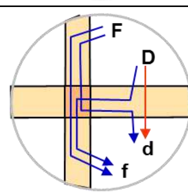
- Floor with 305 mm wood I-joists spaced 400 mm o.c., with 150 mm sound-absorbing material[3] in the cavities
- 16 mm oriented strandboard (OSB) subfloor on each side
- Ceilings with 2 layers of 13 mm fire-rated gypsum board on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented parallel to separating wall and attached to rimboard on one or both sides at junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
SWS89-WF-NLB-1-1 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	59 48 ≥58 58
SWS89-WC-NLB-1-1 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	59 78 69 71
WI305-FW-NLB-1-1 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	53 ≥75 ≥70 ≥60
WI305-FW-NLB-1-1R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff Fd Df	53 ≥80 ≥70 ≥60

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.6.NLB.1.2: Floor-Wall Transmission Paths

Non-loadbearing wall assembly:

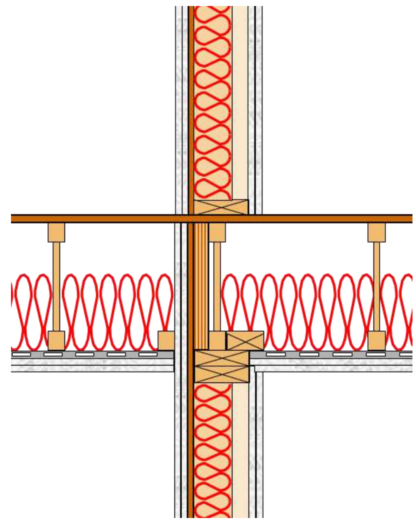
- Two rows of staggered 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side (MR-SWS-06 in Table 2.4.1)
- 2 layers of 13 mm fire-rated gypsum board[2], one side fastened over 16 mm plywood, other side fastened directly to framing

Floor/ceiling assembly:

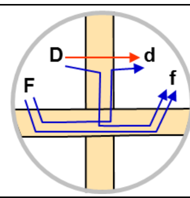
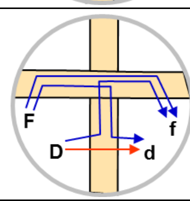
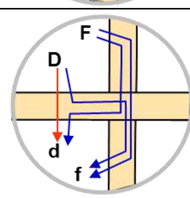
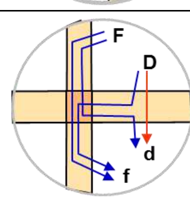
- Floor with 305 mm wood I-joists spaced 400 mm o.c., with 150 mm sound-absorbing material[3] in the cavities
- 16 mm oriented strandboard (OSB) subfloor on each side
- Ceilings with 2 layers of 13 mm fire-rated gypsum board on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented parallel to separating wall and attached to rimboard on one or both sides at junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
SWS89-WF-NLB-1-2 Wall-Floor Loadbearing Junction		Dd	51
		Ff	48
		Fd	58
		Df	52
SWS89-WC-NLB-1-2 Wall-Ceiling Loadbearing Junction		Dd	51
		Ff	78
		Fd	71
		Df	68
WI305-FW-NLB-1-2SH Floor-Wall Loadbearing Junction (Wall gypsum board over plywood shear membrane)		Dd	53
		Ff	≥75
		Fd	≥70
		Df	≥60
WI305-FW-NLB-1-2 Floor-Wall Loadbearing Junction (Wall gypsum board same as case 1-1)		Dd	53
		Ff	≥75
		Fd	≥70
		Df	≥60

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.6.NLB.2.1: Floor-Wall Transmission Paths

Non-loadbearing wall assembly:

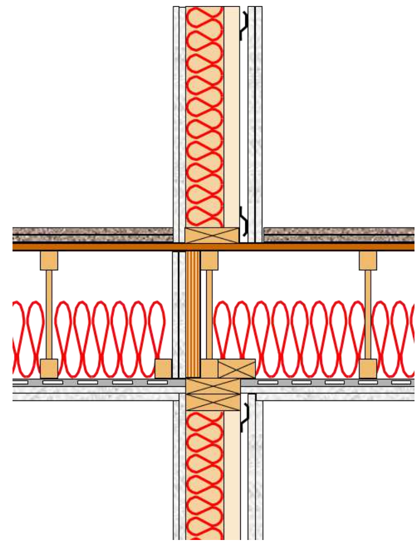
- Two rows of staggered 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side (MR-SWS-7 in Table 2.4.2)
- 2 layers of 13 mm fire-rated gypsum board[2] on each side, one side directly attached, other side on resilient channels[4] spaced 600 mm o.c.

Floor/ceiling assembly:

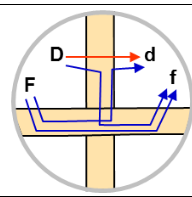
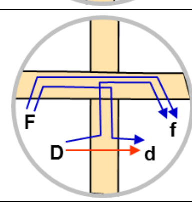
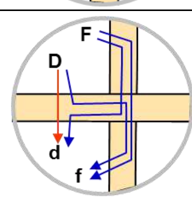
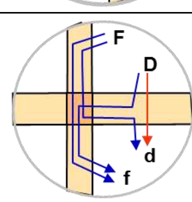
- Floor with 305 mm wood I-joists spaced 400 mm o.c., with 150 mm sound-absorbing material[3] in the cavities
- 16 mm oriented strandboard (OSB) subfloor on each side
- Floor topping of 2 layers of 13 mm fibre-reinforced cement board screwed to OSB subfloor
- Ceilings with 2 layers of 13 mm fire-rated gypsum board on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented parallel to separating wall and attached to rimboard on one or both sides at junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
SWS89-WF-NLB-2-1 Wall-Floor Loadbearing Junction		Dd	59
		Ff	≥58
		Fd	≥60
		Df	60
SWS89-WC-NLB-2-1 Wall-Ceiling Loadbearing Junction		Dd	59
		Ff	78
		Fd	69
		Df	71
WI305-FW-NLB-2-1 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd	57
		Ff	≥75
		Fd	≥70
		Df	≥65
WI305-FW-NLB-2-1R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd	57
		Ff	≥80
		Fd	≥70
		Df	≥70

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.6.NLB.2.2: Floor-Wall Transmission Paths

Non-loadbearing wall assembly:

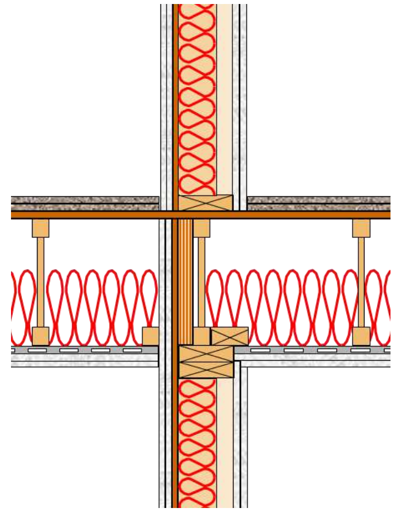
- Two rows of staggered 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side (MR-SWS-06 in Table 2.4.1)
- 2 layers of 13 mm fire-rated gypsum board[2], one side fastened over 16 mm plywood, other side fastened directly to framing

Floor/ceiling assembly:

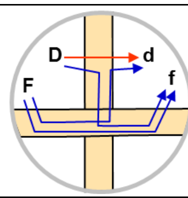
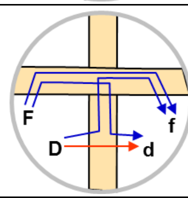
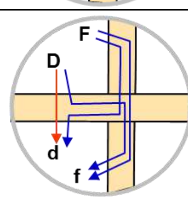
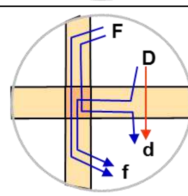
- Floor with 305 mm wood I-joists spaced 400 mm o.c., with 150 mm sound-absorbing material[3] in the cavities
- 16 mm oriented strandboard (OSB) subfloor on each side
- Floor topping of 2 layers of 13 mm fibre-reinforced cement board screwed to OSB subfloor
- Ceilings with 2 layers of 13 mm fire-rated gypsum board on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented parallel to separating wall and attached to rimboard on one or both sides at junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
SWS89-WF-NLB-2-2 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	51 ≥58 60 ≥54
SWS89-WC-NLB-2-2 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	51 78 71 68
WI305-FW-NLB-2-2SH Floor-Wall Loadbearing Junction (Wall gypsum board over plywood shear membrane)		Dd Ff Fd Df	57 ≥75 ≥70 ≥65
WI305-FW-NLB-2-2 Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff Fd Df	57 ≥75 ≥70 ≥65

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.6.NLB.3.1: Floor-Wall Transmission Paths

Non-loadbearing wall assembly:

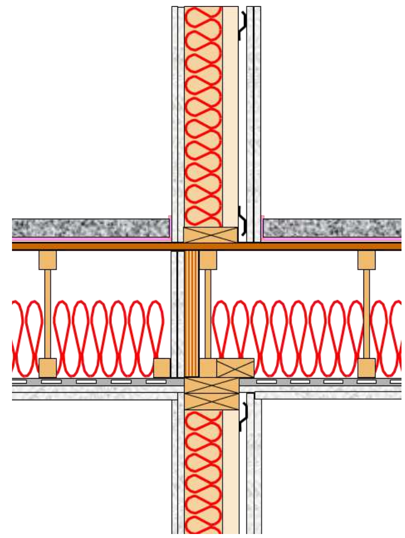
- Two rows of staggered 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side (MR-SWS-7 in Table 2.4.2)
- 2 layers of 13 mm fire-rated gypsum board[2] on each side, one side directly attached, other side on resilient channels[4] spaced 600 mm o.c.

Floor/ceiling assembly:

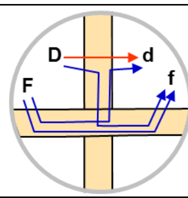
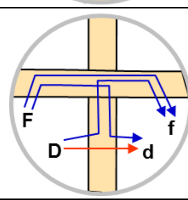
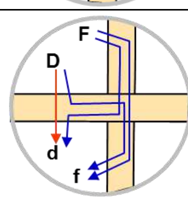
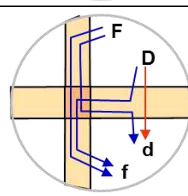
- Floor with 305 mm wood I-joists spaced 400 mm o.c., with 150 mm sound-absorbing material[3] in the cavities
- 16 mm oriented strandboard (OSB) subfloor on each side
- Floor topping of 38 mm gypsum concrete on 9 mm resilient layer
- Ceilings with 2 layers of 13 mm fire-rated gypsum board on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented parallel to separating wall and attached to rimboard on one or both sides at junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
SWS89-WF-NLB-3-1 Wall-Floor Loadbearing Junction		Dd Ff Fd Df	59 ≥61 ≥67 ≥67
SWS89-WC-NLB-3-1 Wall-Ceiling Loadbearing Junction		Dd Ff Fd Df	59 78 69 71
WI305-FW-NLB-3-1 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd Ff Fd Df	68 ≥75 ≥70 ≥70
WI305-FW-NLB-3-1R Floor-Wall Loadbearing Junction (Wall gypsum board on resilient channels)		Dd Ff Fd Df	68 ≥80 ≥70 ≥70

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.6.NLB.3.2: Floor-Wall Transmission Paths

Non-loadbearing wall assembly:

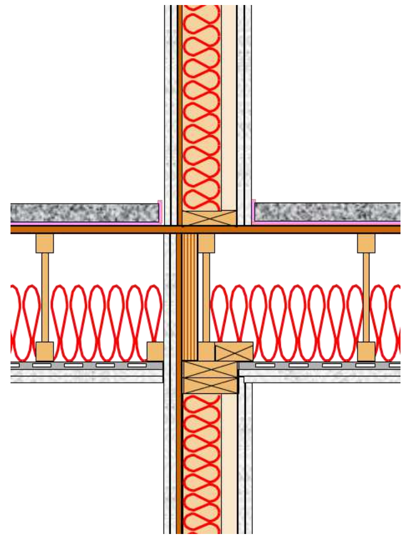
- Two rows of staggered 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side (MR-SWS-06 in Table 2.4.1)
- 2 layers of 13 mm fire-rated gypsum board[2], one side fastened over 16 mm plywood, other side fastened directly to framing

Floor/ceiling assembly:

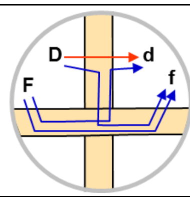
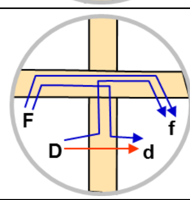
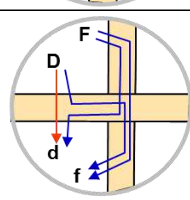
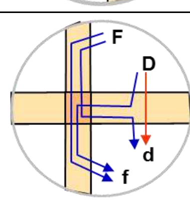
- Floor with 305 mm wood I-joists spaced 400 mm o.c., with 150 mm sound-absorbing material[3] in the cavities
- 16 mm oriented strandboard (OSB) subfloor on each side
- Floor topping of 38 mm gypsum concrete on 9 mm resilient layer
- Ceilings with 2 layers of 13 mm fire-rated gypsum board on resilient channels[4] spaced 400 mm o.c.

Junction:

- Floor joists oriented parallel to separating wall and attached to rimboard on one or both sides at junction



Floor-Wall Junction: Vertical section, approximately to scale

Junction	Diagram	Path	Flanking STC_{ij}
SWS89-WF-NLB-3-2 Wall-Floor Loadbearing Junction		Dd	51
		Ff	≥61
		Fd	≥67
		Df	67
SWS89-WC-NLB-3-2 Wall-Ceiling Loadbearing Junction		Dd	51
		Ff	78
		Fd	71
		Df	68
WI305-FW-NLB-3-2SH Floor-Wall Loadbearing Junction (Wall gypsum board over plywood shear membrane)		Dd	68
		Ff	≥75
		Fd	≥70
		Df	≥70
WI305-FW-NLB-3-2 Floor-Wall Loadbearing Junction (Wall gypsum board attached directly)		Dd	68
		Ff	≥75
		Fd	≥70
		Df	≥70

(For the notes in this table please see the corresponding endnotes on page 166.)

3.7 Wall/Wall Junctions for Mid-Rise Buildings – Wall Assemblies with Staggered Wood Studs

The following tables present flanking sound transmission class values of specific flanking sound transmission paths that were determined from measurements following the procedures of ISO 10848 on a series of mock-up constructions. The facilities and test procedures are described in Section 3.1.

All of the wall assemblies in this Section were framed with two staggered rows of single or triple 38 mm x 89 mm wood studs fastened to common 38 mm x 140 mm bottom plates and top plates.

Each table of Flanking STC results consists of several parts:

1. Brief generic descriptions of the intersecting wall assemblies and their junction
2. A drawing showing the main features of the assemblies and their junction
3. Each wall/wall junction can be viewed as a set of T-junctions. The T-Junction cases are presented in the rows underneath the descriptions, with stylized drawings to identify the paths and the Flanking STC values for each flanking path ij.
4. The naming for the wall/wall junctions follows a simple coding system in four segments:
   - The first segment of the code indicates that the junction consists of wood-framed assemblies and identifies the basic framing of the separating wall.
   - The second 2-letter segment of the code indicates the junction type: WW = wall/wall
   - The third segment of the code corresponds to the junction detail and table number.
   - The last segment of the code indicates the surfaces of the flanking assemblies.

This Section contains 3 tables, for different configurations of wall/wall junctions.

Numbering of the tables has a consistent sequence of codes:

- The first 2 digits match the Section number.
- The final digit is the unique number for that junction detail.

Table 3.7.1: Wall-Wall Transmission Paths

Loadbearing wall assembly:

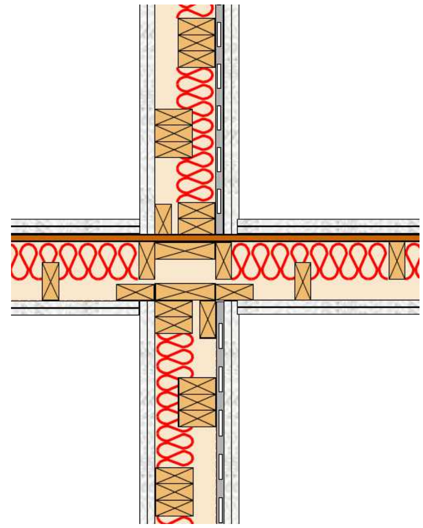
- Two rows of staggered triple 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side (MR-SWS-12 in Table 2.4.2)
- 2 layers of 13 mm fire-rated gypsum board[2] on each side, one side fastened to framing directly, other side fastened to resilient channels[4] spaced 600 mm o.c.

Non-loadbearing wall assembly:

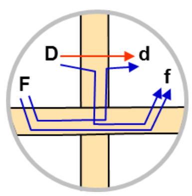
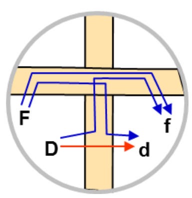
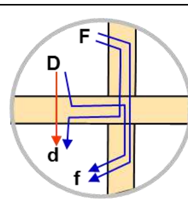
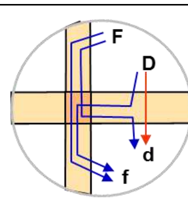
- Two rows of staggered 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side (MR-SWS-06 in Table, 2.4.1)
- 2G13_PLY16_SWS140(WS89@400)_GFB90_2G13
- 2 layers of 13 mm fire-rated gypsum board[2] on each side, one side fastened over 16 mm plywood, other side fastened directly to framing

Junction:

- Shear membrane of non-loadbearing wall continuous at junction



Wall-Wall Junction for mid-rise wood-framed construction. Horizontal section viewed from above, approximately to scale.

Junction	Path	Flanking STC_{ij}
SWS140(3WS89)-WW-1-2SH Wall-Wall Junction with loadbearing separating wall 	Dd Ff Fd Df	55 67 ≥65 65
SWS140(3WS89)-WW-1-2 Wall-Wall Junction with loadbearing separating wall 	Dd Ff Fd Df	55 70 ≥70 65
SWS140(WS89)-WW-1-2 Wall-Wall Junction with non-loadbearing separating wall 	Dd Ff Fd Df	51 77 68 67
SWS140(WS89)-WW-1-2R Wall-Wall Junction with non-loadbearing separating wall 	Dd Ff Fd Df	51 ≥77 ≥68 70

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.7.2: Wall-Wall Transmission Paths

Loadbearing wall assembly:

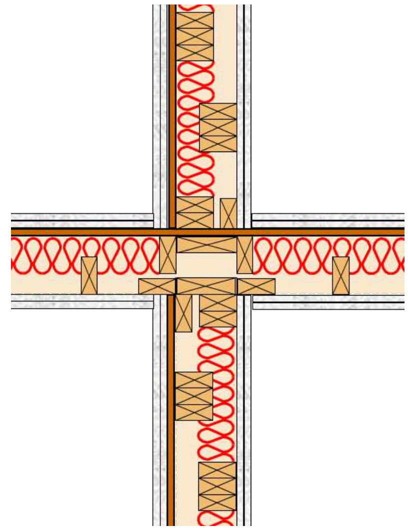
- Two rows of staggered triple 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side (MR-SWS-11 in Table 2.4.2 plus PLY16)
- 2 layers of 13 mm fire-rated gypsum board[2] on each side, one side fastened over 16 mm plywood, other side fastened directly to framing

Non-loadbearing wall assembly:

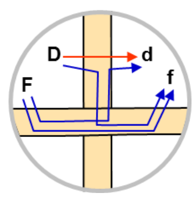
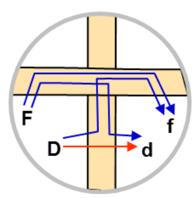
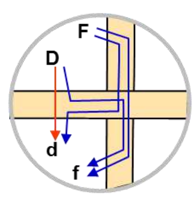
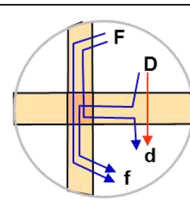
- Two rows of staggered 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side (MR-SWS-06 in Table, 2.4.1)
- 2G13_PLY16_SWS140(WS89@400)_GFB90_2G13
- 2 layers of 13 mm fire-rated gypsum board[2] on each side, one side fastened over 16 mm plywood, other side fastened directly to framing

Junction:

- Shear membrane of non-loadbearing wall continuous at junction



Wall-Wall Junction for mid-rise wood-framed construction. Horizontal section viewed from above, approximately to scale.

Junction	Diagram	Path	Flanking STC_{ij}
SWS140(3WS89)-WW-2-2SH Wall-Wall Junction with loadbearing separating wall		Dd	51
		Ff	67
		Fd	65
		Df	67
SWS140(3WS89)-WW-2-2 Wall-Wall Junction with loadbearing separating wall		Dd	51
		Ff	70
		Fd	65
		Df	65
SWS140(WS89)-WW-2-2SH Wall-Wall Junction with non-loadbearing separating wall		Dd	51
		Ff	77
		Fd	67
		Df	67
SWS140(WS89)-WW-2-2 Wall-Wall Junction with non-loadbearing separating wall		Dd	51
		Ff	77
		Fd	68
		Df	67

(For the notes in this table please see the corresponding endnotes on page 166.)

Table 3.7.3: Wall-Wall Transmission Paths

Loadbearing wall assembly:

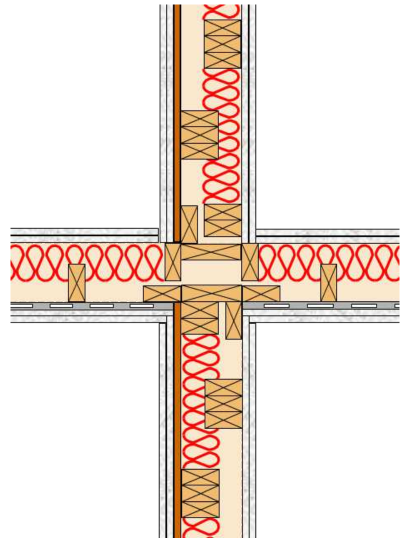
- Two rows of staggered triple 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side (MR-SWS-11 in Table 2.4.2 plus PLY16)
- 2 layers of 13 mm fire-rated gypsum board[2] on each side, one side fastened over 16 mm plywood, other side fastened directly to framing

Non-loadbearing wall assembly:

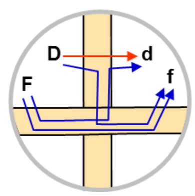
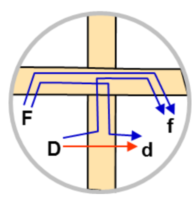
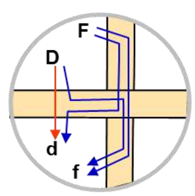
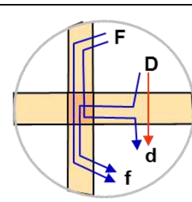
- Two rows of staggered 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side (MR-SWS-07 in Table, 2.4.2)
- 2G13_SWS140(WS89@400)_GFB90_RC13(600)_2G13
- 2 layers of 13 mm fire-rated gypsum board[2] on each side, one side fastened directly to framing, other side fastened to resilient channels[4] spaced 600 mm o.c.

Junction:

- Framing of loadbearing wall continuous at junction



Wall-Wall Junction for mid-rise wood-framed construction. Horizontal section viewed from above, approximately to scale.

Junction	Diagram	Path	Flanking STC_{ij}
SWS140(3WS89)-WW-3-2 Wall-Wall Junction with loadbearing separating wall		Dd	51
		Ff	70
		Fd	65
		Df	65
SWS140(3WS89)-WW-3-2R Wall-Wall Junction with loadbearing separating wall		Dd	51
		Ff	≥77
		Fd	≥70
		Df	≥70
SWS140(WS89)-WW-3-2SH Wall-Wall Junction with non-loadbearing separating wall		Dd	59
		Ff	≥77
		Fd	≥67
		Df	67
SWS140(WS89)-WW-3-2 Wall-Wall Junction with non-loadbearing separating wall		Dd	59
		Ff	77
		Fd	≥69
		Df	68

(For the notes in this table please see the corresponding endnotes on page 166.)

3.8 Summary for Chapter 3: Flanking Sound Transmission in Wood-Framed Constructions

The flanking sound transmission values presented in the almost 70 tables in this Chapter provide an overview of many common construction details. The presented cases highlight parameters that are of importance for achieving good apparent sound insulation.

The following observations and recommendations can be made:

- Building elements that are continuous across a junction can be an important transmitter of acoustic energy from one room to the other, for horizontal and vertical room pairs. For example, a continuous subfloor (potentially in combination with continuous joists, see e.g. Table 3.2.LBC.1.1) leads to very low Flanking STC ratings for the bottom junction. This is particularly apparent for double-stud walls, and introducing a discontinuity in the subfloor can have a large effect on the ASTC rating.
- Aside from discontinuities in joists and subfloor, floor toppings can also effectively supress flanking sound transmission via the bottom junction. As for direct sound insulation, heavier toppings are generally more effective than lighter toppings.
- For the top junction, ceiling surfaces on resilient channels are much better at attenuating sound via flanking paths than ceiling surfaces directly attached to the joists. In addition, resilient channels can also improve the direct airborne and impact sound insulation through a floor/ceiling assembly.
- As for direct transmission, additional layers of gypsum board (directly attached or on resilient channels) have a positive effect on the Flanking STC values.
- As was pointed out in the notes in each section, solid-sawn wood joists and wood I-joists tend to give similar Flanking STC values, assuming a similar joist depth. The same can be said about oriented strandboard (OSB) and plywood of same thickness, though a tongue and groove subfloor is expected to perform differently due to its different stiffness and its anisotropy.

The following Chapter 4 demonstrates the use of the data presented in the tables in this Chapter 3 for the calculation of the ASTC rating, using the Simplified Method of ISO 15712-1.

4 Predicting Sound Transmission in Wood-Framed Buildings

The focus of this chapter is to present and demonstrate the method for predicting the apparent sound insulation between adjacent rooms in a building constructed from lightweight framed wall and floor assemblies. The prediction method uses an empirical calculation approach described in ISO 15712-1 [7] that combines laboratory sound transmission data for individual lightweight framed wall or floor separating assemblies with flanking sound transmission data for each path at their junctions with adjoining assemblies.

The transmission of structure-borne vibration in a building with lightweight framed structures (made of wood or steel members) differs markedly from that in heavy homogeneous structures of concrete or masonry. There is both good news and bad news:

- The good news: For lightweight framed assemblies, the high internal loss factors result in minimal dependence on the connection to the adjoining structures, so that laboratory sound transmission values can be used without adjustment to estimate the direct transmission through the separating assembly in the finished building.
- The bad news: The standardized method of calculating flanking sound transmission from laboratory sound transmission data for individual wall and floor assemblies combined with junction attenuation data does not yield reliable results for lightweight framed building elements, and a different approach is required. The calculation process explained below is very simple (more good news), but it requires a new type of laboratory input data.

Before presenting the calculation process, some background justification seems appropriate. The characteristic transmission of structure-borne vibration can be illustrated by considering the vibration levels in a framed floor assembly excited by a localized impact source, as presented in Figure 4.1.

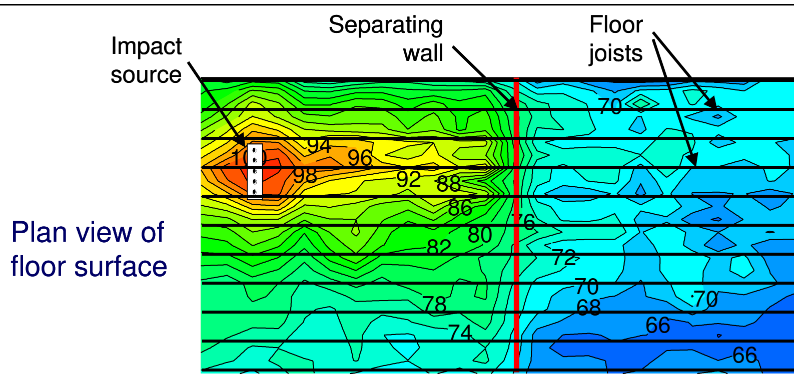


Figure 4.1: Variation across the floor surface of the vibration levels (2 kHz band) due to an impact source. The floor construction in this example has a 19 mm plywood subfloor on wood joists that are perpendicular to the separating wall between the two side-by-side rooms.

Clearly, the lightweight framed floor system is both highly damped and anisotropic – the vibration field exhibits a strong gradient away from the source due to the high internal losses, and the gradient is different in the directions parallel and perpendicular to the joists, unlike the uniform flow of energy in all directions that would be expected in a homogeneous cast-in-place concrete assembly. As a result, the direction of transmission relative to the framing members becomes an additional parameter needed for accurate prediction, and the transmission of sound power to or from a flanking surface is not simply proportional to its area. In general, this vibration field is a poor approximation of a diffuse field, which limits applicability of the energy flow model of ISO 15712-1 (which assumes homogeneous and lightly-damped assemblies that can be sensibly represented by an average vibration level).

Because of the attenuation across a flanking assembly, especially at higher frequencies, the assumption that sound power due to flanking is proportional to the flanking area (implicit in Section 4.1 of ISO 15712-1) is not appropriate. The equations in Section 4.1 of this Report provide more appropriate normalization for highly-damped assemblies such as lightweight wood-framed walls and floors.

Not only do vibration levels vary strongly across the surface of the structural assembly, but also typical changes to the surfaces (such as changing the gypsum board layers and/or their attachment to the walls and ceiling) *change* the attenuation across the structural assembly, with different changes in the three orthogonal directions pertinent to direct and flanking sound transmission. The change provided by a layer added to a surface depends on the weight and stiffness of the surface to which it is added, and if the added material is also anisotropic (for example, strip hardwood over a plywood subfloor) then its effect depends on its orientation relative to the supporting framing.

Hence, the concept of a simple correction to account for adding a given lining is not generally applicable for lightweight framed assemblies. However, the procedures presented in this Report do allow using ΔTL and ΔSTC corrections for floor finishes on a concrete or gypsum concrete subfloor, which is more reverberant.

4.1 Calculation Procedure for Wood-Framed Walls and Floors

The calculation process requires specific laboratory test data, and can be performed using frequency band data or single-number ratings, following the steps illustrated in Figure 4.1.1.

The Detailed Method of ISO 15712-1 combines the set of one-third octave band sound transmission loss data for the direct path and all flanking paths using Eq. 1.1 in this Report to arrive at values of the apparent sound transmission loss (ATL). From the apparent sound transmission loss, the ASTC rating is calculated using the procedure of ASTM E413 [3].

For wood-framed assemblies, using the Simplified Method presented below (and using Eq. 1.2 of this Report rather than Eq. 1.1) should generally provide the same answer as the Detailed Method (within ±1 ASTC points, with no bias). Hence the Simplified Method is used for the following more complete description of the calculation procedure including equations, and for the examples in Sections 4.2, 4.3, and 4.4. See Chapter 1 of this Report for a discussion of the two methods.

Step 1a: For the separating assembly, the *in-situ* TL_{Dd} equals the TL measured in ASTM E90 laboratory tests.

↓

Step 1b: If the separating assembly is a floor assembly with (gypsum) concrete subfloor surface, add ΔTL correction for added finish flooring.

→

Step 3: Combine Direct TL_{Dd} with Flanking TL for the 12 flanking paths to determine ATL. Use ASTM E413 to calculate ASTC.

↓

ASTC

Step 2a: For each edge of the separating assembly, use Flanking TL based on ISO 10848-3 tests for paths Ff, Fd and Df (preferred), or the Flanking TL due to the combination of paths.

↓

Step 2b: For each flanking path, if any surface is a floor assembly with (gypsum) concrete subfloor surface, add ΔTL correction for added finish flooring. If the combination of paths Ff, Fd, Df is used in Step 2a, the linings must be included in the whole junction measurements and no ΔTL correction should be applied.

← (to Step 3)

Figure 4.1.1: Steps to calculate the ASTC rating for wood-framed constructions using transmission loss data. For the Simplified Method with STC ratings, substitute "STC" for "TL".

Step 1: (a) For the separating assembly, the in-situ STC_{Dd} is equal to the STC rating determined in the laboratory according to ASTM E90.
(b) If the separating assembly is a floor assembly with (gypsum) concrete subfloor surface, add the ΔSTC correction for added floor finishes to the STC rating for the bare floor to obtain STC_{Dd}.

Step 2: (a) Determine the Flanking STC values (STC_{Ff}, STC_{Fd}, STC_{Df}) for the 3 flanking paths Ff, Fd, and Df at each edge of the separating assembly with the following adjustments:
- Values measured following the procedures of ISO 10848 must be re-normalized to the scenario dimensions using Eq. 4.1.3.
- If only the Flanking STC rating for the combined transmission by the set of 3 paths at a junction is available, that data may be used.

(b) If one (or both) surface(s) for a flanking path is a floor assembly with (gypsum) concrete subfloor surface, add the ΔSTC correction for any added floor finish:
- If one surface in a flanking path is a floor assembly with (gypsum) concrete subfloor surface, add the ΔSTC correction for the added finish flooring to the value for the bare floor to obtain the Flanking STC rating.
- If both surfaces are floor assemblies with (gypsum) concrete subfloor surface, the correction equals the larger of the two lining ΔSTC corrections plus half of the lesser one.

Step 3: Combine the transmission via the direct path and the 12 flanking paths using Eq. 4.1.1 (equivalent to Eq. 26 in Section 4.4 of ISO 15712-1), with the following adaptations:
- If the Flanking STC rating calculated for any flanking path is over 90, set the value to 90 to allow for the inevitable effect of higher order flanking paths.
- Round the final ASTC rating to the nearest integer.

Expressing the Calculation Process using Equations:

The ASTC rating between two rooms (neglecting sound transmitted by paths that bypass the building structure, e.g. through leaks or ducts) is estimated in the Simplified Method from the logarithmic expression of the combination of the Direct STC rating (STC_{Dd}) of the separating wall or floor element and the combined Flanking STC_{ij} ratings of the three flanking paths for every junction at the four edges of the separating element. This may be expressed as:

$$\mathrm{ASTC} = -10\log_{10}\left[10^{-0.1\cdot \mathrm{STC}_{Dd}} + \sum_{\mathrm{edge}=1}^{4}\left(10^{-0.1\cdot \mathrm{STC}_{Ff}} + 10^{-0.1\cdot \mathrm{STC}_{Fd}} + 10^{-0.1\cdot \mathrm{STC}_{Df}}\right)\right] \quad \text{Eq. 4.1.1}$$

Eq. 4.1.1 is appropriate for all types of building systems similar to the Standard Scenario. It is applied here using the following notes to calculate the sound transmission for each individual path:

For the Separating Assembly:

If the separating assembly is a framed wall assembly or a framed floor assembly without a (gypsum) concrete subfloor surface, then the direct path STC_{Dd} is equal to the laboratory STC rating for that assembly. Alternatively, if the separating assembly is a floor assembly with (gypsum) concrete subfloor surface, add the ΔSTC correction for any added finish flooring to the STC rating for the bare floor to obtain STC_{Dd} for the direct path, as indicated in Eq. 4.1.2.

$$\mathrm{STC}_{Dd} = \mathrm{STC}_{bare} + \Delta\mathrm{STC}_{flooring} \qquad \text{Eq. 4.1.2}$$

For Each Flanking Path:

The options for the calculation of the Flanking STC_{ij} for each flanking path ij include:

- The procedures described in ISO 10848-3 yield experimental values of the normalized flanking level difference D_{nf}. As per the standard, these D_{nf} values are normalized to an absorption area of 10 m^2 in the receiving room. In order to convert the D_{nf} values to Flanking TL_{ij} values, the correction term 10 log(S_{lab}/10) is added, yielding values of Flanking TL normalized to the room dimensions (in metres) of the laboratory. When the laboratory values for Flanking TL or Flanking STC are to be applied for a calculation scenario where the room dimensions are different, they must be re-normalized to reflect room dimension differences between the laboratory test rooms and the prediction scenario (indicated in Eq. 4.1.3 by the subscript "situ"). The expression to use in the calculation is:

$$\text{Flanking STC}_{ij,situ} = \text{Flanking STC}_{ij,lab} + 10\log(S_{situ}/S_{lab}) + 10\log(l_{lab}/l_{situ}) \qquad \text{Eq. 4.1.3}$$

  Here, S_{situ} is the area (in m^2) of the separating assembly and l_{situ} is the junction length (in m) for the prediction scenario, and S_{lab} and l_{lab} are the corresponding values for the specimen in the ISO 10848 laboratory test. The Flanking STC rating may be determined using the procedure of ASTM E413 with the one-third octave band values of Flanking TL as input data.

- If one of the flanking elements is a floor assembly with (gypsum) concrete subfloor surface, add the ΔSTC correction for added floor finishes to the Flanking STC_{ij} for the bare floor to obtain the Flanking STC_{ij} including the flooring.

$$\text{Flanking STC}_{ij} = \text{Flanking STC}_{bare} + \Delta\mathrm{STC}_{flooring} \qquad \text{Eq. 4.1.4}$$

- If flanking elements i and j are both floor assemblies with (gypsum) concrete subfloor surfaces, and both have added finish flooring, add the correction to the Flanking STC_{ij} for the bare floor as in Eq. 4.1.5. Note, however, that lining corrections are not appropriate for framed assemblies with surfaces other than (gypsum) concrete (such as OSB for floors or gypsum board for walls).

$$\text{Flanking STC}_{ij} = \text{Flanking STC}_{bare} + \left\{ max(\Delta\mathrm{STC}_i, \Delta\mathrm{STC}_j) + \frac{min(\Delta\mathrm{STC}_i, \Delta\mathrm{STC}_j)}{2} \right\} \qquad \text{Eq. 4.1.5}$$

Worked Examples

The following sections present a number of worked examples that demonstrate the calculation of the ASTC rating for wood-framed constructions according to the Simplified Method. Each worked example presents all the pertinent physical characteristics of the assemblies and junctions, together with a summary of key steps in the calculation process for these constructions. All examples conform to the Standard Scenario presented in Section 1.2 of this Report.

Within the table for each worked example, the "References" column presents the source of input data (combining the NRC report number and identifier for each laboratory test result or derived result), or identifies applicable equations and sections of ISO 15712-1 at each stage of the calculation, or their counterparts using ASTM ratings as presented in Eq.s 4.1.1 to 4.1.5. Symbols and subscripts identifying the corresponding variable in ISO 15712-1 are given in the adjacent column.

Under the heading "STC or ΔSTC", the examples present input data determined in laboratory tests:

- STC values for laboratory sound transmission loss data for wall and floor assemblies
- ΔSTC values measured in the laboratory for the change in STC due to adding a finish flooring to a base floor assembly with (gypsum) concrete subfloor surfaces
- Flanking STC values for each flanking path at each junction measured following ISO 10848 and re-normalized using Eq. 4.1.3

NOTE: In early versions of the NRC Research Report RR-331 and in other older NRC reports [16.1, 16.5, 16.6, 16.8, 16.10, 16.11, 16.13, 16.14], measured values of Flanking STC for each path were presented with normalization to the actual dimensions of the flanking facilities at NRC. Starting in 2017, data measured at NRC according to ISO 10848 has been normalized to a set of nominal dimensions that correspond more closely to the Standard Scenario used in this Report. The pertinent dimensions for the laboratory data are identified clearly in the worked examples. This change only affects the laboratory values presented under the heading "STC or ΔSTC". It had no effect on the resulting Flanking STC values for each path in the worked examples, since the values were always normalized to the dimensions of the Standard Scenario for the calculation of the ASTC rating.

Under the heading "STC or ASTC", the examples present the calculated values for sound transmission via specific paths:

- Direct STC ratings for in-situ transmission through the separating assembly including linings
- Flanking STC ratings for each flanking transmission path including the change due to linings
- ASTC ratings for the combination of direct and flanking sound transmission paths

When the calculated Flanking STC value for a given path exceeds 90 dB, the value is limited to 90, to allow for the inevitable effect of higher order flanking paths that make the higher calculated value not representative of the true situation. Further enhancements to elements in these paths will give negligible benefit. The consequence of this limit is that the Junction STC value for the set of 3 paths at each edge of the separating assembly cannot exceed 85 and the Total Flanking STC value for all 4 edges cannot exceed 79.

The numeric calculations present the arithmetic step-by-step in each worked example, using compact notation consistent with spreadsheet expressions:

- For the calculation of the Direct STC, these expressions are easily recognized either as:
  - measured STC values without correction for a lining if the separating assembly is a wall
  - measured STC values that may include corrections for added floor finishes if the separating assembly is a floor assembly with (gypsum) concrete subfloor surface
- For the calculation of the Flanking STC rating, these expressions are easily recognized as measured Flanking STC values re-normalized according to Eq. 4.1.3, possibly with a ΔSTC correction for added flooring if one or both of the flanking surfaces is a floor assembly with (gypsum) concrete subfloor surface
- These STC or Flanking STC values are rounded to the nearest integer for consistency with the corresponding measured values

For combining the sound power transmitted via specific paths, the calculation of Eq. 4.1.1 is presented in several stages, first for the subset of paths at each junction, then for the combined effect of all four flanking junctions, and finally for the combination of the direct path and all flanking paths. Note that in the compact notation, a term for transmitted sound power fraction such as $10^{-0.1 \cdot \mathrm{STC}_{ij}}$ becomes 10^-7.4, if STC_{ij} = 74.

For each path or junction, the overall transmission result is converted into decibel form by calculating -10 $\log_{10}$ (transmitted sound power fraction) to facilitate comparison of each path or junction with the Direct STC rating and the final ASTC rating.

The numbering of the tables presenting the worked examples end in an alphanumeric such as "H1" or "V2" to indicate Horizontal Case 1 (with rooms side-by-side) or Vertical Case 2 (with rooms one-above-the-other), respectively.

Repeatability studies in the NRC laboratories for such constructions suggest that these detailed predictions should be expected to agree with actual construction within a standard deviation of about 2 dB, in the absence of construction errors.

The sections of this Report have been divided up between examples typically found in low-rise buildings and examples typically found in mid-rise buildings, for ease of use. However, the height of the building does not change the applicability of the data presented. If a design of a mid-rise building utilizes assemblies that are typically used in low-rise buildings, then the data provided is still applicable. And, if a design of a low-rise building utilizes assemblies that are more typically used in mid-rise buildings, then the data provided is also still applicable.

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4.2 Examples for Low-Rise Buildings – Wall Assemblies with 1 Row of Wood Studs

The worked examples in this Section demonstrate the use of the Simplified Method to calculate the ASTC rating between adjacent units with wood-framed constructions typical for buildings up to 4 storeys:

- Examples 4.2-H1 and 4.2-H2 present ASTC calculations for side-by-side spaces separated by a wood stud wall with a single row of studs and resilient channels on one side.
- Examples 4.2-V1 to 4.2-V3 present ASTC calculations for rooms that are one-above–the-other, separated by a wood-framed floor. Although the drawings show only a single row of studs, essentially the same procedures and results would apply with walls framed with a double row of wood studs.

The STC data needed for the examples in this Section are presented in Section 2.2 and Section 2.5. The Flanking STC data needed for the examples in this Section are presented in Section 3.2 and Section 3.4.

With lightweight framed assemblies, it is common practice to add layers of material such as gypsum board within hidden cavities at junctions between units, to block the spread of fire. Fire control is beyond the scope of this Report, but is discussed in considerable detail in the publication "Best Practice Guide on Fire Stops and Fire Blocks and their Impact on Sound Transmission" [16.12]. The specimens tested to provide the design information in NRC Research Report RR-219 [16.11] and its supporting technical reports included such fire blocking. Additional fire blocking materials installed to protect the rimboard within floor cavities have minimal effect on the structure-borne flanking sound transmission. However, fire blocking within the cavity in a separating wall with a double row of studs can significantly alter the structure-borne flanking sound transmission if they provide a rigid connection between the two rows of studs. This is the focus of the examples in Section 4.3.

EXAMPLE 4.2-H1 **SIMPLIFIED METHOD**

- **Rooms side-by-side**
- **Wood-framed floors and walls**

Separating wall assembly with:

- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the inter-stud cavities
- Resilient metal channels[4] on one side, spaced 600 mm o.c.
- 1 layer of 16 mm fire-rated gypsum board[2] attached to the resilient channels[4] and 2 layers attached directly to framing on the other side

Bottom Junction 1 (separating wall and floor) with:

- Floor with 305 mm wood I-joists spaced 400 mm o.c., with joists oriented perpendicular to separating wall but not continuous across junction, and 150 mm-thick sound-absorbing material[3] in cavities
- Rimboard at junction may be covered with additional fire blocking material such as gypsum board without changing the sound transmission rating
- Subfloor of oriented strandboard (OSB) 19 mm thick and continuous across the junction
- No floor topping

Top Junction 3 (separating wall and ceiling) with:

- Ceiling with 305 mm wood I-joists, same as for bottom junction
- Rimboard at junction may be covered with additional fire blocking material such as gypsum board without changing sound transmission rating
- Ceiling of 1 layer of 13 mm fire-rated gypsum board[2] screwed directly to the bottom of the joists

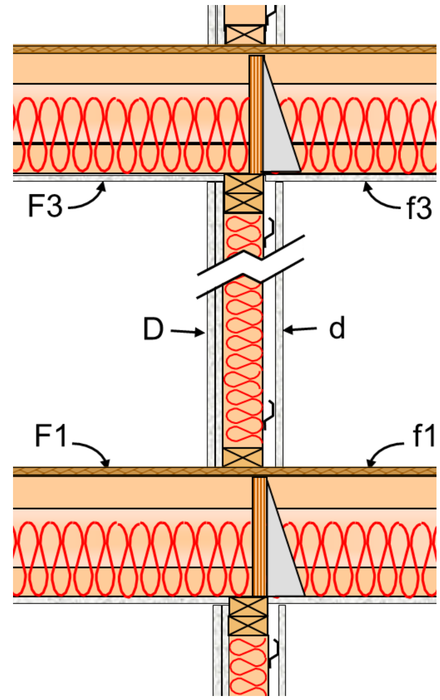
Side Junctions 2 and 4 (separating wall and abutting side walls) with:

- Side walls with single row of 38 mm x 89 mm wood studs spaced 400 mm o.c. with sound-absorbing material[3] filling the stud cavities
- Side wall framing structurally-connected to the separating wall, and continuous across the junction (as illustrated)
- 1 layer of 16 mm fire-rated gypsum board[2] on side walls attached directly to framing and terminating at the separating wall

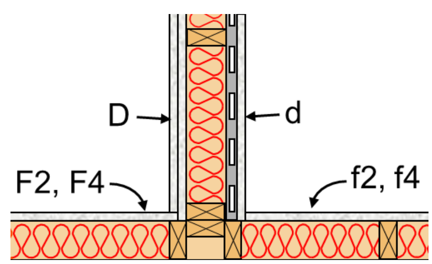
Acoustical Parameters:

	In Scenario	In Laboratory
Separating partition area (m^2) =	12.5	12.5
Floor/separating wall junction length (m) =	5.0	5.0
Wall/separating wall junction length (m) =	2.5	2.5
Normalization for Junctions 1 and 3:		
10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) =	0.00	RR-336, Eq. 4.1.3
Normalization for Junctions 2 and 4:		
10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) =	0.00	RR-336, Eq. 4.1.3

Illustration for this case



Junction 1 and 3 of loadbearing separating wall with floor and ceiling. (Side view)



Junction 2 or 4 of separating wall with abutting side walls with side walls' framing continuous across junction and gypsum board terminating at separating wall. (Plan view)

(For the notes in this table please see the corresponding endnotes on page 166.)

	ISO Symbol	Reference	STC or ΔSTC	STC or ASTC
Separating Partition (Loadbearing Wood-Framed Wall)				
Laboratory STC for Dd	R_s,w	RR-336, WS89-5a	51	
Direct STC in situ	R_Dd,w	RR-336, Eq. 4.1.2 (not a floor, so no ΔSTC correction)		**51**
Junction 1 (Loadbearing Wood-Framed Wall / Wood-Framed Floor)				
For Flanking Path Ff_1:				
Laboratory Flanking STC		RR-336, Table 3.2.LB.1.4, WS89-WF-LB-14	45	
ΔSTC change by Lining on F	ΔR_F,w	No flooring	0	
ΔSTC change by Lining on f	ΔR_f,w	No flooring	0	
Flanking STC for path Ff_1	R_Ff,w	RR-336, Eq. 4.1.3 and Eq. 4.1.5	45 + MAX(0,0)) + MIN(0,0)/2 + 0 =	**45**
For Flanking Path Fd_1:				
Laboratory Flanking STC		RR-336, Table 3.2.LB.1.4, WS89-WF-LB-14	53	
ΔSTC change by Lining on F	ΔR_F,w	No flooring	0	
Flanking STC for path Fd_1	R_ Fd,w	RR-336, Eq. 4.1.3 and Eq. 4.1.4	53 + 0 + 0 =	**53**
For Flanking Path Df_1:				
Laboratory Flanking STC		RR-336, Table 3.2.LB.1.4, WS89-WF-LB-14	51	
ΔSTC change by Lining on f	ΔR_f,w	No flooring	0	
Flanking STC for path Df_1	R_ Df,w	RR-336, Eq. 4.1.3 and Eq. 4.1.4	51 + 0 + 0 =	**51**
Junction 1: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-4.5 + 10^- 5.3 + 10^- 5.1) =	44
Junction 2 (Loadbearing Wood-Framed Separating Wall / Wood-Framed Flanking Walls)				
For Flanking Path Ff_2:				
Laboratory Flanking STC		RR-336, Table 3.4.2.1, WS89-WW-2-1	70	
Flanking STC for path Ff_2	R_Ff,w	RR-336, Eq. 4.1.3	70 + 0 =	**70**
For Flanking Path Fd_2:				
Laboratory Flanking STC		RR-336, Table 3.4.2.1, WS89-WW-2-1	69	
Flanking STC for path Fd_2	R_ Fd,w	RR-336, Eq. 4.1.3	69 + 0 =	**69**
For Flanking Path Df_2:				
Laboratory Flanking STC		RR-336, Table 3.4.2.1, WS89-WW-2-1	68	
Flanking STC for path Df_2	R_ Df,w	RR-336, Eq. 4.1.3	68 + 0 =	**68**
Junction 2: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-7 + 10^- 6.9 + 10^- 6.8) =	64
Junction 3 (Loadbearing Wood-Framed Wall / Wood-Framed Floor/Ceiling)				
For Flanking Path Ff_3:				
Laboratory Flanking STC		RR-336, Table 3.2.LB.1.4, WS89-WC-LB-14	79	
Flanking STC for path Ff_3	R_Ff,w	RR-336, Eq. 4.1.3	79 + 0 =	**79**
For Flanking Path Fd_3:				
Laboratory Flanking STC		RR-336, Table 3.2.LB.1.4, WS89-WC-LB-14	65	
Flanking STC for path Fd_3	R_ Fd,w	RR-336, Eq. 4.1.3	65 + 0 =	**65**
For Flanking Path Df_3:				
Laboratory Flanking STC		RR-336, Table 3.2.LB.1.4, WS89-WC-LB-14	65	
Flanking STC for path Df_3	R_ Df,w	RR-336, Eq. 4.1.3	65 + 0 =	**65**
Junction 3: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-7.9 + 10^- 6.5 + 10^- 6.5) =	62
Junction 4 (Loadbearing Wood-Framed Separating Wall / Wood-Framed Flanking Walls)				
All values the same as for Junction 2				
Flanking STC for path Ff_4	R_Ff,w	Same as for Ff_2		**70**
Flanking STC for path Fd_4	R_ Fd,w	Same as for Fd_2		**69**
Flanking STC for path Df_4	R_ Df,w	Same as for Df_2		**68**
Junction 4: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-7 + 10^- 6.9 + 10^- 6.8) =	64
Total Flanking STC (for all 4 junctions)		Subset of Eq. 4.1.1	Combining 12 Flanking STC values	43
ASTC due to Direct plus Total Flanking		Equation 4.1.1	Combining Direct STC with 12 Flanking STC values	**43**

EXAMPLE 4.2-H2: **SIMPLIFIED METHOD**

- **Rooms side-by-side**
- **Wood-framed floors and walls**
- **Same structure as 4.2-H1 but improved wall and floor surfaces**

Separating wall assembly with:

- Single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the inter-stud cavities
- Resilient metal channels[4] on one side, spaced 600 mm o.c.
- 2 layers of 16 mm fire-rated gypsum board[2] attached to the resilient channels and 2 layers attached directly to framing on the other side

Bottom Junction 1 (separating wall and floor) with:

- Floor with 305 mm wood I-joists spaced 400 mm o.c., with joists oriented perpendicular to separating wall but not continuous across junction, and 150 mm-thick sound-absorbing material[3] in cavities
- Rimboard at junction may be covered with additional fire blocking material such as gypsum board without changing the sound transmission rating
- Subfloor of oriented strandboard (OSB) 19 mm thick and continuous across the junction
- Engineered floor topping of 19 mm plywood and 19 mm oriented strandboard (OSB) on 9 mm resilient interlayer on both sides

Top Junction 3 (separating wall and ceiling) with:

- Ceiling with 305 mm wood I-joists, same as for bottom junction
- Rimboard at junction may be covered with additional fire blocking material such as gypsum board without changing sound transmission rating
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] supported on resilient channels spaced 400 mm o.c.

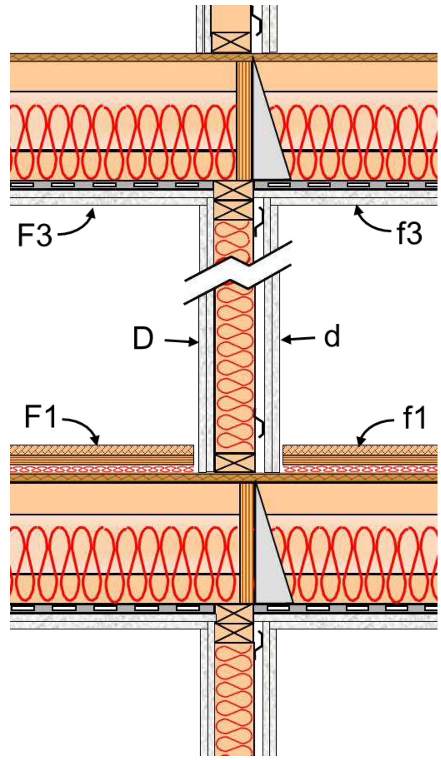
Side Junctions 2 and 4 (separating wall and abutting side walls) with:

- Side walls with single row of 38 mm x 89 mm wood studs spaced 400 mm o.c. with sound-absorbing material[3] filling the stud cavities
- Side wall framing structurally-connected to the separating wall, and continuous across the junction (as illustrated)
- 1 layer of 16 mm fire-rated gypsum board[2] on side walls attached directly to framing and terminating at the separating wall

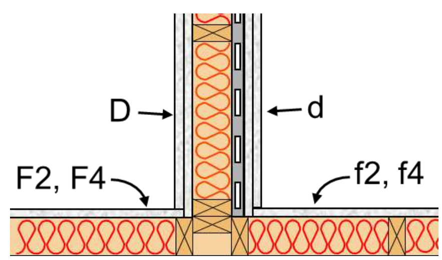
Acoustical Parameters:

	In Scenario	In Laboratory
Separating partition area (m^2) =	12.5	12.5
Floor/separating wall junction length (m) =	5.0	5.0
Wall/separating wall junction length (m) =	2.5	2.5
Normalization for Junctions 1 and 3:		
10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) =	0.00	RR-336, Eq. 4.1.3
Normalization for Junctions 2 and 4:		
10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) =	0.00	RR-336, Eq. 4.1.3

Illustration for this case



Junction 1 and 3 of loadbearing separating wall with floor and ceiling. (Side view)



Junction 2 or 4 of separating wall with abutting side walls with side walls' framing continuous across junction and gypsum board terminating at separating wall. (Plan view)

(For the notes in this table please see the corresponding endnotes on page 166.)

	ISO Symbol	Reference	STC or ΔSTC	STC or ASTC
Separating Partition (Loadbearing Wood-Framed Wall)				
Laboratory STC for Dd	R_s,w	RR-336, WS89-6b	58	
Direct STC in situ	R_Dd,w	RR-336, Eq. 4.1.2 (not a floor, so no ΔSTC correction)		**58**
Junction 1 (Loadbearing Wood-Framed Wall / Wood-Framed Floor)				
For Flanking Path Ff_1:				
Laboratory Flanking STC		RR-336, Table 3.2.LB.6.2, WS89-WF-LB-62	61	
ΔSTC change by Lining on F	ΔR_F,w	No flooring	0	
ΔSTC change by Lining on f	ΔR_f,w	No flooring	0	
Flanking STC for path Ff_1	R_Ff,w	RR-336, Eq. 4.1.3 and Eq. 4.1.5	61 + MAX(0,0)) + MIN(0,0)/2 + 0 =	**61**
For Flanking Path Fd_1:				
Laboratory Flanking STC		RR-336, Table 3.2.LB.6.2, WS89-WF-LB-62	66	
ΔSTC change by Lining on F	ΔR_F,w	No flooring	0	
Flanking STC for path Fd_1	R_ Fd,w	RR-336, Eq. 4.1.3 and Eq. 4.1.4	66 + 0 + 0 =	**66**
For Flanking Path Df_1:				
Laboratory Flanking STC		RR-336, Table 3.2.LB.6.2, WS89-WF-LB-62	63	
ΔSTC change by Lining on f	ΔR_f,w	No flooring	0	
Flanking STC for path Df_1	R_ Df,w	RR-336, Eq. 4.1.3 and Eq. 4.1.4	63 + 0 + 0 =	**63**
Junction 1: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-6.1 + 10^- 6.6 + 10^- 6.3) =	58
Junction 2 (Loadbearing Wood-Framed Separating Wall / Wood-Framed Flanking Walls)				
For Flanking Path Ff_2:				
Laboratory Flanking STC		RR-336, Table 3.4.1.1, WS89-WW-1-1	70	
Flanking STC for path Ff_2	R_Ff,w	RR-336, Eq. 4.1.3	70 + 0 =	**70**
For Flanking Path Fd_2:				
Laboratory Flanking STC		RR-336, Table 3.4.1.1, WS89-WW-1-1	71	
Flanking STC for path Fd_2	R_ Fd,w	RR-336, Eq. 4.1.3	71 + 0 =	**71**
For Flanking Path Df_2:				
Laboratory Flanking STC		RR-336, Table 3.4.1.1, WS89-WW-1-1	68	
Flanking STC for path Df_2	R_ Df,w	RR-336, Eq. 4.1.3	68 + 0 =	**68**
Junction 2: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-7 + 10^- 7.1 + 10^- 6.8) =	65
Junction 3 (Loadbearing Wood-Framed Wall / Wood-Framed Floor/Ceiling)				
For Flanking Path Ff_3:				
Laboratory Flanking STC		RR-336, Table 3.2.LB.6.2, WS89-WC-LB-62	82	
Flanking STC for path Ff_3	R_Ff,w	RR-336, Eq. 4.1.3	82 + 0 =	**82**
For Flanking Path Fd_3:				
Laboratory Flanking STC		RR-336, Table 3.2.LB.6.2, WS89-WC-LB-62	90	
Flanking STC for path Fd_3	R_ Fd,w	RR-336, Eq. 4.1.3	90 + 0 =	**90**
For Flanking Path Df_3:				
Laboratory Flanking STC		RR-336, Table 3.2.LB.6.2, WS89-WC-LB-62	74	
Flanking STC for path Df_3	R_ Df,w	RR-336, Eq. 4.1.3	74 + 0 =	**74**
Junction 3: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-8.2 + 10^- 9 + 10^- 7.4) =	73
Junction 4 (Loadbearing Wood-Framed Separating Wall / Wood-Framed Flanking Walls)				
All values the same as for Junction 2				
Flanking STC for path Ff_4	R_Ff,w	Same as for Ff_2		**70**
Flanking STC for path Fd_4	R_ Fd,w	Same as for Fd_2		**71**
Flanking STC for path Df_4	R_ Df,w	Same as for Df_2		**68**
Junction 4: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-7 + 10^- 7.1 + 10^- 6.8) =	65
Total Flanking STC (for all 4 junctions)		Subset of Eq. 4.1.1	Combining 12 Flanking STC values	56
ASTC due to Direct plus Total Flanking		Equation 4.1.1	Combining Direct STC with 12 Flanking STC values	**54**

EXAMPLE 4.2-V1 **SIMPLIFIED METHOD**

- **Rooms one-above-the-other**
- **Wood-framed floors and walls**

Separating floor/ceiling assembly with:

- Floor with 305 mm wood I-joists spaced 400 mm o.c., with joists oriented perpendicular to loadbearing wall but not continuous across junction, and 150 mm-thick sound-absorbing material[3] in cavities
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2], attached to resilient metal channels[4] spaced 400 mm o.c.
- Subfloor of oriented strandboard (OSB) 19 mm thick
- No floor topping
- No floor covering

Junctions 1 and 3 (loadbearing walls above and below floor) with:

- Joists of separating floor assembly perpendicular to these walls
- Walls framed with 38 mm x 89 mm wood studs spaced 400 mm o.c.
- Wall framing options (single row of wood studs, or staggered studs on a single 38 mm x 140 mm plate, or 2 rows of 38 mm x 89 mm wood studs on separate 38 mm x 89 mm plates) with or without sound-absorbing material[3] in wall cavities give equivalent flanking
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached to wall framing and ending at floor/ceiling assembly

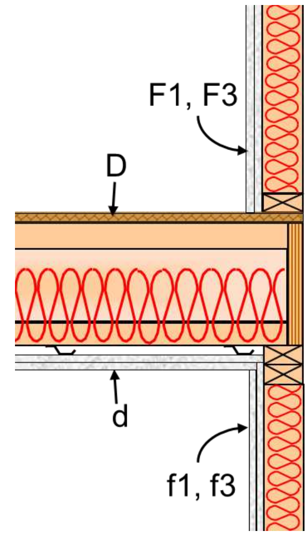
Junctions 2 and 4 (non-loadbearing walls above and below floor) with:

- Joists of floor assembly parallel to these walls
- Wall framing of 38 mm x 89 mm wood studs spaced 400 mm o.c.
- Wall framing options (single row of wood studs, or staggered studs on a single 38 mm x 140 mm plate, or 2 rows of 38 mm x 89 mm wood studs on separate 38 mm x 89 mm plates) with or without sound-absorbing material[3] in wall cavities give equivalent flanking
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached to wall framing and ending at floor/ceiling assembly

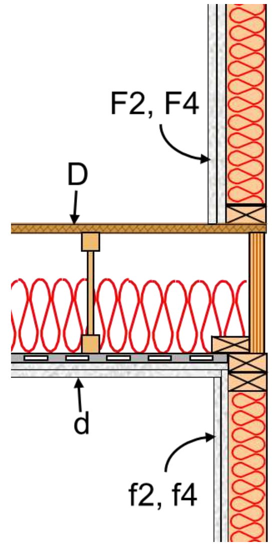
Acoustical Parameters:

	In Scenario	In Laboratory
Separating partition area (m^2) =	20.0	20.0
Floor/LB flanking wall junction length (m) =	5.0	5.0
Floor/NLB flanking wall junction length (m) =	4.0	5.0
Normalization for Junctions 1 and 3:		
10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) =	0.00	RR-336, Eq. 4.1.3
Normalization for Junctions 2 and 4:		
10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) =	0.97	RR-336, Eq. 4.1.3

Illustration for this case



Junction 1 or 3 with loadbearing side walls above and below the floor/ceiling assembly (wood I-joists of floor are perpendicular to loadbearing wall). (Side view)



Junction 2 or 4 with non-loadbearing side walls above and below the floor/ceiling assembly (wood I-joists of floor are parallel to the non-loadbearing wall). (Side view)

(For the notes in this table please see the corresponding endnotes on page 166.)

	ISO Symbol	Reference	STC or ΔSTC	STC or ASTC
Separating Partition (Wood-Framed Floor)				
Laboratory STC for Dd	R_s,w	RR-336, Table 3.2.LB.1.1, WI305-FW-LB-11	55	
ΔSTC change by Lining on D	ΔR_D,w	No finish flooring	0	
Direct STC in situ	R_Dd,w	RR-336, Eq. 4.1.2	55 + 0 =	**55**
Junction 1 (Wood-Framed Floor / Loadbearing Wood-Framed Wall)				
For Flanking Path Ff_1:				
Laboratory Flanking STC		RR-336, Table 3.2.LB.1.1, WI305-FW-LB-11	70	
Flanking STC for path Ff_1	R_Ff,w	RR-336, Eq. 4.1.3	70 + 0 =	**70**
For Flanking Path Fd_1:				
Laboratory Flanking STC		RR-336, Table 3.2.LB.1.1, WI305-FW-LB-11	90	
Flanking STC for path Fd_1	R_ Fd,w	RR-336, Eq. 4.1.3	90 + 0 =	**90**
For Flanking Path Df_1:				
Laboratory Flanking STC		RR-336, Table 3.2.LB.1.1, WI305-FW-LB-11	60	
ΔSTC change by Lining on D	ΔR_D,w	No finish flooring	0	
Flanking STC for path Df_1	R_ Df,w	RR-336, Eq. 4.1.3 and Eq. 4.1.4	60 + 0 + 0 =	**60**
Junction 1: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-7 + 10^- 9 + 10^- 6) =	60
Junction 2 (Wood-Framed Floor / Non-loadbearing Wood-Framed Wall)				
For Flanking Path Ff_2:				
Laboratory Flanking STC		RR-336, Table 3.2.NLB.1.1, WI305-FW-NLB-11	70	
Flanking STC for path Ff_2	R_Ff,w	RR-336, Eq. 4.1.3	70 + 1 =	**71**
For Flanking Path Fd_2:				
Laboratory Flanking STC		RR-336, Table 3.2.NLB.1.1, WI305-FW-NLB-11	90	
Flanking STC for path Fd_2	R_ Fd,w	RR-336, Eq. 4.1.3	90 + 1 =	**90**
For Flanking Path Df_2:				
Laboratory Flanking STC		RR-336, Table 3.2.NLB.1.1, WI305-FW-NLB-11	64	
ΔSTC change by Lining on D	ΔR_D,w	No finish flooring	0	
Flanking STC for path Df_2	R_ Df,w	RR-336, Eq. 4.1.3 and Eq. 4.1.4	64 + 0 + 1 =	**65**
Junction 2: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-7.1 + 10^- 9 + 10^- 6.5) =	64
Junction 3 (Wood-Framed Floor / Loadbearing Wood-Framed Wall)				
Flanking STC for path Ff_3	R_Ff,w	Same as for Ff_1		**70**
Flanking STC for path Fd_3	R_ Fd,w	Same as for Fd_1		**90**
Flanking STC for path Df_3	R_ Df,w	Same as for Df_1		**60**
Junction 3: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-7 + 10^- 9 + 10^- 6) =	60
Junction 4 (Wood-Framed Floor / Non-loadbearing Wood-Framed Wall)				
All values the same as for Junction 2				
Flanking STC for path Ff_4	R_Ff,w	Same as for Ff_2		**71**
Flanking STC for path Fd_4	R_ Fd,w	Same as for Fd_2		**90**
Flanking STC for path Df_4	R_ Df,w	Same as for Df_2		**65**
Junction 4: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-7.1 + 10^- 9 + 10^- 6.5) =	64
Total Flanking STC (for all 4 junctions)		Subset of Eq. 4.1.1	Combining 12 Flanking STC values	55
ASTC due to Direct plus Total Flanking		Equation 4.1.1	Combining Direct STC with 12 Flanking STC values	**52**

EXAMPLE 4.2-V2 **SIMPLIFIED METHOD**

- **Rooms one-above-the-other**
- **Wood-framed floors and walls**
  (Same structure as 4.2-V1 plus improved floor surfaces)

Separating floor/ceiling assembly with:

- Floor with 305 mm wood I-joists spaced 400 mm o.c., with joists oriented perpendicular to loadbearing wall but not continuous across junction, and 150 mm-thick sound-absorbing material[3] in cavities
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2], attached to resilient metal channels[4] spaced 400 mm o.c.
- Subfloor of oriented strandboard (OSB) 19 mm thick
- Engineered floor topping of 19 mm plywood and 19 mm oriented strandboard (OSB) on 9 mm resilient interlayer on both sides

Junctions 1 and 3 (loadbearing walls above and below floor) with:

- Joists of separating floor assembly perpendicular to these walls
- Walls framed with 38 mm x 89 mm wood studs spaced 400 mm o.c.
- Wall framing options (single row of wood studs, or staggered studs on a single 38 mm x 140 mm plate, or 2 rows of 38 mm x 89 mm wood studs on separate 38 mm x 89 mm plates) with or without sound-absorbing material[3] in wall cavities give equivalent flanking
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached to wall framing and ending at floor/ceiling assembly

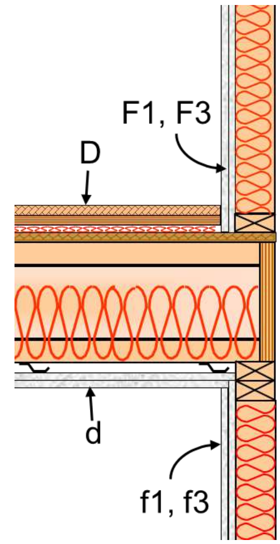
Junctions 2 and 4 (non-loadbearing walls above and below floor) with:

- Joists of floor assembly parallel to these walls
- Walls have 38 mm x 89 mm wood studs spaced 400 mm o.c.
- Wall framing options (single row of wood studs, or staggered studs on a single 38 mm x 140 mm plate, or 2 rows of 38 mm x 89 mm wood studs on separate 38 mm x 89 mm plates) with or without sound-absorbing material[3] in wall cavities give equivalent flanking
- 2 layers of 16 mm fire-rated gypsum board[2] directly attached to wall framing and ending at floor/ceiling assembly

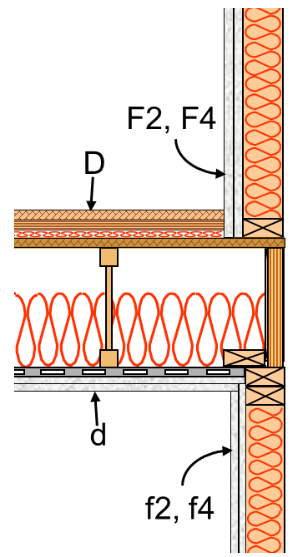
Acoustical Parameters:

	In Scenario	In Laboratory
Separating partition area (m^2) =	20.0	20.0
Floor/LB flanking wall junction length (m) =	5.0	5.0
Floor/NLB flanking wall junction length (m) =	4.0	5.0
Normalization for Junctions 1 and 3:		
10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) =	0.00	RR-336, Eq. 4.1.3
Normalization for Junctions 2 and 4:		
10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) =	0.97	RR-336, Eq. 4.1.3

Illustration for this case



Junction 1 or 3 with loadbearing side walls above and below the floor/ceiling assembly (wood I-joists of floor are perpendicular to loadbearing wall). (Side view)



Junction 2 or 4 with non-loadbearing side walls above and below the floor/ceiling assembly (wood I-joists of floor are parallel to the non-loadbearing wall). (Side view)

(For the notes in this table please see the corresponding endnotes on page 166.)

	ISO Symbol	Reference	STC or ΔSTC	STC or ASTC
Separating Partition (Wood-Framed Floor)				
Laboratory STC for Dd	R_s,w	RR-336, Table 3.2.LB.6.1, WI305-FW-LB-61	65	
ΔSTC change by Lining on D	ΔR_D,w	No finish flooring	0	
Direct STC in situ	R_Dd,w	RR-336, Eq. 4.1.2	65 + 0 =	**65**
Junction 1 (Wood-Framed Floor / Loadbearing Wood-Framed Wall)				
For Flanking Path Ff_1:				
Laboratory Flanking STC		RR-336, Table 3.2.LB.6.1, WI305-FW-LB-61	70	
Flanking STC for path Ff_1	R_Ff,w	RR-336, Eq. 4.1.3	70 + 0 =	**70**
For Flanking Path Fd_1:				
Laboratory Flanking STC		RR-336, Table 3.2.LB.6.1, WI305-FW-LB-61	90	
Flanking STC for path Fd_1	R_ Fd,w	RR-336, Eq. 4.1.3	90 + 0 =	**90**
For Flanking Path Df_1:				
Laboratory Flanking STC		RR-336, Table 3.2.LB.6.1, WI305-FW-LB-61	72	
ΔSTC change by Lining on D	ΔR_D,w	No finish flooring	0	
Flanking STC for path Df_1	R_ Df,w	RR-336, Eq. 4.1.3 and Eq. 4.1.4	72 + 0 + 0 =	**72**
Junction 1: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-7 + 10^- 9 + 10^- 7.2) =	68
Junction 2 (Wood-Framed Floor / Non-loadbearing Wood-Framed Wall)				
For Flanking Paths Ff_2 + Fd_2 + Df_2:				
Laboratory Flanking STC		RR-336, Table 3.2.NLB.6.1, WI305-FW-NLB-61	64	
Flanking STC for Ff+Fd+Df	R_Ff,w	RR-336, Eq. 4.1.3	64 + 1 =	**65**
Junction 2: Flanking STC for all paths				65
Junction 3 (Wood-Framed Floor / Loadbearing Wood-Framed Wall)				
Flanking STC for path Ff_3	R_Ff,w	Same as for Ff_1		**70**
Flanking STC for path Fd_3	R_ Fd,w	Same as for Fd_1		**90**
Flanking STC for path Df_3	R_ Df,w	Same as for Df_1		**72**
Junction 3: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-7 + 10^- 9 + 10^- 7.2) =	68
Junction 4 (Wood-Framed Floor / Non-loadbearing Wood-Framed Wall)				
All values the same as for Junction 2				
Flanking STC for Ff+Fd+Df	R_Ff,w	Same as for Junction 2		**65**
Junction 4: Flanking STC for all paths				65
Total Flanking STC (for all 4 junctions)		Subset of Eq. 4.1.1	Combining Flanking STC values	60
ASTC due to Direct plus Total Flanking		Equation 4.1.1	Combining Direct STC with Flanking STC values	**59**

EXAMPLE 4.2-V3 **SIMPLIFIED METHOD**

- **Rooms one-above-the-other**
- **Wood-framed floors and walls**
  (Same structure as 4.2-V1 + improved floor and wall surfaces)

Separating floor/ceiling assembly with:

- Floor with 305 mm wood I-joists spaced 400 mm o.c., with joists oriented perpendicular to loadbearing wall but not continuous across junction, and 150 mm-thick sound-absorbing material[3] in cavities
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2], attached to resilient metal channels[4] spaced 400 mm o.c.
- Subfloor of oriented strandboard (OSB) 19 mm thick
- Floor topping of 38 mm-thick gypsum concrete on 9 mm thick resilient foam underlay

Junctions 1 and 3 (loadbearing walls above and below floor) with:

- Joists of separating floor assembly perpendicular to these walls
- Walls framed with 38 mm x 89 mm wood studs spaced 400 mm o.c.
- Wall framing options (single row of wood studs, or staggered studs on a single 38 mm x 140 mm plate, or 2 rows of 38 mm x 89 mm wood studs on separate 38 mm x 89 mm plates) with or without sound-absorbing material[3] in wall cavities give equivalent flanking
- 2 layers of 16 mm fire-rated gypsum board[2] on resilient metal channels[4] spaced 600 mm o.c. and ending at floor/ceiling assembly

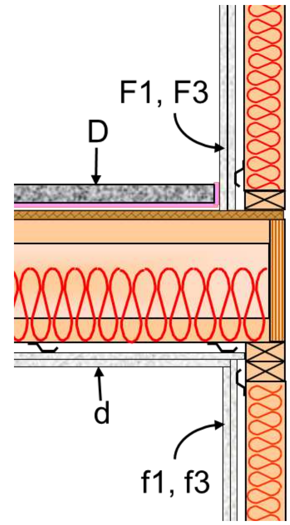
Junctions 2 and 4 (non-loadbearing walls above and below floor) with:

- Joists of floor assembly parallel to these walls
- Walls have 38 mm x 89 mm wood studs spaced 400 mm o.c.
- Wall framing options (single row of wood studs, or staggered studs on a single 38 mm x 140 mm plate, or 2 rows of 38 mm x 89 mm wood studs on separate 38 mm x 89 mm plates) with or without sound-absorbing material[3] in wall cavities give equivalent flanking
- 2 layers of 16 mm fire-rated gypsum board[2] on resilient metal channels[4] spaced 600 mm o.c. and ending at floor/ceiling assembly

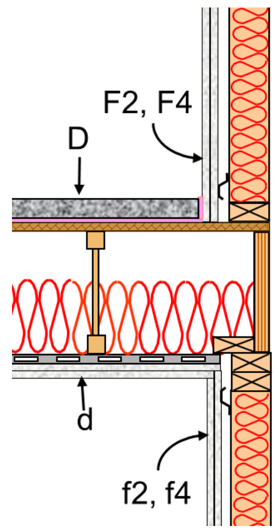
Acoustical Parameters:

	In Scenario	In Laboratory
Separating partition area (m^2) =	20.0	20.0
Floor/LB flanking wall junction length (m) =	5.0	5.0
Floor/NLB flanking wall junction length (m) =	4.0	5.0
Normalization for Junctions 1 and 3:		
10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) =	0.00	RR-336, Eq. 4.1.3
Normalization for Junctions 2 and 4:		
10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) =	0.97	RR-336, Eq. 4.1.3

Illustration for this case



Junction 1 or 3 with loadbearing side walls above and below the floor/ceiling assembly (wood I-joists of floor are perpendicular to loadbearing wall). (Side view)



Junction 2 or 4 with non-loadbearing side walls above and below the floor/ceiling assembly (wood I-joists of floor are parallel to the non-loadbearing wall). (Side view)

(For the notes in this table please see the corresponding endnotes on page 166.)

	ISO Symbol	Reference	STC or ΔSTC	STC or ASTC
Separating Partition (Wood-Framed Floor)				
Laboratory STC for Dd	R_s,w	RR-336, Table 3.2.LB.5.2, WI305-FW-LB-52R	70	
ΔSTC change by Lining on D	ΔR_D,w	No finish flooring	0	
Direct STC in situ	R_Dd,w	RR-336, Eq. 4.1.2	70 + 0 =	**70**
Junction 1 (Wood-Framed Floor / Loadbearing Wood-Framed Wall)				
For Flanking Paths Ff_1 + Fd_2 + Df_2:				
Laboratory Flanking STC		RR-336, Table 3.2.LB.5.2, WI305-FW-LB-52R	74	
Flanking STC for path Ff_1	R_Ff,w	RR-336, Eq. 4.1.3	74 + 0 =	**74**
Junction 1: Flanking STC for all paths		Subset of Eq. 4.1.1		74
Junction 2 (Wood-Framed Floor / Non-loadbearing Wood-Framed Wall)				
For Flanking Paths Ff_2 + Fd_2 + Df_2:				
Laboratory Flanking STC		RR-336, Table 3.2.NLB.5.2, WI305-FW-NLB-52R	73	
Flanking STC for Ff+Fd+Df	R_Ff,w	RR-336, Eq. 4.1.3	73 + 1 =	**74**
Junction 2: Flanking STC for all paths				74
Junction 3 (Wood-Framed Floor / Loadbearing Wood-Framed Wall)				
Flanking STC for Ff+Fd+Df	R_Ff,w	Same as for Junction 1		**74**
Junction 3: Flanking STC for all paths				74
Junction 4 (Wood-Framed Floor / Non-loadbearing Wood-Framed Wall)				
All values the same as for Junction_2				
Flanking STC for Ff+Fd+Df	R_Ff,w	Same as for Junction 2		**74**
Junction 4: Flanking STC for all paths				74
Total Flanking STC (for all 4 junctions)		Subset of Eq. 4.1.1	Combining Flanking STC values	68
ASTC due to Direct plus Total Flanking		Equation 4.1.1	Combining Direct STC with Flanking STC values	**66**

Summary for Section 4.2: Examples for Low-Rise Buildings – Wall Assemblies with 1 Row of Wood Studs

The worked examples in this Section (4.2-H1 to H2 and 4.2-V1 to V3) illustrate the use of the Simplified Method for calculating the apparent sound transmission class (ASTC) ratings between rooms in a building with wood-framed floor and wall assemblies. All of the examples in this section are for cases where the loadbearing walls are framed with a single row of wood studs.

The examples show the performance for cases with bare floor surfaces and for cases with improvements in direct and/or flanking sound transmission loss via specific paths due to selected changes in the surface layers of the walls and floors.

Separating Walls with Single Row of Wood Studs

Example 4.2-H2 for a horizontal pair of rooms separated by a single-stud wall shows improvements relative to the base case (4.2-H1) due to improving the weakest paths:

- Improving the wall by adding a layer of gypsum board increases the Direct STC from 51 to 58 and also provides a small improvement to path Fd at both sidewall junctions.
- Changing the ceiling surfaces from one layer of 13 mm gypsum board directly attached to two layers of 16 mm gypsum board on resilient channels improves the Flanking STC at the wall/ceiling junction from 62 to 73.
- The main improvement is due to the addition of a wood raft floor topping, which increases the Flanking STC at the floor/wall junction from 44 to 58. This gives a good balance between the flanking sound transmission at the four junctions and the direct sound transmission.

Separating Floors

Examples 4.2-V2 and 4.2-V3 for a vertical pair of rooms show the improvements relative to the base case (4.2-V1) as the floor and wall surfaces are upgraded.

- As shown in 4.2-V2, the obvious first step to increase the ASTC rating is to improve the floor surface, in this case by adding a wood raft floor topping, which increases the Direct STC from 55 to 65 and the ASTC from 52 to 59.
- Example 4.2-V3 shows how the ASTC increased can be further improved by changing the floor topping to 38 mm-thick gypsum concrete on a resilient mat and by adding resilient channels to the wall assemblies. The Direct STC increases to 70, and the ASTC increases to 66. The ASTC rating is now limited equally by direct transmission and by flanking sound transmission via all four junctions.

4.3 Examples for Low-Rise Buildings – Wall Assemblies with 2 Rows of Wood Studs

The worked examples in this Section demonstrate the use of the Simplified Method to calculate the ASTC rating between adjacent units for side-by-side spaces separated by a wood stud wall with a double row of 38 mm x 89 mm (2x4) studs. The corresponding vertical cases with one unit above the other are equivalent to the examples in Section 4.2 where one space is above the other.

The STC data needed for the examples in this Section are presented in Section 2.3 and Section 2.5. The Flanking STC data needed for examples in this Section are presented in Section 3.3 and Section 3.5.

With lightweight framed assemblies, it is common practice to add layers of material such as gypsum board within hidden cavities at junctions between units, to block the spread of fire. This issue is beyond the scope of this Report, but is discussed in considerable detail in the publication "Best Practice Guide on Fire Stops and Fire Blocks and their Impact on Sound Transmission" [16.12]. The specimens tested to provide the design information in NRC Research Report RR-219 [16.11] and its supporting technical reports included such fire blocking. Additional fire blocking materials installed to protect the rimboard within floor cavities have minimal effect on the structure-borne flanking sound transmission.

Fire blocking within the cavity in a separating wall with a double row of studs can significantly alter the structure-borne flanking sound transmission if they provide a rigid connection between the two rows of studs. This is the focus of the comparisons in most examples of this Section.

EXAMPLE 4.3-H1 **SIMPLIFIED METHOD**

- **Rooms side-by-side**
- **Wood-framed floors and walls**
- **Double wood stud separating wall**

Separating wall assembly with:

- Double row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 25 mm space between rows and 90 mm-thick sound-absorbing material[3] filling the cavities of one row of studs
- 1 layer of 16 mm fire-rated gypsum board[2] on each side

Bottom Junction 1 (separating wall and floor) with:

- Floor with 38 mm x 235 mm wood joists spaced 400 mm o.c., not continuous across the junction, and with 150 mm-thick sound-absorbing material[3] in the joist cavities
- Subfloor of oriented strandboard (OSB) 19 mm thick and continuous across the junction
- No floor topping

Top Junction 3 (separating wall and ceiling) with:

- Ceiling with 235 mm wood joists, same as for bottom junction
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] supported on resilient metal channels[4] spaced 400 mm o.c.

Two options are compared:

⇨ **Case A** with the joists of the floor and ceiling **parallel** to the separating wall as illustrated in the upper detail,

⇨ **Case B** with floor and ceiling joists **perpendicular** to the separating wall as illustrated in the lower detail.

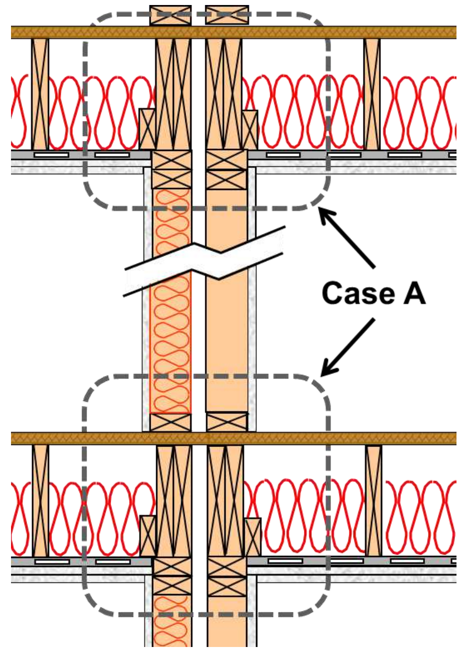
Side Junctions 2 and 4 (separating wall and abutting side walls) with:

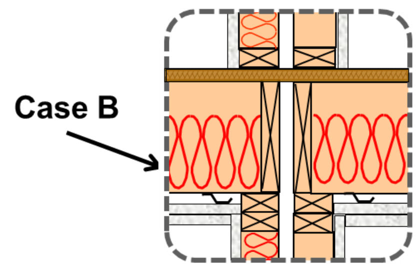
- Side walls with single row of 38 mm x 89 mm wood studs spaced 400 mm o.c. with sound-absorbing material[3] filling the cavities
- Side wall framing structurally-connected to the separating wall, and continuous across the junction (as illustrated)
- 1 layer of 16 mm fire-rated gypsum board[2] on resilient channels and terminating at the separating wall

Acoustical Parameters:

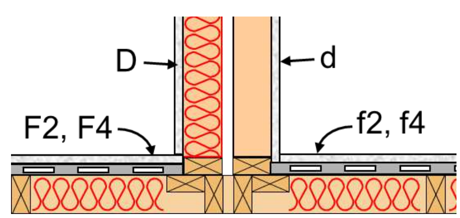
	In Scenario	In Laboratory
Separating partition area (m^2) =	12.5	12.5
Floor/separating wall junction length (m) =	5.0	5.0
Wall/separating wall junction length (m) =	2.5	2.5
Normalization for Junctions 1 and 3:		
10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) =	0.00	RR-336, Eq. 4.1.3
Normalization for Junctions 2 and 4:		
10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) =	0.00	RR-336, Eq. 4.1.3

Illustration for this case:





Two choices for Junctions 1 and 3 where the framing of the floor and ceiling connects to the separating wall. (Side view)



Junction 2 or 4 of separating wall with abutting side walls with side walls' framing continuous across junction and gypsum board terminating at separating wall. (Plan view)

(For the notes in this table please see the corresponding endnotes on page 166.)

Note: For these examples, Flanking TL data for individual paths at each junction are not available, so these examples use the available data for junctions.

CASE A: Floor Joists Parallel to Separating Wall

	ISO Symbol	Reference	STC or ΔSTC	STC or ASTC
Separating Partition (Wall Framed with 2 Rows of Studs)				
Laboratory STC for Dd	R_s,w	RR-336, Table 3.3.NLB.1.1.1, DWS89-WF-NLB-1-1-1	54	
Direct STC in situ	R_Dd,w	RR-336, Eq. 4.1.2 (not a floor, so no ΔSTC correction)		**54**
Junction 1 (Wall/Floor Junction: Non-loadbearing Wall / Floor Joists Parallel to Wall)				
Measured Laboratory Flanking STC		RR-336, Table 3.3.NLB.1.1.1, DWS89-WF-NLB-1-1-1	47	
Junction 1: Flanking STC for all paths			47 + 0 =	**47**
Junction 2 (Non-loadbearing Separating Wall / Wood-Framed Flanking Walls)				
Measured Laboratory Flanking STC		RR-336, Table 3.5.1.1, DWS89-WW-1-1R	68	
Junction 2: Flanking STC for all paths			68 + 0 =	**68**
Junction 3 (Wall/Ceiling Junction: Non-loadbearing Wall / Ceiling Joists Parallel to Wall)				
Measured Laboratory Flanking STC		RR-336, Table 3.3.NLB.1.1.1, DWS89-WC-NLB-1-1-1	62	
Junction 3: Flanking STC for all paths			62 + 0 =	**62**
Junction 4 (Non-loadbearing Separating Wall / Wood-Framed Flanking Walls)				
Measured Laboratory Flanking STC		RR-336, Table 3.5.1.1, DWS89-WW-1-1R	68	
Junction 4: Flanking STC for all paths			68 + 0 =	**68**
Total Flanking STC (for all 4 junctions)		RR-336, Subset of Eq. 4.1.1	Combining 4 Junction Flanking STC values	47
ASTC due to Direct plus Total Flanking		RR-336, Eq. 4.1.1	Combining Direct STC with Flanking STC values	**46**

CASE B: Floor Joists Perpendicular to Separating Wall

	ISO Symbol	Reference	STC or ΔSTC	STC or ASTC
Separating Partition (Wall Framed with 2 Rows of Studs)				
Laboratory STC for Dd	R_s,w	RR-336, Table 3.3.LB.1.1.1, DWS89-WF-LB-1-1-1	54	
Direct STC in situ	R_Dd,w	RR-336, Eq. 4.1.2 (not a floor, so no ΔSTC correction)		**54**
Junction 1 (Wall/Floor Junction: Separating Wall / Floor Joists Perpendicular to Wall)				
Measured Laboratory Flanking STC		RR-336, Table 3.3.LB.1.1.1, DWS89-WF-LB-1-1-1	49	
Junction 1: Flanking STC for all paths			49 + 0 =	**49**
Junction 2 (Separating Wall / Wood-Framed Flanking Walls)				
Measured Laboratory Flanking STC		RR-336, Table 3.5.1.1, DWS89-WW-1-1R	68	
Junction 2: Flanking STC for all paths			68 + 0 =	**68**
Junction 3 (Wall/Ceiling Junction: Separating Wall / Ceiling Joists Perpendicular to Wall)				
Measured Laboratory Flanking STC		RR-336, Table 3.3.LB.1.1.1, DWS89-WC-LB-1-1-1	68	
Junction 3: Flanking STC for all paths			68 + 0 =	**68**
Junction 4 (Separating Wall / Wood-Framed Flanking Walls)				
Measured Laboratory Flanking STC		RR-336, Table 3.5.1.1, DWS89-WW-1-1R	68	
Junction 4: Flanking STC for all paths			68 + 0 =	**68**
Total Flanking STC (for all 4 junctions)		RR-336, Subset of Eq. 4.1.1	Combining 4 Junction Flanking STC values	49
ASTC due to Direct plus Total Flanking		RR-336, Eq. 4.1.1	Combining Direct STC with Flanking STC values	**48**

EXAMPLE 4.3-H2 **SIMPLIFIED METHOD**

- **Rooms side-by-side**
- **Wood-framed floors and walls**
- **Double wood stud separating wall**

Separating wall assembly with:

- Double row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 25 mm space between rows and 90 mm-thick sound-absorbing material[3] filling the cavities of both rows of studs
- 1 layer of 16 mm fire-rated gypsum board[2] on each side

Bottom Junction 1 (separating wall and floor) with:

- Floor with 38 mm x 235 mm wood joists spaced 400 mm o.c., not continuous across the junction, and with 150 mm-thick sound-absorbing material[3] in the joist cavities
- Subfloor of oriented strandboard (OSB) 19 mm thick
- No floor topping

Top Junction 3 (separating wall and ceiling) with:

- Ceiling with 235 mm wood joists, same as for bottom junction
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] supported on resilient metal channels[4] spaced 400 mm o.c.

Two options are compared:

⇨ **Case A** with the OSB subfloor continuous across the floor and ceiling junctions, as illustrated in the upper detail,

⇨ **Case B** with the OSB subfloor **not** continuous across the junctions as illustrated in the lower detail. Because both wall cavities are full of sound-absorbing material, the solid fire block is not required.

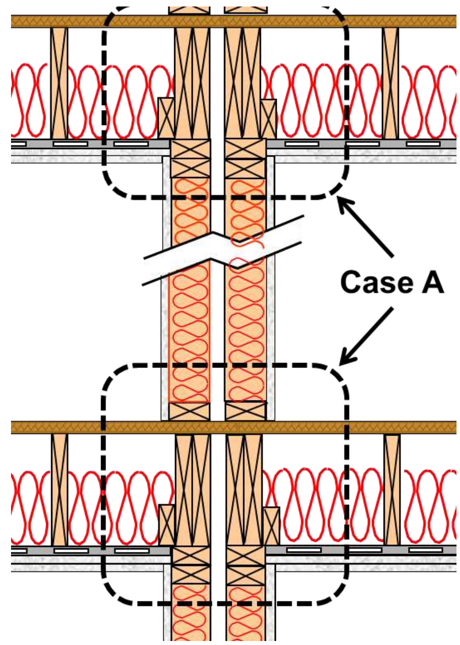
Side Junctions 2 and 4 (separating wall and abutting side walls) with:

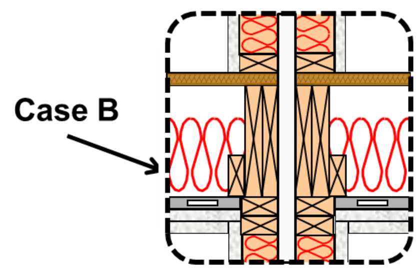
- Side walls with single row of 38 mm x 89 mm wood studs spaced 400 mm o.c. with sound-absorbing material[3] filling the cavities
- Side wall framing structurally-connected to the separating wall, and continuous across the junction (as illustrated)
- 1 layer of 16 mm fire-rated gypsum board[2] on resilient channels and terminating at the separating wall

Acoustical Parameters:

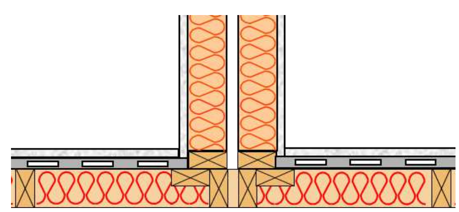
	In Scenario	In Laboratory
Separating partition area (m^2) =	12.5	12.5
Floor/separating wall junction length (m) =	5.0	5.0
Wall/separating wall junction length (m) =	2.5	2.5
Normalization for Junctions 1 and 3:		
10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) =	0.00	RR-336, Eq. 4.1.3
Normalization for Junctions 2 and 4:		
10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) =	0.00	RR-336, Eq. 4.1.3

Illustration for this case:





Two choices for Junctions 1 and 3 where the framing of the floor and ceiling connects to the separating wall. (Side view)



Junction 2 or 4 of separating wall with abutting side walls with side walls' framing continuous across junction and gypsum board terminating at separating wall. (Plan view)

(For the notes in this table please see the corresponding endnotes on page 166.)

Note: For these examples, Flanking TL data for individual paths at each junction are not available, so these examples use the available data for junctions.

CASE A: OSB Subfloor Continuous

	ISO Symbol	Reference	STC or ΔSTC	STC or ASTC
Separating Partition (Wall Framed with 2 Rows of Studs)				
Laboratory STC for Dd	R_s,w	RR-336, Table 3.3.NLB.1.1.2, DWS89-WF-NLB-1-1-2	57	
Direct STC in situ	R_Dd,w	RR-336, Eq. 4.1.2 (not a floor, so no ΔSTC correction)		**57**
Junction 1 (Wall/Floor Junction: Non-loadbearing Wall / Floor Joists Parallel to Wall)				
Measured Laboratory Flanking STC		RR-336, Table 3.3.NLB.1.1.2, DWS89-WF-NLB-1-1-2	47	
Junction 1: Flanking STC for all paths			47 + 0 =	**47**
Junction 2 (Non-loadbearing Separating Wall / Wood-Framed Flanking Walls)				
Measured Laboratory Flanking STC		RR-336, Table 3.5.1.1, DWS89-WW-1-1R	68	
Junction 2: Flanking STC for all paths			68 + 0 =	**68**
Junction 3 (Wall/Ceiling Junction: Non-loadbearing Wall / Ceiling Joists Parallel to Wall)				
Measured Laboratory Flanking STC		RR-336, Table 3.3.NLB.1.1.2, DWS89-WC-NLB-1-1-2	62	
Junction 3: Flanking STC for all paths			62 + 0 =	**62**
Junction 4 (Non-loadbearing Separating Wall / Wood-Framed Flanking Walls)				
Measured Laboratory Flanking STC		RR-336, Table 3.5.1.1, DWS89-WW-1-1R	68	
Junction 4: Flanking STC for all paths			68 + 0 =	**68**
Total Flanking STC (for all 4 junctions)		RR-336, Subset of Eq. 4.1.1	Combining 4 Junction Flanking STC values	47
ASTC due to Direct plus Total Flanking		RR-336, Eq. 4.1.1	Combining Direct STC with Flanking STC values	**46**

CASE B: OSB Subfloor Not Continuous

	ISO Symbol	Reference	STC or ΔSTC	STC or ASTC
Separating Partition (Wall Framed with 2 Rows of Studs)				
Laboratory STC for Dd	R_s,w	RR-336, Table 3.3.NLB.2.1.2, DWS89-WF-NLB-2-1-2	57	
Direct STC in situ	R_Dd,w	RR-336, Eq. 4.1.2 (not a floor, so no ΔSTC correction)		**57**
Junction 1 (Wall/Floor Junction: Non-loadbearing Wall / Floor Joists Parallel to Wall)				
Measured Laboratory Flanking STC		RR-336, Table 3.3.NLB.2.1.2, DWS89-WF-NLB-2-1-2	85	
Junction 1: Flanking STC for all paths			85 + 0 =	**85**
Junction 2 (Non-loadbearing Separating Wall / Wood-Framed Flanking Walls)				
Measured Laboratory Flanking STC		RR-336, Table 3.5.1.1, DWS89-WW-1-1R	68	
Junction 2: Flanking STC for all paths			68 + 0 =	**68**
Junction 3 (Wall/Ceiling Junction: Non-loadbearing Wall / Ceiling Joists Parallel to Wall)				
Measured Laboratory Flanking STC		RR-336, Table 3.3.NLB.2.1.2, DWS89-WC-NLB-2-1-2	85	
Junction 3: Flanking STC for all paths			85 + 0 =	**85**
Junction 4 (Non-loadbearing Separating Wall / Wood-Framed Flanking Walls)				
Measured Laboratory Flanking STC		RR-336, Table 3.5.1.1, DWS89-WW-1-1R	68	
Junction 4: Flanking STC for all paths			68 + 0 =	**68**
Total Flanking STC (for all 4 junctions)		RR-336, Subset of Eq. 4.1.1	Combining 4 Junction Flanking STC values	65
ASTC due to Direct plus Total Flanking		RR-336, Eq. 4.1.1	Combining Direct STC with Flanking STC values	**56**

EXAMPLE 4.3-H3 **SIMPLIFIED METHOD**

- **Rooms side-by-side**
- **Double wood stud separating wall**
- **Wood-framed floors with concrete topping**

Separating wall assembly with:

- Double row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 25 mm space between rows and 90 mm-thick sound-absorbing material[3] filling the cavities of both rows of studs
- 1 layer of 16 mm fire-rated gypsum board[2] on each side

Bottom Junction 1 (separating wall and floor) with:

- Floor with 38 mm x 235 mm wood joists spaced 400 mm o.c., not continuous across the junction, and with 150 mm-thick sound-absorbing material[3] in the joist cavities
- Subfloor of oriented strandboard (OSB) 19 mm thick
- Floor topping of 38 mm concrete

Top Junction 3 (separating wall and ceiling) with:

- Ceiling with 235 mm wood joists, same as for bottom junction
- Ceiling of 2 layers of 16 mm fire-rated gypsum board[2] supported on resilient metal channels[4] spaced 400 mm o.c.

Two options are compared:

⇨ **Case A** with the OSB subfloor continuous across the floor and ceiling junctions, as illustrated in the upper detail,

⇨ **Case B** with the OSB subfloor **not** continuous across the junctions as illustrated in the lower detail. Because both wall cavities are full of sound-absorbing material, the solid fire block is not required.

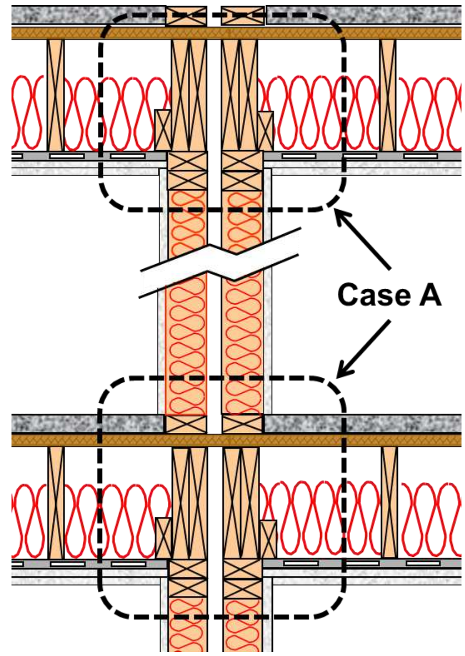
Side Junctions 2 and 4 (separating wall and abutting side walls) with:

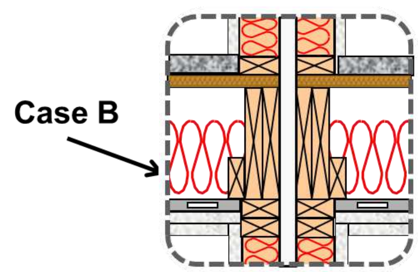
- Side walls with single row of 38 mm x 89 mm wood studs spaced 400 mm o.c. with sound-absorbing material[3] filling the cavities
- Side wall framing structurally-connected to the separating wall, and continuous across the junction (as illustrated)
- 1 layer of 16 mm fire-rated gypsum board[2] on resilient channels and terminating at the separating wall

Acoustical Parameters:

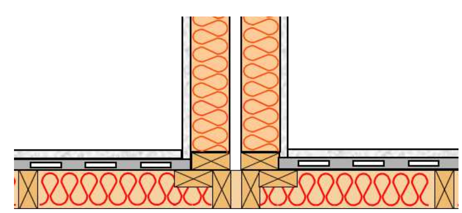
	In Scenario	In Laboratory
Separating partition area (m^2) =	12.5	12.5
Floor/separating wall junction length (m) =	5.0	5.0
Wall/separating wall junction length (m) =	2.5	2.5
Normalization for Junctions 1 and 3:		
10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) =	0.00	RR-336, Eq. 4.1.3
Normalization for Junctions 2 and 4:		
10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) =	0.00	RR-336, Eq. 4.1.3

Illustration for this case:





Two choices for Junctions 1 and 3 where the framing of the floor and ceiling connects to the separating wall. (Side view)



Junction 2 or 4 of separating wall with abutting side walls with side walls' framing continuous across junction and gypsum board terminating at separating wall. (Plan view)

(For the notes in this table please see the corresponding endnotes on page 166.)

Note: For these examples, Flanking TL data for individual paths at each junction are not available, so these examples use the available data for junctions.

CASE A: OSB Subfloor Continuous

	ISO Symbol	Reference	STC or ΔSTC	STC or ASTC
Separating Partition (Wall Framed with 2 Rows of Studs)				
Laboratory STC for Dd	R_s,w	RR-336, Table 3.3.NLB.1.2.2, DWS89-WF-NLB-1-2-2	57	
Direct STC in situ	R_Dd,w	RR-336, Eq. 4.1.2 (not a floor, so no ΔSTC correction)		**57**
Junction 1 (Wall/Floor Junction: Non-loadbearing Wall / Floor Joists Parallel to Wall)				
Measured Laboratory Flanking STC		RR-336, Table 3.3.NLB.1.2.2, DWS89-WF-NLB-1-2-2	61	
Junction 1: Flanking STC for all paths			61 + 0 =	**61**
Junction 2 (Non-loadbearing Separating Wall / Wood-Framed Flanking Walls)				
Measured Laboratory Flanking STC		RR-336, Table 3.5.1.1, DWS89-WW-1-1R	68	
Junction 2: Flanking STC for all paths			68 + 0 =	**68**
Junction 3 (Wall/Ceiling Junction: Non-loadbearing Wall / Ceiling Joists Parallel to Wall)				
Measured Laboratory Flanking STC		RR-336, Table 3.3.NLB.1.2.2, DWS89-WC-NLB-1-2-2	68	
Junction 3: Flanking STC for all paths			68 + 0 =	**68**
Junction 4 (Non-loadbearing Separating Wall / Wood-Framed Flanking Walls)				
Measured Laboratory Flanking STC		RR-336, Table 3.5.1.1, DWS89-WW-1-1R	68	
Junction 4: Flanking STC for all paths			68 + 0 =	**68**
Total Flanking STC (for all 4 junctions)		RR-336, Subset of Eq. 4.1.1	Combining 4 Junction Flanking STC values	59
ASTC due to Direct plus Total Flanking		RR-336, Eq. 4.1.1	Combining Direct STC with Flanking STC values	**55**

CASE B: OSB Subfloor Not Continuous

	ISO Symbol	Reference	STC or ΔSTC	STC or ASTC
Separating Partition (Wall Framed with 2 Rows of Studs)				
Laboratory STC for Dd	R_s,w	RR-336, Table 3.3.NLB.2.2.2, DWS89-WF-NLB-2-2-2	57	
Direct STC in situ	R_Dd,w	RR-336, Eq. 4.1.2 (not a floor, so no ΔSTC correction)		**57**
Junction 1 (Wall/Floor Junction: Non-loadbearing Wall / Floor Joists Parallel to Wall)				
Measured Laboratory Flanking STC		RR-336, Table 3.3.NLB.2.2.2, DWS89-WF-NLB-2-2-2	85	
Junction 1: Flanking STC for all paths			85 + 0 =	**85**
Junction 2 (Non-loadbearing Separating Wall / Wood-Framed Flanking Walls)				
Measured Laboratory Flanking STC		RR-336, Table 3.5.1.1, DWS89-WW-1-1R	68	
Junction 2: Flanking STC for all paths			68 + 0 =	**68**
Junction 3 (Wall/Ceiling Junction: Non-loadbearing Wall / Ceiling Joists Parallel to Wall)				
Measured Laboratory Flanking STC		RR-336, Table 3.3.NLB.2.2.2, DWS89-WC-NLB-2-2-2	85	
Junction 3: Flanking STC for all paths			85 + 0 =	**85**
Junction 4 (Non-loadbearing Separating Wall / Wood-Framed Flanking Walls)				
Measured Laboratory Flanking STC		RR-336, Table 3.5.1.1, DWS89-WW-1-1R	68	
Junction 4: Flanking STC for all paths			68 + 0 =	**68**
Total Flanking STC (for all 4 junctions)		RR-336, Subset of Eq. 4.1.1	Combining 4 Junction Flanking STC values	65
ASTC due to Direct plus Total Flanking		RR-336, Eq. 4.1.1	Combining Direct STC with Flanking STC values	**56**

Summary for Section 4.3: Examples for Low-Rise Buildings – Wall Assemblies with 2 Rows of Wood Studs

The worked examples in this Section (4.3-H1 to 4.3-H3) illustrate the use of the Simplified Method for calculating the apparent sound transmission class (ASTC) ratings between rooms in a building with wood-framed floor and wall assemblies. All of the examples in this section concern cases where the separating walls are framed with a double row of wood studs.

The examples show the performance for cases with bare floor surfaces and for cases with improvements in direct and/or flanking sound transmission loss via specific paths due to selected changes in the junction or surface layers of the walls and floors.

Vertical Room Pairs (Separating Floors)

Examples in Section 4.2 for calculating the ASTC rating between a pair of rooms where one is above the other show the improvements relative to the base case (4.2-V1) as the floor and wall surfaces are upgraded. These are presented for the cases where separating walls have just a single row of studs, but they apply equally well to cases where the separating wall has a double row of studs. The pertinent issues are presented in Examples 4.2-V1 to 4.2-V3 and discussed at the end of Section 4.2.

Side-by-Side Rooms (Separating Walls with Double Row of Wood Studs)

Examples 4.3-H1 to 4.3-H3 illustrate the effect of changing some details for a horizontal pair of rooms separated by a double-stud wall.

- In the base Case A in 4.2-H1, the separating wall has a Direct STC rating of 54, but the ASTC is limited to 46 by flanking sound transmission at the floor/wall junction due to the rigid connection provided by the continuous OSB subfloor. This junction detail has advantages for shear bracing and provides a fire block, but also causes low Flanking STC values. If the continuous subfloor is essential for structural reasons, the flanking sound transmission can be moderated by orienting the floor joists perpendicular to the separating wall as shown in Case B of 4.2-H1. This raises the ASTC over 47, with no changes in the details of the wall or floor assemblies.
- In Example 4.2-H2, sound-absorbing material is added to the stud cavities on both sides of the separating wall, which raises the Direct STC from 54 to 57. However, adding the sound-absorbing material has negligible effect on the structure-borne flanking sound transmission, so flanking sound transmission via the wall/floor junction limits the ASTC for Case A to only 46, as in the previous example. In this example, because there is absorption filling the stud cavities on both sides of the wall, a solid fire block at the junctions is not required, and eliminating continuity of the OSB subfloor across the junctions (as shown in Case B) eliminates the flanking sound transmission there, raising the ASTC rating to 56.

For larger buildings, the continuity of the subfloor (or some other solid fire block) may be necessary for structural stability. In such cases, two obvious options to improve the ASTC are to increase the Direct STC by adding more gypsum board on the separating walls, and/or to add a heavy topping (such as a concrete subfloor, or an extra layer of OSB or plywood, or even strip hardwood flooring) on the floor surfaces to control the dominant flanking path.

- In Example 4.2-H3, the effect of adding a concrete topping over the OSB subfloor on both sides of the separating wall is illustrated. The Direct STC is 57, as in Example 4.2-H2. However, adding the floor topping has a significant effect on the structure-borne flanking sound transmission, so the ASTC rating for Case A improves from 46 to 55 due to reduced flanking sound transmission via the wall/floor junction. In this example, because there is absorption filling the stud cavities on both sides of the wall, a solid fire block at the junctions is not required, and eliminating continuity of the OSB subfloor across the junctions (as shown in Case B) eliminates the flanking sound transmission there, raising the ASTC to 56, limited only by direct transmission and flanking via the side walls as in the previous example. Although the ASTC is not better than for Option B in 4.2-H2, addition of the floor topping would also benefit the sound insulation between units one-above-the-other.

Overall, these examples show the clear benefit of suitable wall and ceiling surface layers in achieving high ASTC values, and emphasize the cost/benefit of focussing improvements on the weakest path(s).

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4.4 Examples for Mid-Rise Buildings – Wall Assemblies with Staggered Wood Studs

The worked examples in this Section demonstrate the use of the Simplified Method to calculate the ASTC rating for wood-framed constructions for mid-rise buildings.

The STC data needed for the examples in this Section are presented in Section 2.4 and Section 2.5. The Flanking STC data needed for examples in this Section are presented in Section 3.6 and Section 3.7.

EXAMPLE 4.4-H1: SIMPLIFIED METHOD

- **Rooms side-by-side**
- **Wood-framed floors and walls**

Separating wall assembly with:

- Two rows of staggered triple 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side (MR-SWS-12 in Table 2.4.2)
- 2G13_PLY16_SWS140(3WS89@400)_GFB90_2G13
- 2 layers of 13 mm fire-rated gypsum board[2], one side fastened over 16 mm plywood, other side fastened directly to framing

Bottom Junction 1 (separating wall and floor) with:

- Floor with 305 mm wood I-joists perpendicular to the wall, spaced 400 mm o.c. and with 150 mm sound-absorbing material[3] in cavities
- Subfloor of oriented strandboard (OSB) 16 mm thick on both sides, continuous across the junction
- No floor topping

Top Junction 3 (separating wall and ceiling) with:

- Ceiling with 305 mm wood I-joists, same as for bottom junction
- 2 layers of 13 mm fire-rated gypsum board on resilient channels[4] spaced 400 mm o.c.

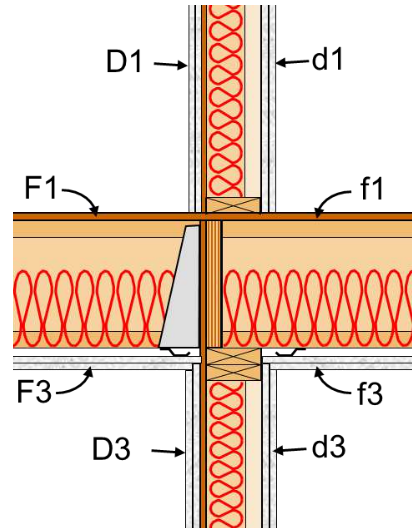
Side Junctions 2 and 4 (separating wall and side walls) with:

- Flanking walls with 2 rows of staggered 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side
- 2 layers of 13 mm fire-rated gypsum board[2] directly attached
- (MR-SWS-06 in Table, 2.4.1)

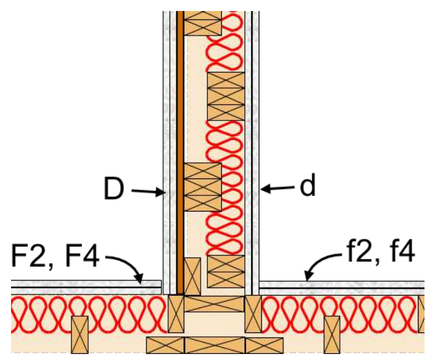
Acoustical Parameters:

	In Scenario	In Laboratory
Separating partition area (m^2) =	12.5	12.5
Floor/separating wall junction length (m) =	5.0	5.0
Wall/separating wall junction length (m) =	2.5	2.5
Normalization for Junctions 1 and 3:		
10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) =	0.00	RR-336, Eq. 4.1.3
Normalization for Junctions 2 and 4:		
10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) =	0.00	RR-336, Eq. 4.1.3

Illustration for this case



Junction 1 and 3 of loadbearing separating wall with floor and ceiling. (Side view)



Junction 2 or 4 of separating wall with abutting side walls with side walls' framing continuous across junction and gypsum board terminating at separating wall (Plan view)

(For the notes in this table please see the corresponding endnotes on page 166.)

	ISO Symbol	Reference	STC or ΔSTC	ASTC
Separating Partition (Loadbearing Wood-Framed Wall)				
Laboratory STC for Dd	R_s,w	RR-336, Table 3.6.LB.1.2, SWS89-WF-LB-1-2	51	
Direct STC in situ	R_Dd,w	RR-336, Eq. 4.1.2 (not a floor, so no ΔSTC correction)		**51**
Junction 1 (Loadbearing Wall / Wood-Framed Floor)				
For Flanking Path Ff_1:				
Laboratory Flanking STC		RR-336, Table 3.6.LB.1.2, SWS89-WF-LB-1-2	52	
ΔSTC change by Lining on F	ΔR_F,w	No flooring	0	
ΔSTC change by Lining on f	ΔR_f,w	No flooring	0	
Flanking STC for path Ff_1	R_Ff,w	RR-336, Eq. 4.1.3 and Eq. 4.1.5	52 + MAX(0,0)) + MIN(0,0)/2 + 0 =	**52**
For Flanking Path Fd_1:				
Laboratory Flanking STC		RR-336, Table 3.6.LB.1.2, SWS89-WF-LB-1-2	58	
ΔSTC change by Lining on F	ΔR_F,w	No flooring	0	
Flanking STC for path Fd_1	R_ Fd,w	RR-336, Eq. 4.1.3 and Eq. 4.1.4	58 + 0 + 0 =	**58**
For Flanking Path Df_1:				
Laboratory Flanking STC		RR-336, Table 3.6.LB.1.2, SWS89-WF-LB-1-2	54	
ΔSTC change by Lining on f	ΔR_f,w	No flooring	0	
Flanking STC for path Df_1	R_ Df,w	RR-336, Eq. 4.1.3 and Eq. 4.1.4	54 + 0 + 0 =	**54**
Junction 1: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-5.2 + 10^- 5.8 + 10^- 5.4) =	49
Junction 2 (Loadbearing Wood-Framed Separating Wall / Wood-Framed Flanking Walls)				
For Flanking Path Ff_2:				
Laboratory Flanking STC		RR-336, Table 3.7.2, SWS140(3WS89)-WW-2-2	70	
Flanking STC for path Ff_2	R_Ff,w	RR-336, Eq. 4.1.3	70 + 0 =	**70**
For Flanking Path Fd_2:				
Laboratory Flanking STC		RR-336, Table 3.7.2, SWS140(3WS89)-WW-2-2	65	
Flanking STC for path Fd_2	R_ Fd,w	RR-336, Eq. 4.1.3	65 + 0 =	**65**
For Flanking Path Df_2:				
Laboratory Flanking STC		RR-336, Table 3.7.2, SWS140(3WS89)-WW-2-2	65	
Flanking STC for path Df_2	R_ Df,w	RR-336, Eq. 4.1.3	65 + 0 =	**65**
Junction 2: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-7 + 10^- 6.5 + 10^- 6.5) =	61
Junction 3 (Loadbearing Wood-Framed Wall / Wood-Framed Floor/Ceiling)				
For Flanking Path Ff_3:				
Laboratory Flanking STC		RR-336, Table 3.6.LB.1.2, SWS89-WC-LB-1-2	80	
Flanking STC for path Ff_3	R_Ff,w	RR-336, Eq. 4.1.3	80 + 0 =	**80**
For Flanking Path Fd_3:				
Laboratory Flanking STC		RR-336, Table 3.6.LB.1.2, SWS89-WC-LB-1-2	67	
Flanking STC for path Fd_3	R_ Fd,w	RR-336, Eq. 4.1.3	67 + 0 =	**67**
For Flanking Path Df_3:				
Laboratory Flanking STC		RR-336, Table 3.6.LB.1.2, SWS89-WC-LB-1-2	69	
Flanking STC for path Df_3	R_ Df,w	RR-336, Eq. 4.1.3	69 + 0 =	**69**
Junction 3: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-8 + 10^- 6.7 + 10^- 6.9) =	65
Junction 4 (Loadbearing Wood-Framed Separating Wall / Wood-Framed Flanking Walls)				
All values the same as for Junction 2				
Flanking STC for path Ff_4	R_Ff,w	Same as for Ff_2		**70**
Flanking STC for path Fd_4	R_ Fd,w	Same as for Fd_2		**65**
Flanking STC for path Df_4	R_ Df,w	Same as for Df_2		**65**
Junction 4: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-7 + 10^- 6.5 + 10^- 6.5) =	61
Total Flanking STC (for all 4 junctions)		Subset of Eq. 4.1.1	Combining 12 Flanking STC values	49
ASTC due to Direct plus Total Flanking		Equation 4.1.1	Combining Direct STC with 12 Flanking STC values	**47**

EXAMPLE 4.4-H2: SIMPLIFIED METHOD

- **Rooms side-by-side**
- **Wood-framed floors and walls**

Separating wall assembly with:

- Two rows of staggered triple 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side (MR-SWS-12 in Table 2.4.2)
- 2G13_PLY16_SWS140(3WS89@400)_GFB90_2G13
- 2 layers of 13 mm fire-rated gypsum board[2], one side attached to the framing, other side on resilient channels spaced 600 mm o.c.

Bottom Junction 1 (separating wall and floor) with:

- Floor with 305 mm wood I-joists perpendicular to the wall, spaced 400 mm o.c. and with 150 mm sound-absorbing material[3] in cavities
- Subfloor of oriented strandboard (OSB) 16 mm thick on both sides, continuous across the junction
- Floor topping of 38 mm-thick gypsum concrete on 9 mm-thick foam

Top Junction 3 (separating wall and ceiling) with:

- Ceiling with 305 mm wood I-joists, same as for bottom junction
- 2 layers of 13 mm fire-rated gypsum board on resilient channels[4] spaced 400 mm o.c.

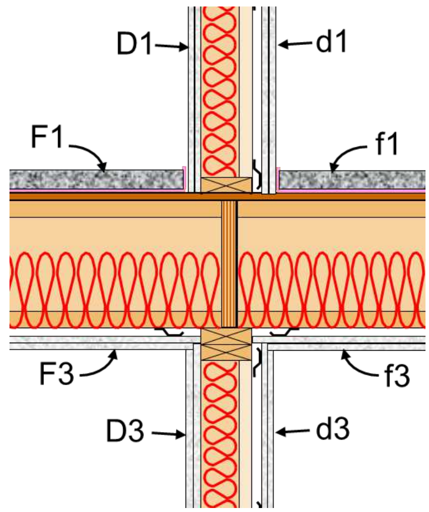
Side Junctions 2 and 4 (separating wall and side walls) with:

- Flanking walls with 2 rows of staggered 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side
- 2 layers of 13 mm fire-rated gypsum board[2] directly attached
- (MR-SWS-06 in Table, 2.4.1)

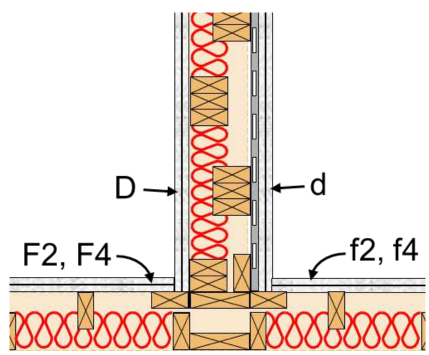
Acoustical Parameters:

	In Scenario	In Laboratory
Separating partition area (m^2) =	12.5	12.5
Floor/separating wall junction length (m) =	5.0	5.0
Wall/separating wall junction length (m) =	2.5	2.5
Normalization for Junctions 1 and 3:		
10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) =	0.00	RR-336, Eq. 4.1.3
Normalization for Junctions 2 and 4:		
10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) =	0.00	RR-336, Eq. 4.1.3

Illustration for this case



Junction 1 and 3 of loadbearing separating wall with floor and ceiling. (Side view)



Junction 2 or 4 of separating wall with abutting side walls with side walls' framing continuous across junction and gypsum board terminating at separating wall (Plan view)

(For the notes in this table please see the corresponding endnotes on page 166.)

	ISO Symbol	Reference	STC or ΔSTC	ASTC
Separating Partition (Loadbearing Wood-Framed Wall)				
Laboratory STC for Dd	R_s,w	RR-336, Table 2.4.2, MR-SWS-12	55	
Direct STC in situ	R_Dd,w	RR-336, Eq. 4.1.2 (not a floor, so no ΔSTC correction)		**55**
Junction 1 (Loadbearing Wall / Wood-Framed Floor)				
For Flanking Path Ff_1:				
Laboratory Flanking STC		RR-336, Table 3.6.LB.3.1, SWS89-WF-LB-3-1	65	
ΔSTC change by Lining on F	ΔR_F,w	No flooring	0	
ΔSTC change by Lining on f	ΔR_f,w	No flooring	0	
Flanking STC for path Ff_1	R_Ff,w	RR-336, Eq. 4.1.3 and Eq. 4.1.5	65 + MAX(0,0)) + MIN(0,0)/2 + 0 =	**65**
For Flanking Path Fd_1:				
Laboratory Flanking STC		RR-336, Table 3.6.LB.3.1, SWS89-WF-LB-3-1	68	
ΔSTC change by Lining on F	ΔR_F,w	No flooring	0	
Flanking STC for path Fd_1	R_ Fd,w	RR-336, Eq. 4.1.3 and Eq. 4.1.4	68 + 0 + 0 =	**68**
For Flanking Path Df_1:				
Laboratory Flanking STC		RR-336, Table 3.6.LB.3.1, SWS89-WF-LB-3-1	68	
ΔSTC change by Lining on f	ΔR_f,w	No flooring	0	
Flanking STC for path Df_1	R_ Df,w	RR-336, Eq. 4.1.3 and Eq. 4.1.4	68 + 0 + 0 =	**68**
Junction 1: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-6.5 + 10^- 6.8 + 10^- 6.8) =	62
Junction 2 (Loadbearing Wood-Framed Separating Wall / Wood-Framed Flanking Walls)				
For Flanking Path Ff_2:				
Laboratory Flanking STC		RR-336, Table 3.7.1, SWS140(3WS89)-WW-1-2	70	
Flanking STC for path Ff_2	R_Ff,w	RR-336, Eq. 4.1.3	70 + 0 =	**70**
For Flanking Path Fd_2:				
Laboratory Flanking STC		RR-336, Table 3.7.1, SWS140(3WS89)-WW-1-2	70	
Flanking STC for path Fd_2	R_ Fd,w	RR-336, Eq. 4.1.3	70 + 0 =	**70**
For Flanking Path Df_2:				
Laboratory Flanking STC		RR-336, Table 3.7.1, SWS140(3WS89)-WW-1-2	65	
Flanking STC for path Df_2	R_ Df,w	RR-336, Eq. 4.1.3	65 + 0 =	**65**
Junction 2: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-7 + 10^- 7 + 10^- 6.5) =	63
Junction 3 (Loadbearing Wood-Framed Wall / Wood-Framed Floor/Ceiling)				
For Flanking Path Ff_3:				
Laboratory Flanking STC		RR-336, Table 3.6.LB.3.1, SWS89-WC-LB-3-1	80	
Flanking STC for path Ff_3	R_Ff,w	RR-336, Eq. 4.1.3	80 + 0 =	**80**
For Flanking Path Fd_3:				
Laboratory Flanking STC		RR-336, Table 3.6.LB.3.1, SWS89-WC-LB-3-1	77	
Flanking STC for path Fd_3	R_ Fd,w	RR-336, Eq. 4.1.3	77 + 0 =	**77**
For Flanking Path Df_3:				
Laboratory Flanking STC		RR-336, Table 3.6.LB.3.1, SWS89-WC-LB-3-1	67	
Flanking STC for path Df_3	R_ Df,w	RR-336, Eq. 4.1.3	67 + 0 =	**67**
Junction 3: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-8 + 10^- 7.7 + 10^- 6.7) =	66
Junction 4 (Loadbearing Wood-Framed Separating Wall / Wood-Framed Flanking Walls)				
All values the same as for Junction_2				
Flanking STC for path Ff_4	R_Ff,w	Same as for Ff_2		**70**
Flanking STC for path Fd_4	R_ Fd,w	Same as for Fd_2		**70**
Flanking STC for path Df_4	R_ Df,w	Same as for Df_2		**65**
Junction 4: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-7 + 10^- 7 + 10^- 6.5) =	63
Total Flanking STC (for all 4 junctions)		Subset of Eq. 4.1.1	Combining 12 Flanking STC values	57
ASTC due to Direct plus Total Flanking		Equation 4.1.1	Combining Direct STC with 12 Flanking STC values	**53**

EXAMPLE 4.4-V1 SIMPLIFIED METHOD

- **Rooms one-above-the-other**
- **Wood-framed floors and walls**

Separating floor/ceiling assembly with:

- Floor with 305 mm wood I-joists spaced 400 mm o.c., with joists oriented perpendicular to loadbearing wall and 150 mm-thick sound-absorbing material[3] in cavities
- Subfloor of 16 mm oriented strandboard (OSB)
- 2 layers of 13 mm fire-rated gypsum board on resilient channels[4] spaced 400 mm o.c.

Junction 1 and 3 (loadbearing walls above and below floor) with:

- Joists of separating floor assembly perpendicular to these walls
- Two rows of staggered triple 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side (MR-SWS-12 in Table 2.4.2)
- Code: 2G13_PLY16_SWS140(3WS89@400)_GFB90_2G13
- 2 layers of 13 mm fire-rated gypsum board[2], one side fastened over 16 mm plywood, other side fastened directly to framing

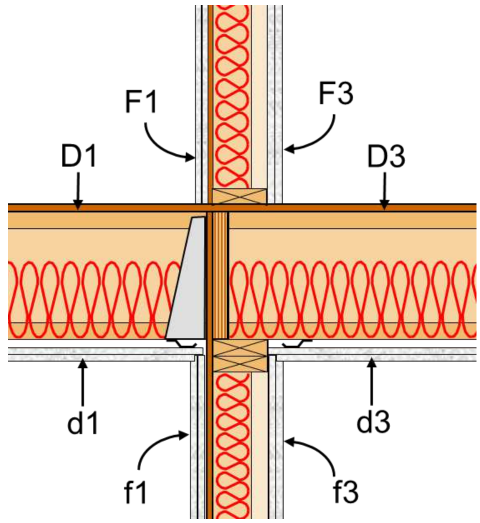
Junction 2 and 4 (non-loadbearing walls above and below floor) with:

- Joists of separating floor assembly parallel to these walls
- Two rows of staggered 38 mm x 89 mm wood studs spaced 400 mm o.c., with 90 mm-thick sound-absorbing material[3] filling the cavities on one side (MR-SWS-06 in Table, 2.4.1)
- 2 layers of 13 mm fire-rated gypsum board[2] directly attached

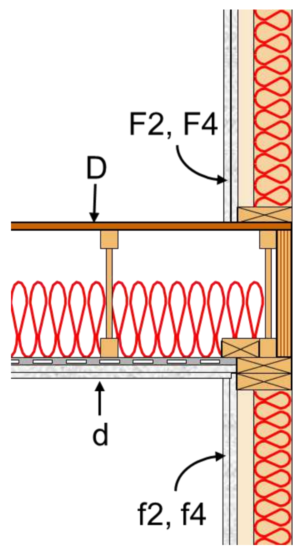
Acoustical Parameters:

	In Scenario	In Laboratory
Separating partition area (m^2) =	20.0	20.0
Floor/LB flanking wall junction length (m) =	5.0	5.0
Floor/NLB flanking wall junction length (m) =	4.0	5.0
Normalization for Junctions 1 and 3:		
10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) =	0.00	RR-336, Eq. 4.1.3
Normalization for Junctions 2 and 4:		
10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) =	0.97	RR-336, Eq. 4.1.3

Illustration for this case



Junction 1 or 3 with loadbearing side walls above and below the floor/ceiling assembly (wood I joists of floor are perpendicular to loadbearing wall). (Side view)



Junction 2 or 4 with non-loadbearing side walls above and below the floor/ceiling assembly (wood I joists of floor are parallel to the non-loadbearing wall). (Side view)

(For the notes in this table please see the corresponding endnotes on page 166.)

	ISO Symbol	Reference	STC or ΔSTC	ASTC
Separating Partition (Wood-Framed Floor)				
Laboratory STC for Dd	R_s,w	RR-336, Table 3.6.LB.1.2, WI305-FW-LB-1-2SH	53	
ΔSTC change by Lining on D	ΔR_D,w	No finish flooring	0	
Direct STC in situ	R_Dd,w	RR-336, Eq. 4.1.2	53 + 0 =	**53**
Junction 1 (Wood-Framed Floor / Loadbearing Wood-Framed Wall)				
For Flanking Path Ff_1:				
Laboratory Flanking STC		RR-336, Table 3.6.LB.1.2, WI305-FW-LB-1-2SH	75	
Flanking STC for path Ff_1	R_Ff,w	RR-336, Eq. 4.1.3	75 + 0 =	**75**
For Flanking Path Fd_1:				
Laboratory Flanking STC		RR-336, Table 3.6.LB.1.2, WI305-FW-LB-1-2SH	70	
Flanking STC for path Fd_1	R_ Fd,w	RR-336, Eq. 4.1.3	70 + 0 =	**70**
For Flanking Path Df_1:				
Laboratory Flanking STC		RR-336, Table 3.6.LB.1.2, WI305-FW-LB-1-2SH	60	
ΔSTC change by Lining on D	ΔR_D,w	No finish flooring	0	
Flanking STC for path Df_1	R_ Df,w	RR-336, Eq. 4.1.3 and Eq. 4.1.4	60 + 0 + 0 =	**60**
Junction 1: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-7.5 + 10^- 7 + 10^- 6) =	59
Junction 2 (Wood-Framed Floor / Non-loadbearing Wood-Framed Wall)				
For Flanking Path Ff_2:				
Laboratory Flanking STC		RR-336, Table 3.6.NLB.1.2, WI305-FW-NLB-1-2	75	
Flanking STC for path Ff_2	R_Ff,w	RR-336, Eq. 4.1.3	75 + 1 =	**76**
For Flanking Path Fd_2:				
Laboratory Flanking STC		RR-336, Table 3.6.NLB.1.2, WI305-FW-NLB-1-2	70	
Flanking STC for path Fd_2	R_ Fd,w	RR-336, Eq. 4.1.3	70 + 1 =	**71**
For Flanking Path Df_2:				
Laboratory Flanking STC		RR-336, Table 3.6.NLB.1.2, WI305-FW-NLB-1-2	60	
ΔSTC change by Lining on D	ΔR_D,w	No finish flooring	0	
Flanking STC for path Df_2	R_ Df,w	RR-336, Eq. 4.1.3 and Eq. 4.1.4	60 + 0 + 1 =	**61**
Junction 2: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-7.6 + 10^- 7.1 + 10^- 6.1) =	60
Junction 3 (Wood-Framed Floor / Loadbearing Wood-Framed Wall)				
Flanking STC for path Ff_3	R_Ff,w	Junction WI305-FW-LB-1-2, but all values the same as for Ff_1		**75**
Flanking STC for path Fd_3	R_ Fd,w	Junction WI305-FW-LB-1-2, but all values the same as for Fd_1		**70**
Flanking STC for path Df_3	R_ Df,w	Junction WI305-FW-LB-1-2, but all values the same as for Df_1		**60**
Junction 3: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-7.5 + 10^- 7 + 10^- 6) =	59
Junction 4 (Wood-Framed Floor / Non-loadbearing Wood-Framed Wall)				
Flanking STC for path Ff_4	R_Ff,w	Same as for Ff_2		**76**
Flanking STC for path Fd_4	R_ Fd,w	Same as for Fd_2		**71**
Flanking STC for path Df_4	R_ Df,w	Same as for Df_2		**61**
Junction 4: Flanking STC for all paths		Subset of Eq. 4.1.1	- 10*LOG10(10^-7.6 + 10^- 7.1 + 10^- 6.1) =	60
Total Flanking STC (4 Junctions)		Subset of Eq. 4.1.1	Combining 12 Flanking STC values	54
ASTC due to Direct plus Total Flanking		Equation 4.1.1	Combining Direct STC with 12 Flanking STC values	**50**

Summary for Section 4.4: Examples for Mid-Rise Buildings – Wall Assemblies with Staggered Wood Studs

The worked examples in this Section (4.4-H1 to 4.4-H2 and 4.4-V1) illustrate the use of the Simplified Method for calculating the apparent sound transmission class (ASTC) ratings between rooms in a building with wood-framed floor and staggered stud wall assemblies suitable for multi-storey applications.

The examples in this section concern cases where the loadbearing separating walls are framed with staggered wood studs (2 staggered rows of triple 38 mm x 89 mm studs with common bottom plate and top plate) with high loadbearing capacity suitable for mid-rise buildings.

Example 4.4-H1 (for side-by-side rooms separated by a staggered-stud wall) shows that ASTC values of 47 or higher can be achieved even with a basic floor assembly with no topping over the plywood or OSB subfloor. Any improvements relative to this base case must start by improving the weakest paths – the set of paths involving the floor surfaces, and then the separating wall.

Example 4.4-H2 illustrates such an improvement:

- A 38 mm-thick floor topping on the subfloor increases the Flanking STC at the bottom junction from 49 to 62. Adding resilient channels to the separating assembly increases the Direct STC from 51 to 55. The two changes combined increase the ASTC rating from 47 to 53.

Example 4.4-V1 (for one room above the other) shows that an ASTC rating of 50 is achieved even with a basic OSB subfloor and no topping. The similar flanking sound transmission at all four junctions gives a combined Flanking STC of 54, almost matching the Direct STC rating of 53 for direct transmission through the floor.

- In this case, it can be observed that the direct transmission (Path Dd) and the Df flanking paths for all four junctions limit the ASTC rating. The obvious improvement is adding a topping on the floor surface (D).
- For example, with a cement board topping, the ASTC would rise to 54, and the heavier concrete topping would improve the performance further to ASTC 60.

5 References and Endnotes

Technical Standards

1. ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements", ASTM International, West Conshohocken, PA, USA.

2. ASTM E336-16, "Standard Test Method for Measurement of Airborne Sound Insulation in Buildings", ASTM International, West Conshohocken, PA, USA.

3. ASTM E413-16, "Classification for Rating Sound Insulation", ASTM International, West Conshohocken, PA, USA.

4. ASTM E2235-04, "Standard Test Method for Determination of Decay Rates for Use in Sound Insulation Test Methods", ASTM International, West Conshohocken, PA, USA.

5. ISO 717:2013, "Acoustics—Rating of sound insulation in buildings and of building elements", International Organization for Standardization, Geneva.

   5.1. Part 1: Airborne Sound Insulation

   5.2. Part 2: Impact Sound Insulation

6. ISO 10140:2011, Parts 1 to 5, "Laboratory measurement of sound insulation of building elements", International Organization for Standardization, Geneva.

   6.1. Note: In 2011, the ISO 10140 series replaced ISO 140 Parts 1, 3, 6, 8, 10, 11 and 16.

   6.2. Note: In 2014, ISO 140-4 was replaced by ISO 16283-1, "Field measurement of sound insulation in buildings and of building elements."

7. ISO 10848:2006, Parts 1 to 4, "Laboratory measurement of flanking transmission of airborne and impact sound between adjoining rooms", International Organization for Standardization, Geneva.

8. ISO 15712:2005, Part 1, "Estimation of acoustic performance of buildings from the performance of elements", International Organization for Standardization, Geneva.

Other Technical References

9. L. Cremer and M. Heckl, "Structure-borne sound", edited by E. E. Ungar, Springer-Verlag, New York (original edition 1973, 2nd edition 1996).

10. E. Gerretsen, "Calculation of the sound transmission between dwellings by partitions and flanking structures", Applied Acoustics, Vol. 12, pp. 413-433 (1979), and "Calculation of airborne and impact sound insulation between dwellings", Applied Acoustics, Vol. 19, pp. 245-264 (1986).

11. R. J. M. Craik, "Sound transmission through buildings: Using Statistical Energy Analysis", Gower Publishing (1996).

12. D. B. Pedersen, "Evaluation of EN 12354 Part 1 and 2 for Nordic Dwelling Houses", Building Acoustics, Vol. 6, No. 3, pp. 259-268 (1999), (Validation studies for the ISO 15712 procedures).

NRC Publications

Source references for sound transmission data (both collections of conventional laboratory test results for wall and floor assemblies according to ASTM E90, and flanking sound transmission tests according to ISO 10848) including many NRC Construction reports in the RR- and IR- series are available from the Publications Archive of the National Research Council Canada at http://nparc.cisti-icist.nrc-cnrc.gc.ca/npsi/ctrl?lang=en.

13. RR-331, "Guide to Calculating Airborne Sound Transmission in Buildings", 3rd Edition, 2017, C. Hoeller, D. Quirt, J. Mahn. RR-331 presents both the "Detailed Method" of ISO 15712-1 and the "Simplified Method" for calculating the apparent sound transmission in buildings for a variety of constructions types.

14. The software application *soundPATHS* is accessible online at the website of the National Research Council Canada. The calculations are based on experimental studies in the laboratories of the NRC: http://www.nrc-cnrc.gc.ca/eng/solutions/advisory/soundpaths/index.html

15. Direct and flanking sound transmission loss data that is used in RR-331 and in *soundPATHS* is provided in a series of accompanying NRC Research Reports:

    15.1. RR-333, "Apparent Sound Insulation in Concrete Buildings", (expected 2018).

    15.2. RR-334, "Apparent Sound Insulation in Concrete Block Buildings", B. Zeitler, D. Quirt, S. Schoenwald, J. Mahn, (2015).

    15.3. RR-335, "Apparent Sound Insulation in Cross-Laminated Timber Buildings", C. Hoeller, J. Mahn, D. Quirt, S. Schoenwald, B. Zeitler, (2017).

    15.4. RR-336, "Apparent Sound Insulation in Wood-Framed Buildings", C. Hoeller, D. Quirt, M. Mueller-Trapet, (2017).

    15.5. RR-337, "Apparent Sound Insulation in Cold-Formed Steel-Framed Buildings", C. Hoeller, D. Quirt, B. Zeitler, I. Sabourin, (2017).

16. Technical details concerning the measurement protocol (consistent with ASTM E90 and ISO 10848) and discussion of the findings of the experimental studies are presented in a series of NRC reports:

    16.1. IR-754, "Flanking Transmission at Joints in Multi-Family Dwellings. Phase 1: Effects of Fire Stops at Floor/Wall Intersections", T. R. T. Nightingale and R. E. Halliwell, (1997).

    16.2. IR-761, "Gypsum Board Walls: Transmission Loss Data", R. E. Halliwell, T. R. T. Nightingale, A. C. C. Warnock and J. A. Birta, (1998).

    16.3. IR-766, "Summary Report for Consortium on Fire Resistance and Sound Insulation of Floors: Sound Transmission Class and Impact Insulation Class Results", A. C. C. Warnock and J. A. Birta, (1998).

    16.4. IR-811, "Detailed Report for Consortium on Fire Resistance and Sound Insulation of Floors: Sound Transmission and Impact Insulation Data", A. C. C. Warnock and J. A. Birta, (2000).

16.5. RR-103, “Flanking Transmission in Multi-Family Dwellings Phase II: Effects of Continuous Structural Elements at Wall/Floor Junctions”, T. R. T. Nightingale, R. E. Halliwell, J. D. Quirt, (2002).

16.6. RR-168, “Transmission at the Wall/Floor Junction in Multifamily Dwellings – Quantification and Methods of Suppression”, T. R. T. Nightingale, R. E. Halliwell, J. D. Quirt, F. King, (2005).

16.7. RR-169, “Summary Report for Consortium on Fire Resistance and Sound Insulation of Floors: Sound Transmission and Impact Insulation Data”, A. C. C. Warnock, (2005).

16.8. RR-193, “Guide for Sound Insulation in Wood Frame Construction – Part 1: Controlling Flanking at the Wall-Floor Junction”, J. D. Quirt, T. R. T. Nightingale, R. E. Halliwell, (2005).

16.9. A. C. C. Warnock, SOCRATES (**SO**und **C**lassification **RAT**ing **ES**timator) software, (2005).

16.10. RR-218, “Flanking Transmission in Multi-Family Dwellings Phase IV”, T. R. T. Nightingale, J. D. Quirt, F. King and R. E. Halliwell, (2006).

16.11. RR-219, “Guide for Sound Insulation in Wood Frame Construction”, J. D. Quirt, T. R. T. Nightingale, and F. King, (2006).

16.12. NRC Report #49677, “Best Practice Guide on Fire Stops and Fire Blocks and their Impact on Sound Transmission”, J. K. Richardson, J. D. Quirt, R. Hlady, (2007).

16.13. NRC Construction Technology Update 66, “Airborne Sound Insulation in Multi-Family Buildings”, J. D. Quirt, T. R. T. Nightingale, (2008).

16.14. NRC Report A1-100035-02.1, ”Acoustics: Sound insulation in mid-rise wood buildings” (Report to Research Consortium for wood and wood-hybrid mid-rise buildings), S. Schoenwald, B. Zeitler, F. King, I. Sabourin, (2014).

17. Other relevant NRC publications:

17.1. I. Sabourin, B. Zeitler, F. King: “Effect of structural load and joist type on flanking sound transmission”, Proceedings of Acoustics Week in Canada, Niagara-on-the-Lake, (2009).

17.2. F. King, S. Schoenwald, I. Sabourin: “Characterizing flanking transmission paths in the NRC-IRC flanking facility”, Proceedings of Acoustics Week in Canada, Niagara-on-the-Lake, (2009).

17.3. T. Estabrooks, F. King, T. R. T. Nightingale, I. Sabourin: “NRC-IRC flanking sound transmission facility”, Proceedings of Acoustics Week in Canada, Niagara-on-the-Lake, (2009).

Endnotes

1 Wood framing includes floor joists and wall studs that are cut from wood to standard cross-section dimensions. In the case of wood studs, the common dimensions are 38 mm x 89 mm or 38 mm x 140 mm. In the case of wood joists, the thickness is normally 38 mm, but depths are varied depending on the floor span.

2 Gypsum board panels commonly form the exposed surface on lightweight framed wall or floor assemblies and on linings for heavy homogeneous structural wall or floor assemblies of concrete, concrete block or CLT. The gypsum board in this Report had nominal thickness of 12.7 mm (1/2 in.) or 15.9 mm (5/8 in.) denoted in specimen codes as 13 mm and 16 mm respectively.

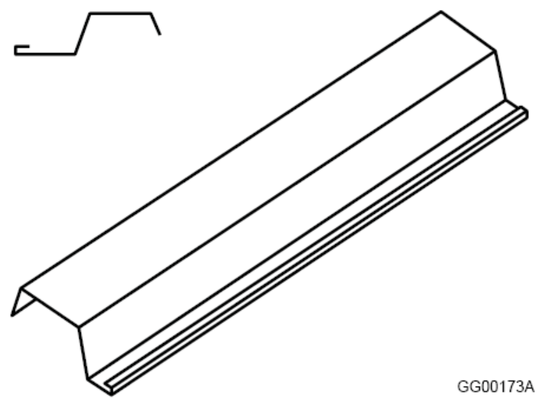
"Fire-rated gypsum board" is typically heavier than non-fire-rated gypsum board. The higher mass per area of the fire-rated gypsum board gives improved resistance to sound transmission through the assembly. The descriptor "fire-rated" is used in this Report to denote gypsum board with proven fire-resistant properties, with mass per unit area of at least 8.7 kg/m^2 for 12.7 mm thickness, or 10.7 kg/m^2 for 15.9 mm thickness. Gypsum board panels are installed with framing, fasteners and fastener spacing conforming to installation details required by CSA A82.31-M or ASTM C754. The sound transmission results should only be used where the actual construction details correspond to the details of the test specimens on which the ratings are based.

3 Sound-absorbing material is porous (closed-cell foam is not included) and readily-compressible, and includes fibre processed from rock, slag, glass or cellulose fibre. Such material provides acoustical benefit for direct transmission through lightweight framed wall or floor assemblies, and for flanking sound transmission when installed in the cavities between lining surfaces and heavy homogeneous structural elements. Note that overfilling the cavity could diminish the benefit of the sound absorbers.

4 Resilient metal channels are formed from steel with a maximum thickness of 0.46 mm (25 gauge), with a profile essentially as shown in Figure 5.1, with slits or holes in the single "leg" between the faces fastened to the framing and to the gypsum board. Installation of the resilient channels must conform to ASTM C754.

Figure 5.1: Drawing to illustrate the typical profile of resilient metal channels; approximate dimensions in cross-section are 13 mm x 60 mm (not precisely to scale).

(Copied from Figure A-9.10.3.1. of the National Building Code of Canada, used with permission)



5 For purposes of this Report, the term “wood floor joists” (also referred to in this Report as “floor joists” or “wood joists”) generally includes three types of framing. The applicability of the sound transmission loss data presented in this Report for each of the three types is noted in each Section. The general properties of the three types of wood floor joists conform to the Notes to Table 9.10.3.1. in the 2015 National Building Code of Canada:

1) Wood joists of solid-sawn wood with minimum member size of 38 mm (width) x 235 mm (depth). Where specifically noted, the sound transmission data also applies to solid-sawn wood joists of size 38 mm x 184 mm.
2) Wood I-joists with minimum flange size of 38 mm x 38 mm and minimum joist depth of 241 mm
3) Wood trusses (finger-joined, or metal-web, or metal-plate-connected) with minimum depths according to the type of truss (330 mm, or 286 mm, or 305 mm, respectively)

The wood floors joists are combined with end plates of solid wood or rimboard of the same depth to frame the floor assembly.