# Apparent sound insulation in concrete block buildings

Zeitler, Berndt; Quirt, David; Schoenwald, Stefan; Mahn, Jeffrey



**Publisher's version / Version de l'éditeur:**
https://doi.org/10.4224/21275887
*Research Report (National Research Council of Canada. Construction), 2015-06*

NRC·CNRC Construction

# RR-334
# Apparent Sound Insulation in Concrete Block Buildings

Berndt Zeitler, David Quirt, Stefan Schoenwald, Jeffrey Mahn

June, 2015

National Research Council Canada Conseil national de recherches Canada

Canada

**Overview**

This report presents the results from two substantial experimental studies of sound transmission, together with an explanation of calculation procedures to predict the sound transmission between adjacent spaces in a building whose construction combines concrete block walls with other types of constructions.

**Acknowledgements**

The research studies on which this report is based were supported by the Canadian Concrete Masonry Producers Association.

**Disclaimer**

Although it is not repeated at every step of this report, it should be understood that some variation is to be expected in practice due to changing specific design details, poor workmanship, substitution of "generic equivalents" or simply rebuilding the construction.

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.

# 1 Sound Transmission via Many Paths

The simplest approach to sound transmission between adjacent rooms in buildings considers only the sound transmission through the wall or floor that separates the adjacent spaces. This perspective has been entrenched in North American building codes, which for many decades have considered only the ratings for the individual separating assembly: Sound Transmission Class (STC) or Field Sound Transmission Class (FSTC) for airborne sources or Impact Insulation Class (IIC) for footstep noise.

Implicit in this approach is the simplistic assumption (illustrated in Figure 1.1) 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 ascribed to errors in either design of the separating assembly or the workmanship of those who built it, and remediation focuses on that assembly. Unfortunately, this paradigm is still common among designers and builders in North America. In reality, the technical issue is more complex, as illustrated in Figure 1.2.

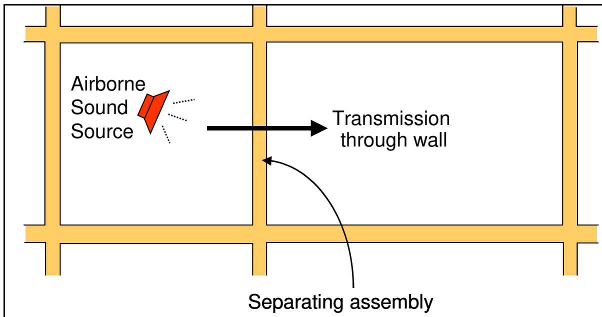



**Figure 1.1**: The drawings in Figure 1.1 and 1.2 show a cross-section through a building with two adjacent rooms. Part of the sound from an airborne source in one unit (represented by red loudspeaker in the drawings, which could include anything from a home theatre to people talking loudly) is transmitted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

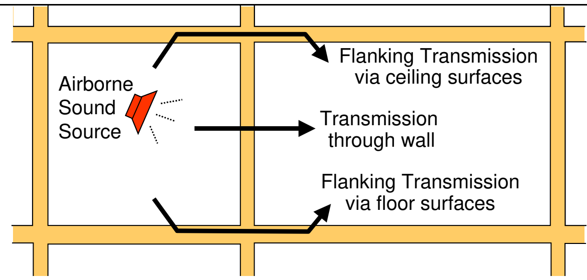



**Figure 1.2**: In reality, there are many paths for sound transmission between adjacent rooms, including both direct transmission through the separating assembly and indirect structure-borne paths, a few of which are indicated here. (See Section 1.4 for more detail.) The structure-borne paths usually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

There is direct transmission of sound through the separating assembly, but as Figure 1.2 shows, that is only part of the story. 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, where a part of the vibrational energy is radiated as sound. This is called flanking sound transmission.

It follows that the sound insulation between adjacent rooms is always worse than the sound insulation provided by just the obvious separating assembly. This is because the occupants of the adjacent room actually hear the combination of sound due to direct transmission through the separating assembly and any leaks, plus sound due to structure-borne flanking transmission involving all the other elements coupled to the separating assembly.

Of course, this has long been recognized in principle and the fundamental science was largely explained decades ago, with key contributions made by Cremer and Heckl (1), Gerretsen (2,3) and Craik (4), among others. The challenges for being able to predict the structure-borne flanking transmission have 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 a 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 has recently defined the corresponding Apparent Sound Transmission Class (ASTC), which is used in examples in this Report.

While measuring the ASTC rating in a building (following ASTM Standard E336 (5)) is quite straightforward, predicting the ASTC rating 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 calculations use standardized measurements to characterize the sub-assemblies (walls, floors, junctions) as inputs to empirical calculations of the sound insulation between rooms.

In 2005, ISO published a calculation method, ISO 15712-1:2005, "Building acoustics — Estimation of acoustic performance of buildings from the performance of elements — Part 1: Airborne sound insulation between rooms" (6). This is one part of a series of standards: Part 2 (7) deals with "impact sound insulation between rooms", Part 3 (8) deals with "airborne sound insulation against outdoor sound" and Part 4 (9) deals with "transmission of indoor sound to the outside." The ISO 15712 series was originally prepared by the European Commission for Normalization (Committee CEN/TC 126) as EN 12354:2000 (10). The EN 12354 standards have been used for more than a decade to support performance-based European code systems, and they were subsequently adopted as ISO standards without modification by Technical Committee ISO/TC 43/2.

However, there are two significant impediments to applying the methods of ISO 15712-1:2005 in a North American context:

- ISO 15712-1 provides very reliable estimates for some types of construction, but not for the lightweight framed construction widely used for low-rise and mid-rise buildings in North America.
- ISO standards for building acoustics have 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 common types of construction.

This Report was developed in a project established by the National Research Council of Canada to support transition of construction industry practice to using the ASTC rating rather than the STC rating 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 in both Canada and the USA.

## 1.1 Predicting Sound Transmission in a Building

As noted in the previous section, ISO 15712-1:2005 provides reliable estimates of sound transmission for buildings with structural concrete floors and walls of concrete masonry (constructed with normal weight or lightweight units) or concrete, but it is less accurate for other common types of constructions, especially lightweight wood frame and steel frame constructions.

ISO 15712-1:2005 has other limitations, too. For example, in several places (especially for light frame construction) the ISO standard identifies situations where the detailed calculation is not appropriate, but 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 made according to the ISO 10848 series of standards (11–14). The four parts of ISO 10848 were developed by working groups of ISO TC 43/2 to deal with measuring flanking 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 the more recent standards such as the ISO 10848 series or the ISO 10140 series (15–19) that is replacing the current ISO 140 series referenced in ISO 15712-1.

To work around these limitations, and to provide more guidance to users on how to use this calculation procedure for specific situations, this Report presents an approach suited to each type of construction:

- For types of construction where the calculation procedure of ISO 15712-1 ***<u>is appropriate</u>***, this Report outlines the steps of the standardized calculation process. 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;
- For types of construction where the calculation procedure of ISO 15712 ***<u>is not appropriate</u>***, this Report presents an alternative approach which is based on experimental data obtained using the ISO 10848 series of standards for laboratory measurement of flanking transmission. The approach combines the sound power due to direct and flanking transmission in the same way as ISO 15712-1, as described in Section 1.4 of this Report.

The appropriate calculation process to be used depends on the type of wall and floor constructions to be combined with the concrete block walls to form a complete building as well as the details of junctions by which they are connected. For this reason, Chapter 4 is divided into sections which describe the suitability for the combination of concrete block walls with other constructions:

- concrete masonry walls with concrete floors in Chapter 4.1,
- concrete masonry walls with lightweight wood-framed walls and floors in Chapter 4.2,
- concrete masonry walls with lightweight steel-framed walls and floors in Chapter 4.3,
- concrete masonry walls with precast concrete floors in Chapter 4.4.

In all cases, the masonry walls may be constructed from normal weight or lightweight concrete block masonry units.

## 1.2 Standard Scenario for Examples in this Report

When dealing with the prediction of sound transmission between adjoining spaces in a building, as described in the previous section, the predicted attenuation for the various paths depends not just on the constructions involved, but also on the size and shape of each of the room surfaces as well as 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 in Chapter 4, easy and meaningful comparison of results is facilitated by calculating all the examples for a common set of room geometries and dimensions and using a consistent rating (ASTC) to describe the overall system performance. There are many pairs of examples in the following sections where such comparisons are instructive. This is particularly useful where only one part of the construction is changed from one example to another, since the construction change can be unequivocally related to the change in predicted ASTC rating.

Hence a Standard Scenario has been used for all the examples. The Standard Scenario includes:

- two adjacent rooms that 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;
- pairs of rooms that are either side-by-side (illustrated in Figure 1.3) or one-above-the-other (illustrated in Figure 1.4).

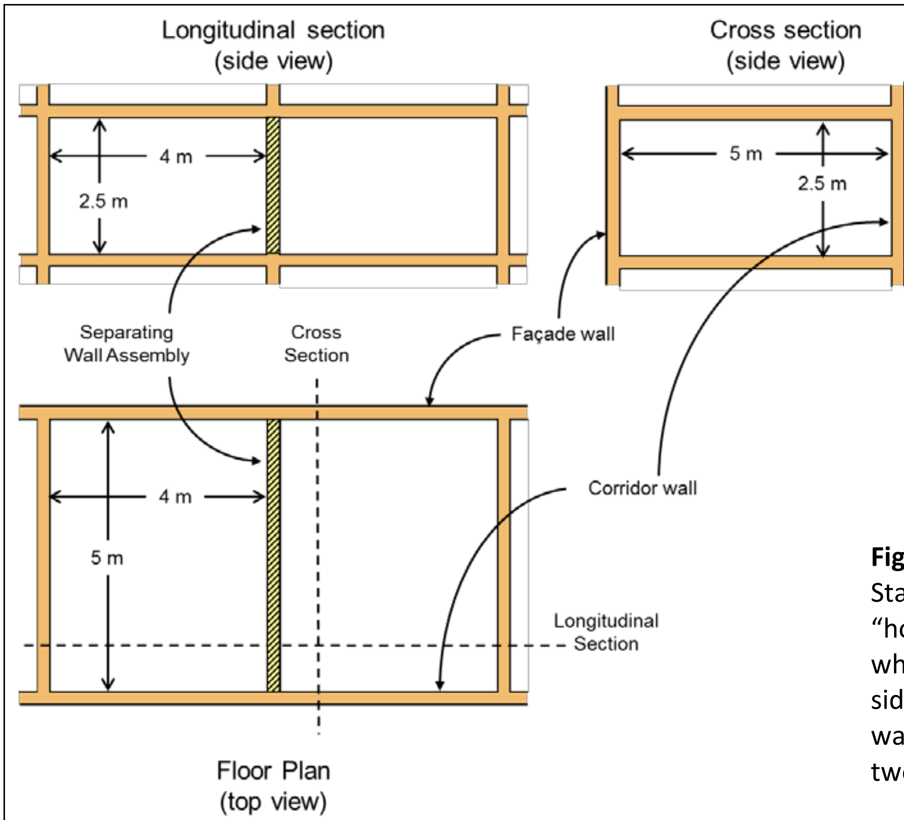



**Figure 1.3**: Standard Scenario for "horizontal room pair" case where the pair of rooms are side-by side with a separating wall assembly between the two rooms

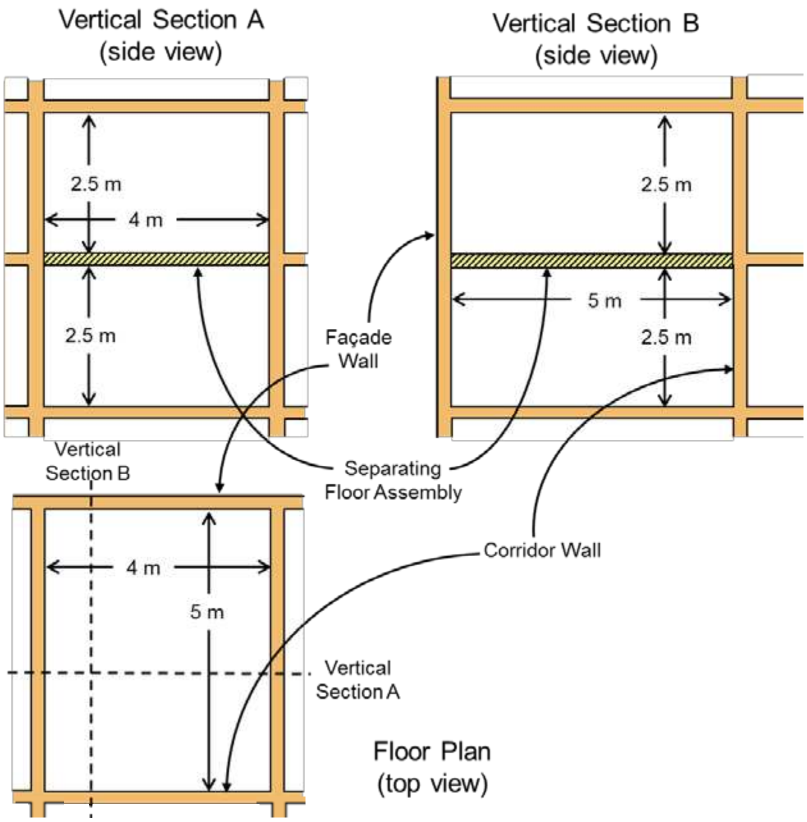



**Figure 1.4:** Standard Scenario for "vertical room pair" case where one of the pair of rooms is above the other, with a floor/ceiling assembly between the two rooms

The pertinent dimensions and junction details (as shown in Figures 1.3 and 1.4) are:

- For horizontal room pairs (i.e. rooms are side-by-side) the separating wall is 2.5 m high by 5 m wide, the flanking floor/ceilings are 4 m by 5 m and the 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 the flanking walls in both rooms are 2.5 m high.
- In general, it is assumed that the 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 the 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 the 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.

In a building, cases with cross junctions at separating walls on either side and at the corridor side seem quite common, and deviations from this Standard Scenario, such as pairs where one is an end unit, should tend to give slightly higher ASTC ratings.

## 1.3 Applying the Concepts of ISO Standards in an ASTM Environment

Although the building acoustics standards developed by ASTM Committee E33 are very similar in concept to the corresponding standards developed by ISO TC 43/2, they do present numerous barriers to using a mix of standards from the two domains due to both differences in terminology and the different technical requirements for some of the measurement procedures and ratings.

Even though the ASTM standard E336 recognizes the contribution of flanking to the apparent sound transmission, there are no ASTM standards for measuring the structure-borne flanking transmission that often dominates sound transmission between rooms. Nor is there an ASTM counterpart of ISO 15712-1 for predicting the combination of direct and flanking transmission. In the absence of suitable ASTM standards, this Report uses the procedures of ISO 15712-1 and data from the complementary ISO 10848 measurement standards for some constructions, but connects this ISO calculation framework to the ASTM terms and test data which are widely used by the North American construction industry. To facilitate the use of ISO calculation procedures as well as an understanding by a North American audience, this Report both identifies where data from ASTM laboratory tests can reasonably be used in place of their ISO counterparts and presents the results using ASTM terminology (or new terminology for flanking transmission that is consistent with existing ASTM terms). Some obvious counterparts are shown in Table 1.1, and a detailed lexicon of the ISO terms is given in ISO 15712-1:2005.

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

| ISO Designation | Description | ASTM Counterpart |
|---|---|---|
| ISO 10140 Parts 1 and 2 | Laboratory measurement of the airborne sound transmission through a wall or floor | ASTM E90 (20) |
| sound reduction index $R$ (10140-2 test) | Fraction of sound power transmitted (in dB) in each 1/3-octave-frequency band in standard laboratory test | sound transmission loss TL (ASTM E90 test) |
| weighted sound reduction index $R_w$ (ISO 717-1 (21) from 10140-2 data) | Single-number rating determined from the R or TL values for the set of standard 1/3-octave-frequency bands | sound transmission class STC (ASTM E413 (22) from E90 data) |
| apparent sound reduction index $R'$ (ISO 16283-1 (23) test or calculation) | Fraction of sound power transmitted (in dB) in each 1/3-octave-frequency band, including all of the transmission paths between two rooms | apparent transmission loss ATL (ASTM E336 test or calculation) |
| weighted apparent sound reduction index $R'_w$ | Single-number rating determined from the $R'$ or ATL values for the set of standard 1/3-octave-frequency bands | apparent sound transmission class ASTC |

Note that for this description, “counterpart” does not imply the ASTM and ISO standards or terms are exactly equivalent, but in most cases they are very similar. The laboratory test procedures used to measure the airborne sound transmission through wall or floor assemblies – ASTM E90 and its ISO counterpart ISO 10140-2 – are based on essentially the same procedure with minor variants in test requirements. Hence, the measured quantities "airborne sound transmission loss" from the ASTM E90 test and "sound reduction index" from the ISO standards are sufficiently similar so that data from ASTM E90 measurements can be used in place of data from ISO 10140-2 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 ratings. But, $R_W$ and STC are not interchangeable. Neither are $R'_W$ and ASTC because of significant differences in the calculation procedures. The close parallel between "sound reduction index" and "sound transmission loss" also means that results from ISO 15712-1 calculation (normally expressed as R' values) can confidently be treated as the calculated Apparent Transmission Loss (ATL) values and then processed according to ASTM 413 to calculate the ASTC rating which is the suggested objective for designers or regulators in the North American context.

A glossary of additional new terms is presented in Table 1.2.

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

| Other Terms used in this Report | Description |
|---|---|
| Structural reverberation time | Structural reverberation time ($T_S$) is a measure indicating the rate of decay of structural vibration in an assembly 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 | Transmission loss in-situ is the counterpart of sound reduction index in-situ ($R_{situ}$) described in ISO 15712 as "the sound reduction index of an element in the actual field situation". For the detailed calculation of ISO 15712, this depends on structural reverberation time of the element (wall or floor assembly) in the laboratory and in-situ. |
| Vibration reduction index | Vibration reduction index ($K_{ij}$) is described in ISO 15712 as "direction-averaged vibration level difference over a junction, normalised to the junction length and the equivalent sound absorption length to make it an invariant quantity". For practical application, a value of $K_{ij}$ may be determined using equations in Annex E of ISO 15712-1 or the measurement procedures of ISO 10848. |
| Junction velocity level difference | Junction velocity level difference (JVLD) is described in ISO 15712 as "junction velocity level difference in-situ between an excited element (wall or floor) and the receiving element (wall or floor)". It is calculated by correcting $K_{ij}$ to allow for edge losses (identified through structural reverberation times) of the assemblies in-situ. |
| Flanking transmission loss | Flanking transmission loss (Flanking TL) is the counterpart of flanking sound reduction index ($R_{ij}$) in ISO 15712. 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, normalised like apparent sound transmission loss and ASTC, and is described in detail in Section 1.4. |
| Flanking STC | Flanking STC is the single number rating calculated following the STC-calculation procedure of ASTM E413, using values of the flanking transmission loss for one flanking path as the input data. |

The terms in the table have counterparts in ISO 15712-1 (using terminology consistent with measures used in ASTM standards) and pertinent ISO standards such as ISO 15712 and ISO 10848.

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

## 1.4 Combining Sound Transmitted via Many Paths

The calculations of ISO 15712-1 must deal with the combination of the sound power transmitted via the direct path as well as a set of flanking paths. To discuss this, it is useful to introduce the convention for labelling the transmission paths that is used in ISO 15712-1, as explained in Figure 1.5.

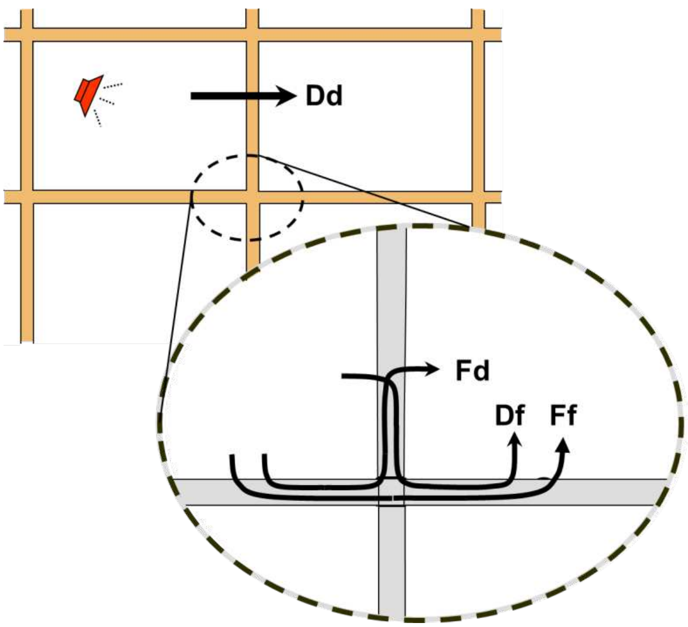



**Figure 1.5:** This figure shows the labelling convention for transmission paths used in ISO 15712-1. Consider transmission from a source room at the left to the receiving room beside it. Each transmission path involves one surface in the source room (denoted by a capital letter) and one in the receiving room (lower case). **D**irect transmission through the separating wall is path **Dd**. For each edge of the separating assembly there are three flanking paths, each involving a surface in the source room and one in the receiving room, that connect at this edge: **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 in the receiving room.

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, as detailed in the following Table 1.3. These labels and their use will become more obvious in the calculation examples in Chapter 4 of this Report.

**Table 1.3:** Surfaces (D, d, F and f) for flanking paths at each junction, as applied in the examples using the Standard Scenario presented in Section 1.2 of this Report. Related drawings are shown in Figures 1.3 and 1.4.

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

In Canada, building elements are normally tested according to the ASTM E90 [1] standard, and as of the 2015 revision of the NBCC, the building code requirements are given in terms of the Apparent Sound Transmission Class (ASTC) which is determined according to ASTM E413 from the apparent sound transmission loss (ATL) for the set of 1/3 octave bands from 125 to 4000 Hz. Merging this context with the ISO procedures of ISO 15712-1, the terms "direct sound transmission loss" and "flanking sound transmission loss" have been introduced to provide consistency with the ASTM terminology while matching the function of the direct and flanking sound reduction index (as defined in ISO 15712-1), in keeping with the discussion of terms in Section 1.3.

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 with that transmitted via the twelve first-order flanking paths (three paths at each edge of the separating assembly, as illustrated in Figure 1.5). Equation 14 in ISO 15712-1 is recast here with a 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 the sound that by-passes the building structure, e.g. leaks, ducts,…) is the resultant of the direct sound transmission loss ($\mathrm{TL}_{Dd}$) through the separating wall or floor element and the set of flanking sound transmission loss contributions ($\mathrm{TL}_{Ff}$, $\mathrm{TL}_{Fd}$, and $\mathrm{TL}_{Df}$) of the three flanking paths for every junction at the edges of the separating element (as shown in Fig. 1.5) such that:

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

Eq. 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.

The most suitable method to calculate the values for direct transmission or flanking transmission for each path in Eq. 1.1 depends on the type of wall and floor constructions to be combined with the concrete block walls to form the complete building. For this reason, Chapter 4 (which presents the calculation methods and examples) is divided into the following sections suitable for the combination of concrete block walls with other constructions:

- concrete masonry walls with concrete floors in Chapter 4.1
- concrete masonry walls with lightweight wood-framed walls and floors in Chapter 4.2
- concrete masonry walls with lightweight steel-framed walls and floors in Chapter 4.3
- concrete masonry walls with precast concrete floors in Chapter 4.4

Each of the flanking sound transmission loss values for a specific path is normalized to nominal room absorption 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 transmission input data to the case where receiving room absorption is numerically equal to the area of the separating assembly (i.e. using the apparent sound transmission loss and the ASTC rating as the measure of system performance) requires suitable corrections in the calculations of ISO 15712-1, or values of flanking 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 included in the calculation procedures in each section of Chapter 4.

The examples presented in this report use the Simplified Method of ISO 15712-1 to calculate the ATL. The Simplified Method uses the single-number ratings (STC or Flanking STC for each transmission path) as the values for each path transmission loss ($TL_{Dd}$, $TL_{Ff}$ , $TL_{Fd}$ or $TL_{Df}$ ) in Equation 1.1 such that:

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

Where:

(a) In this adaptation of the Simplified Method, the Apparent Sound Transmission Class (ASTC) is substituted for the ATL in Eq. 1.1.

(b) The direct path $STC_{Dd}$ is obtained from the laboratory measured STC rating of the bare element and the ΔSTC changes due to linings on source "D" and/or receiving side "d" of the separating assembly such that:

$$STC_{Dd} = STC_{lab} + max(\Delta STC_D, \Delta STC_d) + \frac{min(\Delta STC_D, \Delta STC_d)}{2} \quad \text{Eq. 1.3}$$

(c) The flanking STC for each path $STC_{ij}$ is calculated such that:

$$STC_{ij} = \frac{STC_i}{2} + \frac{STC_j}{2} + K_{ij} + max\left(\Delta STC_i, \Delta STC_j\right) + \frac{min(\Delta STC_i, \Delta STC_j)}{2} + 10\log_{10}\left(\frac{S_S}{l_o l_{ij}}\right) \quad \text{Eq. 1.4}$$

where the indices *i* and *j* refer to the coupled flanking elements. Therefore, "*i*" can either be "D" or "F" and "*j*" can be "f" or "d". The geometric correction factor at the end of Eq. 4.1.3 depends on the surface area of the separating assembly ($s_S$), the length of the junction between flanking and separating elements ($l_{ij}$) and the reference length $l_0$ = 1 m.

The Simplified Method has been widely used by designers in Europe for many years for calculations based on $R_W$ data. The primary advantage of the Simplified Method is the simplicity of the procedure, which makes it usable by non-specialists, as illustrated by the worked examples in Chapter 4. Although it is less rigorous than the Detailed Method presented in ISO 15712-1 and Guide RR-331 (24), in most cases, the differences between the results of the two methods have been found to be small, and the calculations use approximations that should ensure the results are conservative (lower ASTC values than using the Detailed Method of calculating the ASTC).

Note that this report provides both the data to perform the calculations by the Simplified Method (in tables in Chapters 2 and 3) and the data needed to perform calculations using the Detailed Method (in the Appendices).

The set of path TLs used in Equations 1.1 and 1.2 is less general than the corresponding list of transmission factors in ISO 15712-1 so as to reflect the simplifications due to the Standard Scenario (see Section 1.2 above) and some further simplifications noted in the following cautions.

**Cautions and limitations to examples presented in this Report:**

This Report was developed to support a proposed transition to ASTC ratings for sound control objectives of the National Building Code of Canada, and simplifications were made in the presentation 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 to be negligible (and lumped in the rated value for $TL_{Dd}$).
- Indirect airborne transmission (for example airborne flanking via an unblocked attic or crawl space) is assumed to be suppressed by normal fire blocking requirements.

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

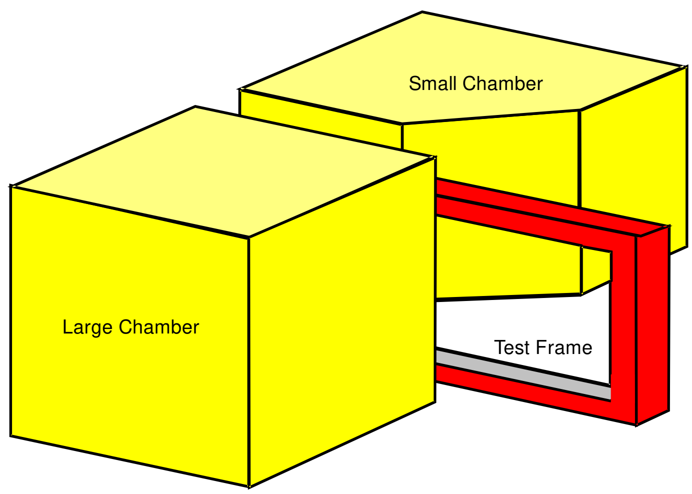
If this Report is applied to situations other than the separation between adjacent units in multi-family residential buildings, some of these issues may have to be explicitly addressed in the calculation process. For example, for adjoining rooms within a single office or home, flanking paths such as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

# 2 Sound Transmission Measurements for Concrete Block Walls

This chapter presents the results of experimental testing of a series of concrete block walls of several types, including walls with a wide variety of linings covering one or both surfaces of the wall specimen.

Testing was conducted according to the ASTM E90 test protocol [1] for direct airborne sound transmission testing of walls or floors, in the NRC's Wall Sound Transmission Test Facility. The facility conforms to all of the facility requirements of ASTM E90, see more details in Appendix A. Full scale wall assemblies were placed in a testing frame with a test opening 3.66 m wide and 2.44 m high, between two decoupled rooms with volumes of approximately 250 $m^3$ and 140 $m^3$ (designated "large chamber" and "small chamber," respectively). A concept drawing of the NRC Wall Sound Transmission Facility is shown in Figure 2.1. The facility was equipped with an automated sound and measurement system for data acquisition and post processing. Sound transmission loss was measured in both directions – from the large chamber to the small chamber and vice-versa – and results were averaged to reduce measurement uncertainty due to factors such as calibration errors.

**Figure 2.1**:
A concept drawing of the Wall Sound Transmission Facility at the NRC. The wall specimen was mounted in the movable test frame between two decoupled reverberant rooms.




The frequency dependent sound transmission loss was measured for all assemblies in 1/3-octave bands over an extended frequency range from 31.5 Hz to 10 kHz, although only a limited subset of these is considered in the calculation of the Sound Transmission Class (STC). Note that:

- The set of transmission loss results from 50 Hz to 5000 Hz is presented in Appendix A1.
- This chapter presents a more compact summary of results in terms of the single-number ratings required for the calculations in Chapter 4 to determine the ASTC rating between adjacent spaces in a building.

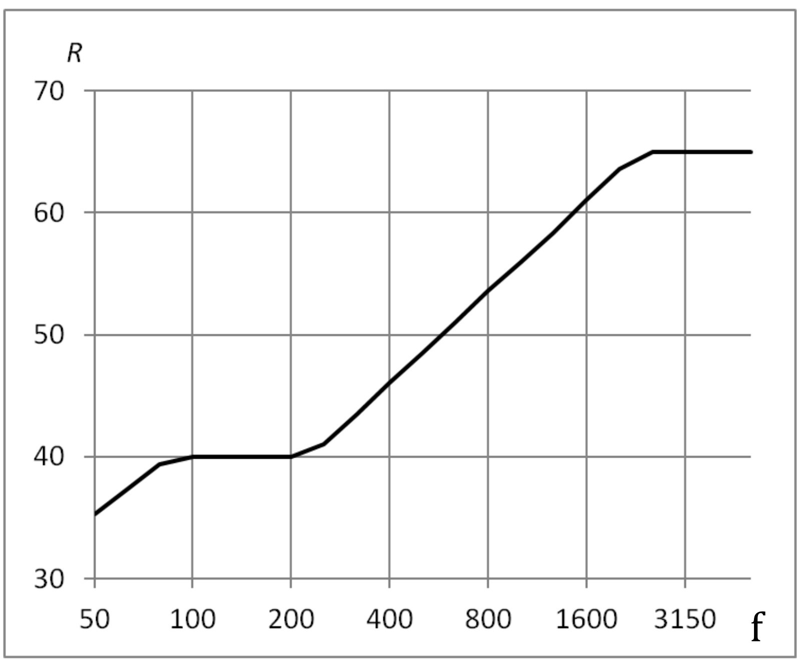
It is common practice, especially in residential buildings, to add finishing surfaces to the basic structural masonry or concrete wall assemblies (for example, gypsum board wall and ceiling surfaces that conceal both the bare concrete surfaces and building services such as electrical wiring, water pipes and ventilation ducts). The finish commonly comprises gypsum board panels, framing used to support them, and often sound absorptive material filling the inter-stud cavities between the gypsum board and the face of the concrete blocks. These elements are described in ISO 15712-1 as "linings" or "liners" or "layers" or "coverings". The first term - "linings"- is used in this Report.

To characterize the change in the sound transmission loss due to adding a specific lining to a heavy base wall (a concrete block wall in this case), a single number rating called ΔSTC is introduced.

ASTM does not define such a rating, but there is a counterpart, $\Delta R_W$ in the ISO standards (Annex B of ISO 140-16) and it is a required input for the Simplified Method of ISO 15712-1 presented in Chapter 4. The procedure used in this Report follows that of ISO 140-16 (25) with the STC calculation substituted for the ISO single-number rating calculation, plus additional Steps 4 and 5 as discussed on the next page.

The procedure to calculate ΔSTC values for the Simplified Method of ISO 15712-1 (used in Chapter 4) uses Reference Curve B.1 from ISO 140-16 (shown in Fig. 2.2) – a smoothed sound transmission loss curve typical of a heavy wall of masonry.

**<u>Figure 2.2:</u>**
Reference curve for the calculation of ΔSTC




**Reference Curve B.1** from Annex B of ISO 140-16, for a "Basic wall with low coincidence frequency" which is appropriate for heavy masonry walls

| *f*<br>Hz | *R*<br>dB |
|---|---|
| 50 | 35.3 |
| 63 | 37.3 |
| 80 | 39.4 |
| 100 | 40.0 |
| 125 | 40.0 |
| 160 | 40.0 |
| 200 | 40.0 |
| 250 | 41.0 |
| 315 | 43.5 |
| 400 | 46.1 |
| 500 | 48.5 |
| 630 | 51.0 |
| 800 | 53.6 |
| 1000 | 56.0 |
| 1250 | 58.4 |
| 1600 | 61.1 |
| 2000 | 63.6 |
| 2500 | 65.0 |
| 3150 | 65.0 |
| 4000 | 65.0 |
| 5000 | 65.0 |

**Determining the Single Number Rating ΔSTC for Added Linings**

The procedure presented here for calculating the ΔSTC is a subset of a more general set of procedures presented in Report RR-331. Values of the ΔSTC calculated from the experimental data in this Report are presented in Tables 2.2.2 and 2.3.2. Readers of this report can simply use the tabulated ΔSTC values without the need to perform the calculations detailed here.

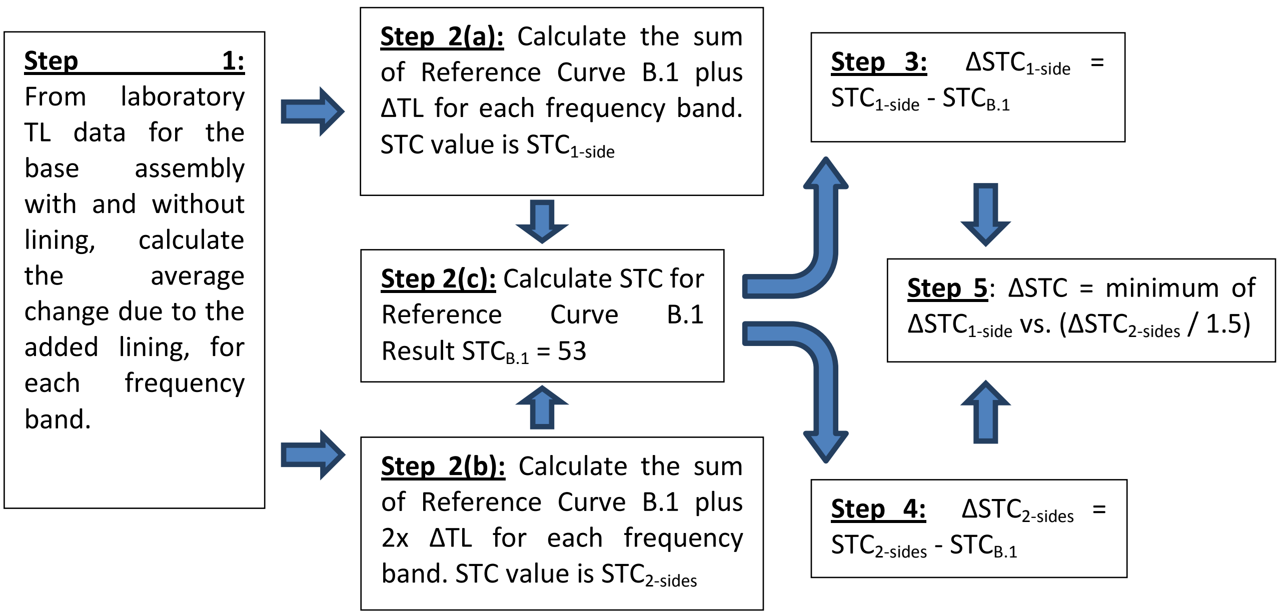



**Figure 2.3**: Steps to calculate the Single Number Rating ΔSTC for Added Linings (as detailed below)

The sound transmission loss is measured according to ASTM E90 both for a given base wall (such as the bare concrete block wall assemblies in Section 2.1) and for the base wall with an added lining on one side, and/or both sides. The transmission loss data (in 1/3-octave bands) are processed as follows:

Step 1. The change in sound transmission loss (ΔTL) due to adding the lining is calculated from the measurement results (with and without the added lining) for each frequency band, including at least 125 Hz to 4 kHz. This may involve averaging results from several pairs of specimens as detailed in Sections 2.2 and 2.3.

Step 2. (a) Calculate the sum of the TL for the Reference Curve B.1 (in Figure 2.2) plus ΔTL for each frequency band. The STC value for this set of TL values is $STC_{1\text{-side}}$.

Step 3. (b) Calculate the sum of the TL for the Reference Curve B.1 (in Figure 2.2) plus 2 x ΔTL for each frequency band. The STC value for this set of TL values is $STC_{2\text{-sides}}$.

Step 4. (c) Calculate the STC value for Reference Curve B.1 ($STC_{B.1}$ )

Step 5. Subtract the STC value for Reference Curve B.1 ($STC_{B.1}$ = 53) from $STC_{1\text{-side}}$ to obtain $\Delta STC_{1\text{-side}}$.

Step 6. Subtract the STC value for Reference Curve B.1 ($STC_{B.1}$ = 53) from $STC_{2\text{-sides}}$ to obtain $\Delta STC_{2\text{-sides}}$.

Step 7. ΔSTC is the smaller of $\Delta STC_{1\text{-side}}$ or $\Delta STC_{2\text{-sides}}$ /1.5 rounded to an integer (e.g. 20/1.5 = 13).

ΔSTC is used only in the simplified calculation procedures presented in Chapter 4. Consideration of the change in STC when there is a lining on both sides of the wall (Step 4) and dividing $\Delta STC_{2\text{-sides}}$ by 1.5 in Step 5 can be understood by considering the use of ΔSTC values in Eq. 4.1.2 and 4.1.3 and in the worked examples in Chapter 4. Selection of the more conservative value (at Step 5) is required to avoid a misleading (over-optimistic) ΔSTC rating in the simplified calculation procedure, as discussed further in Sections 2.2 and 2.3.

## 2.1 Concrete Block Walls without Gypsum Board Linings

The focus of this section is the concrete block masonry wall (concrete masonry block units and mortar) without a lining.

This study included tests on walls constructed of two types of concrete blocks:

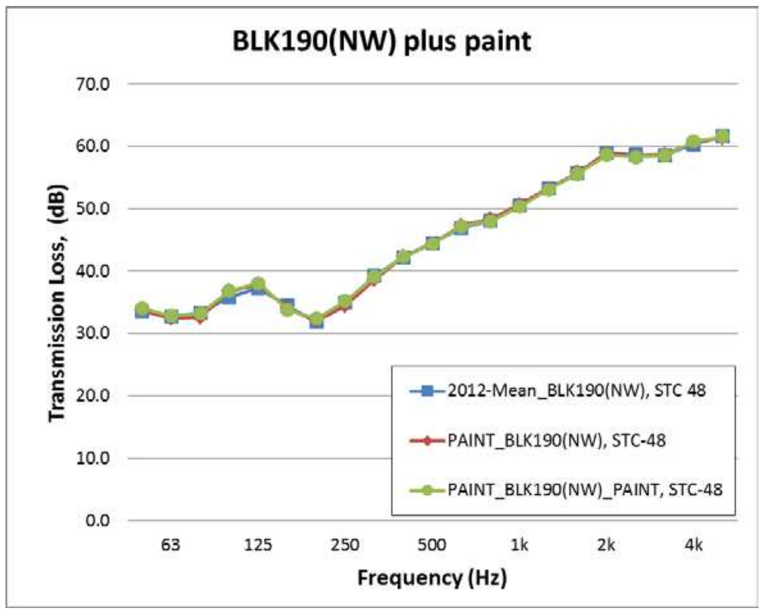
- 190 mm normal weight concrete block units, nominally 53% solid (assembly surface weight 238kg/$m^2$) designated here as BLK190(NW). See End Note 1 for more details.
- 140 mm lightweight concrete block units, nominally 58% solid (assembly surface weight 134kg/$m^2$) designated here as BLK140(LW). See End Note 4 for more details.

The TL of each of these walls was measured several times, both with the surfaces of the concrete blocks untreated and with one or both surfaces sealed with appropriate sealer/paint. Sealing the surfaces had negligible effect on the sound transmission for walls of BLK190(NW), as shown in Figure 2.1.1. The cases without painted surfaces have the same STC rating as those with paint on one side or both sides, and the TL curves match within less than 1 dB at all frequencies.

**Figure 2.1.1:**
Sound transmission loss for walls of normal weight concrete blocks (BLK190(NW)) with or without paint on the surfaces.

The specimen codes in the legend indicate whether the block assemblies are unsealed [blue squares for BLK190(NW)], or painted on one side [red diamonds for PAINT_BLK190(NW)], or painted on both sides [green circles for PAINT_BLK190(NW)_PAINT].

Similar coding is used to identify the specimen constructions in subsequent Figures.

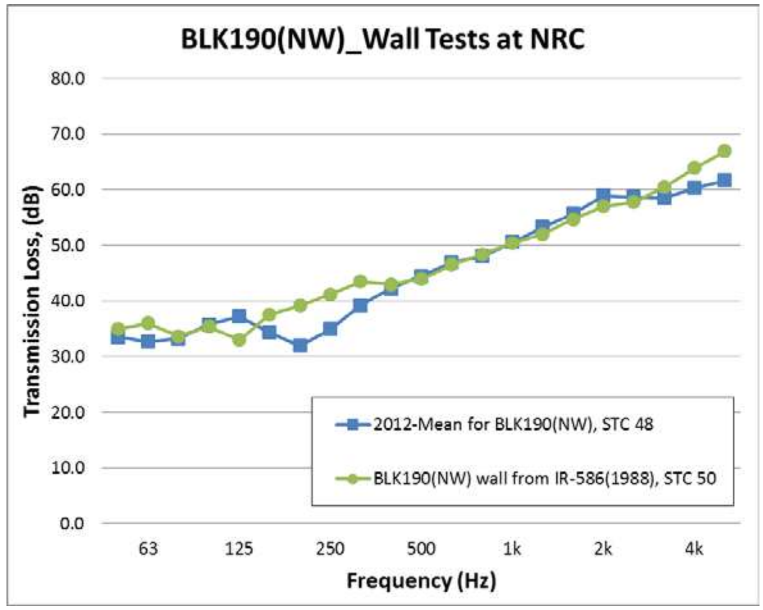



The average of the two tests without painted surfaces was used as the reference case for subsequent evaluation of changes in sound transmission due to sealing the surfaces or adding gypsum board linings. The average of the two tests without painted surfaces provides the best reference for the performance of <u>this</u> set of concrete block wall specimens without a lining and it is designated in subsequent discussion and in Fig. 2.2.1 as "2012-Mean BLK190(NW)".

However, as a basis for estimating the performance of a "typical" concrete block wall of this type, this is just one of the available sources of information, and is inevitably biased by its size and boundary conditions. Another series of tests was performed in 1988 by Warnock using a similar test procedure and specimens assembled from very similar concrete blocks (specimen weight per unit area matched within 1%), but with different specimen size and edge conditions. Results from those tests were published in the NRC report IR-586 (26) and a series of research papers (27–29). The studies by

Warnock provides a good second example and the results from the two studies are compared in Figure 2.1.2.

**Figure 2.1.2**:
Sound transmission loss for wall specimens of 190 mm normal weight concrete blocks, from two test series in the NRC laboratory.

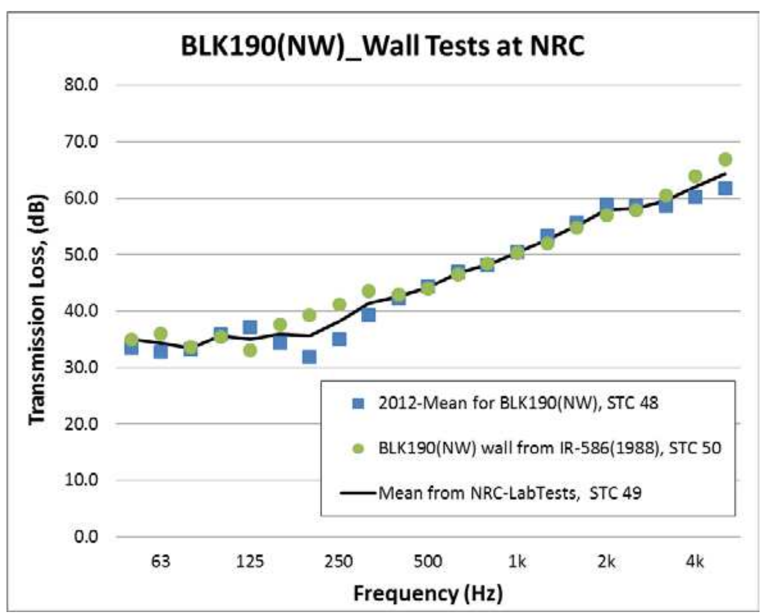



The two walls have similar STC ratings, but the transmission loss curves differ appreciably at the frequencies from 100 to 400Hz where the results for such walls are most affected by the edge conditions. Each result is a valid result for the conditions of the test specimen, but there is no basis for arguing that either is more representative of the expected performance when the wall is installed in a building. The average from the two studies (as shown in Figure 2.1.3) is proposed as the best estimate for BLK190(NW) for calculating sound insulation in buildings in Chapter 4.

**Figure 2.1.3:**

Sound transmission loss for wall specimens of 190 mm normal weight concrete blocks, from two test series in the NRC laboratory with different edge conditions.

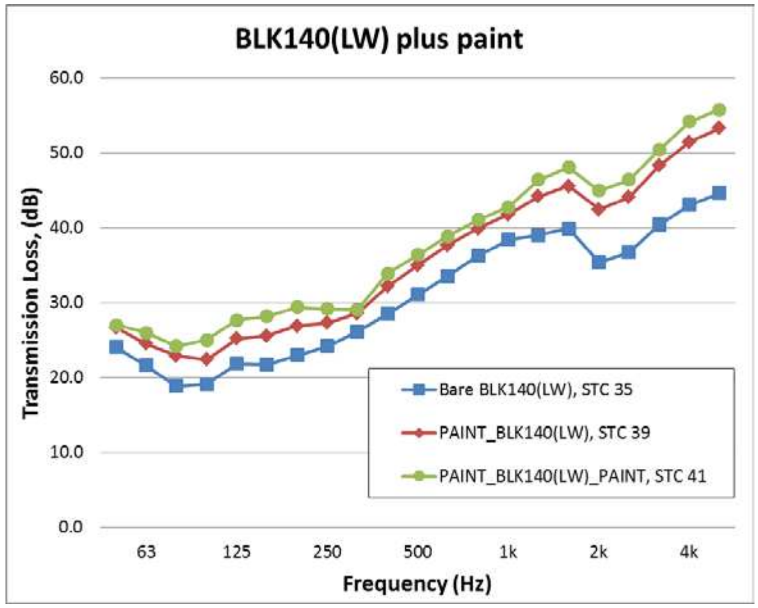
The mean result is proposed as the best estimate for “typical” BLK190(NW) walls in buildings, and its 1/3-octave-band sound transmission loss data are listed in Table A1.1 in Appendix A1. It is labelled in this report as “NRC-Mean BLK190(NW)”



For walls built from lightweight concrete block masonry units, sealing the surfaces with paint resulted in a marked change in the TL results as shown in Figure 2.1.4. In this case, there were three (essentially identical) tests of the wall specimen with unsealed block. The mean of the three TL results for unsealed BLK140(LW) is shown in Figure 2.1.4, for comparison with the quite different results with paint sealing on one side or both sides of the wall.

**Figure 2.1.4:**
Sound transmission loss for a wall specimen of lightweight concrete blocks BLK140(LW) with and without paint on one or both surfaces.

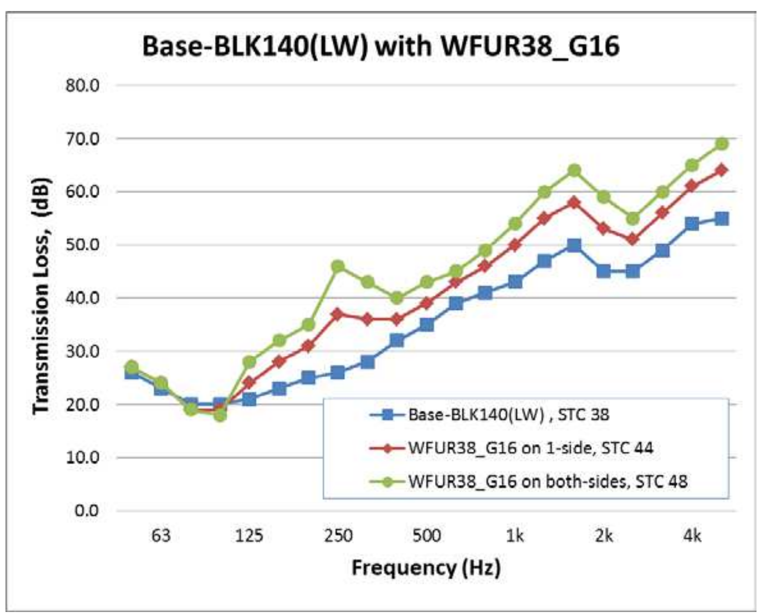
The specimen codes in the legend indicate whether block assemblies are bare [blue squares for BLK140(NW)], or painted on one side [red diamonds for PAINT_BLK140(NW)], or painted on both sides [green circles for PAINT_BLK140(NW)_PAINT].




Adding paint to seal one side increased the STC rating from 35 to 39. The smaller changes due to painting the second side raised the STC rating further to 41. For this hollow lightweight concrete block wall, it was concluded that significant sound power leaks through the porous aggregate-cement matrix unless the blocks are sealed. A similar pattern of improvement was observed when the bare wall was sealed with linings of gypsum board on wood furring as shown in Figure 2.1.5.

**Figure 2.1.5:**
Sound transmission loss for a wall specimen of lightweight concrete blocks BLK140(LW) when a lining of 16 mm gypsum board on 38 mm wood furring (WFUR38_G16) is added on one or both surfaces of the assembly of unpainted blocks.

As in Figure 2.1.4, the change due to adding the lining on the first side is greater than the change when the lining is added on the second side, because adding the first lining also suppresses most of the sound leakage through the blocks.

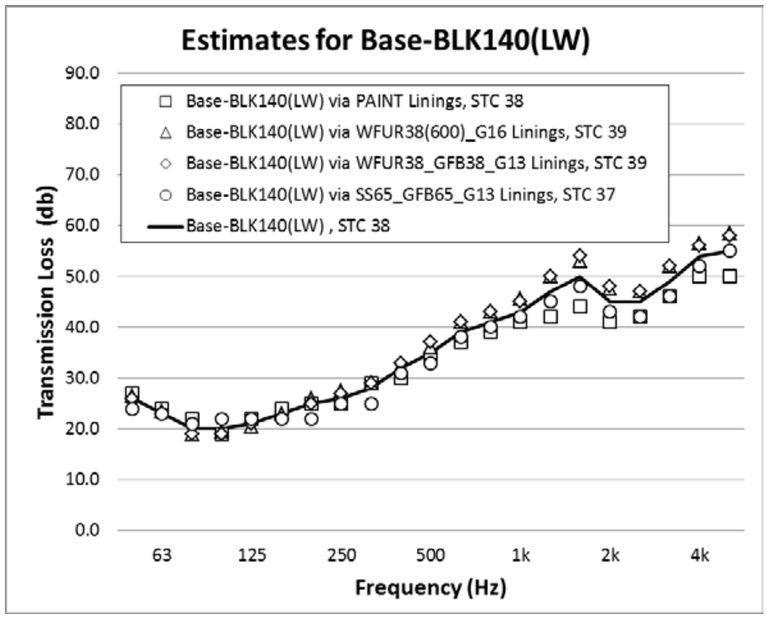


For both types of surface treatments added to the block assembly (PAINT and WFUR38_G16, as shown in Figures 2.1.4 and 2.1.5, respectively), the added layer serves two functions. First, it provides a surface that effectively blocks air flow and thus increases the TL by suppressing any sound leakage through the lightweight aggregate matrix of the concrete blocks. Second, it also changes the coupling between the sound field in the adjacent room and the concrete block wall assembly – that is, the paint or the gypsum board assembly both function as linings.

Results like those in Figures 2.1.4 and 2.1.5 can be used to separate the effect of suppressing the leakage from the change in TL due only to adding the lining. The smaller changes due to adding a lining on the second side of the wall provide the best estimate of the improvement due to the lining itself, because the sound leakage has already been eliminated by the impervious lining added to the first side. If the change due to adding a lining on the second side is subtracted from the sound transmission loss for the block wall assembly with the same lining on one side, the difference should be a good estimate of the sound transmission loss through the unlined block wall with leakage eliminated.

**Figure 2.1.6:**
Sound transmission loss for a wall specimen of lightweight concrete blocks BLK140(LW) without the reduction due to leakage through the porous lightweight aggregate.

Estimates of the sound transmission loss without leakage were obtained from the changes due to four types of linings, as explained below. The mean of the four estimates (solid black line) is taken as the best estimate for sound transmission without leakage, designated as Base-BLK140(LW).




Four linings (identified in caption of Figure 2.1.6) had valid tests when installed on 1 side and on both sides of the bare block wall assembly. These four sets of data yielded estimates of sound transmission through the lightweight block assembly with sound leakage suppressed; these estimates are presented in Figure 2.1.6. These four estimates of the sound transmission loss for unlined BLK140(LW) with the effect of leakage suppressed are not identical but there is no basis to reject or prefer any of them. Hence the mean is taken as the best estimate, and this is designated as **Base-BLK140(LW)**.

The results are applied and presented as follows:

- Mean 1/3-octave-band sound transmission loss data for the bare unsealed concrete block walls and for the Base-BLK140(LW) wall without leakage, are given in Table A1.1 in Appendix A1.
- The estimated sound transmission without leakage is used for the calculations of sound transmission via direct and flanking paths for calculation of ASTC according to the Simplified Method in Chapter 4, and is also applicable to calculation by the Detailed Method.
- The change in the STC ratings due to the addition of various linings on lightweight block walls is discussed in detail in Section 2.3.

## 2.2 Adding Linings on Concrete Block Masonry Walls Constructed with Normal Weight Units

This section presents the results of sound transmission measurements for a series of wall specimens comprising a concrete block wall assembly of normal weight units with an added lining covering one side or both sides. The linings are described in Table 2.2.1.

**Table 2.2.1**: Linings tested on BLK190(NW) base wall specimen. In all cases, the furring or studs are spaced 610 mm on center and the faces of the concrete block are not painted except where the lining PAINT is explicitly identified.

| Lining Code | Descriptive Lining Code | Description of Lining |
|---|---|---|
| ΔTL-BLK(NW)-01 | PAINT | Paint/sealer covering the surface of the wall |
| ΔTL-BLK(NW)-02 | G13 | 13 mm gypsum board fastened to surface of blocks |
| ΔTL-BLK(NW)-21 | FC22_G13 | 13 mm gypsum board fastened to 22 mm metal furring channels (“hat” profile)* |
| ΔTL-BLK(NW)-22 | FC22_GFB38_G13 | 13 mm gypsum board fastened to 22 mm metal furring channels* with 38mm thick glass fiber batts in compressed in cavities |
| ΔTL-BLK(NW)-31 | WFUR38_G13 | 13 mm gypsum board fastened to 38x38 mm wood furring* |
| ΔTL-BLK(NW)-32 | WFUR38_2G13 | 2 x 13 mm gypsum board fastened to 38x38 mm wood furring* |
| ΔTL-BLK(NW)-33 | WFUR38_GFB38_G13 | 13 mm gypsum board fastened to 38x38 mm wood furring* with 38mm thick glass fiber batts in cavities |
| ΔTL-BLK(NW)-34 | WFUR38_GFB38_2G13 | 2 x 13 mm gypsum board fastened to 38x38 mm wood furring* with 38mm thick glass fiber batts in cavities |
| ΔTL-BLK(NW)-35 | WFUR38_G16 | 16 mm gypsum board fastened to 38x38 mm wood furring* |
| ΔTL-BLK(NW)-36 | WFUR38_GFB38_G16 | 16 mm gypsum board fastened to 38x38 mm wood furring* with 38mm thick glass fiber batts in cavities |
| ΔTL-BLK(NW)-41 | SS41_G13 | 13 mm gypsum board fastened to 41 mm steel studs** |
| ΔTL-BLK(NW)-42 | SS41_GFB38_G13 | 13 mm gypsum board fastened to 41 mm steel studs** with 38mm thick glass fiber batts in cavities |
| ΔTL-BLK(NW)-61 | SS65_G13 | 13 mm gypsum board fastened to 65 mm steel studs** |
| ΔTL-BLK(NW)-62 | SS65_GFB65_G13 | 13 mm gypsum board fastened to 65 mm steel studs** with 65 mm thick glass fiber batts in cavities |
| ΔTL-BLK(NW)-63 | SS65_GFB65_2G13 | 2 x 13 mm gypsum board fastened to 65 mm steel studs** with 65 mm thick glass fiber batts in cavities |
| ΔTL-BLK(NW)-65 | SS65_GFB65_G16 | 16 mm gypsum board fastened to 65 mm steel studs** with 65 mm thick glass fiber batts in cavities |
| ΔTL-BLK(NW)-91 | SS92_G13 | 13 mm gypsum board fastened to 92 mm steel studs** |
| ΔTL-BLK(NW)-92 | SS92_GFB38_G13 | 13 mm gypsum board fastened to 92 mm steel studs** with 38 mm thick glass fiber batts in cavities |
| ΔTL-BLK(NW)-93 | SS92_GFB65_G13 | 13 mm gypsum board fastened to 92 mm steel studs** with 65 mm thick glass fiber batts in cavities |
| ΔTL-BLK(NW)-94 | SS92_GFB92_G13 | 13 mm gypsum board fastened to 92 mm steel studs** with 92 mm thick glass fiber batts in cavities |
| ΔTL-BLK(NW)-96 | SS92_GFB92_2G13 | 2 x 13 mm gypsum board fastened to 92 mm steel studs** with 38 mm thick glass fiber batts in cavities |

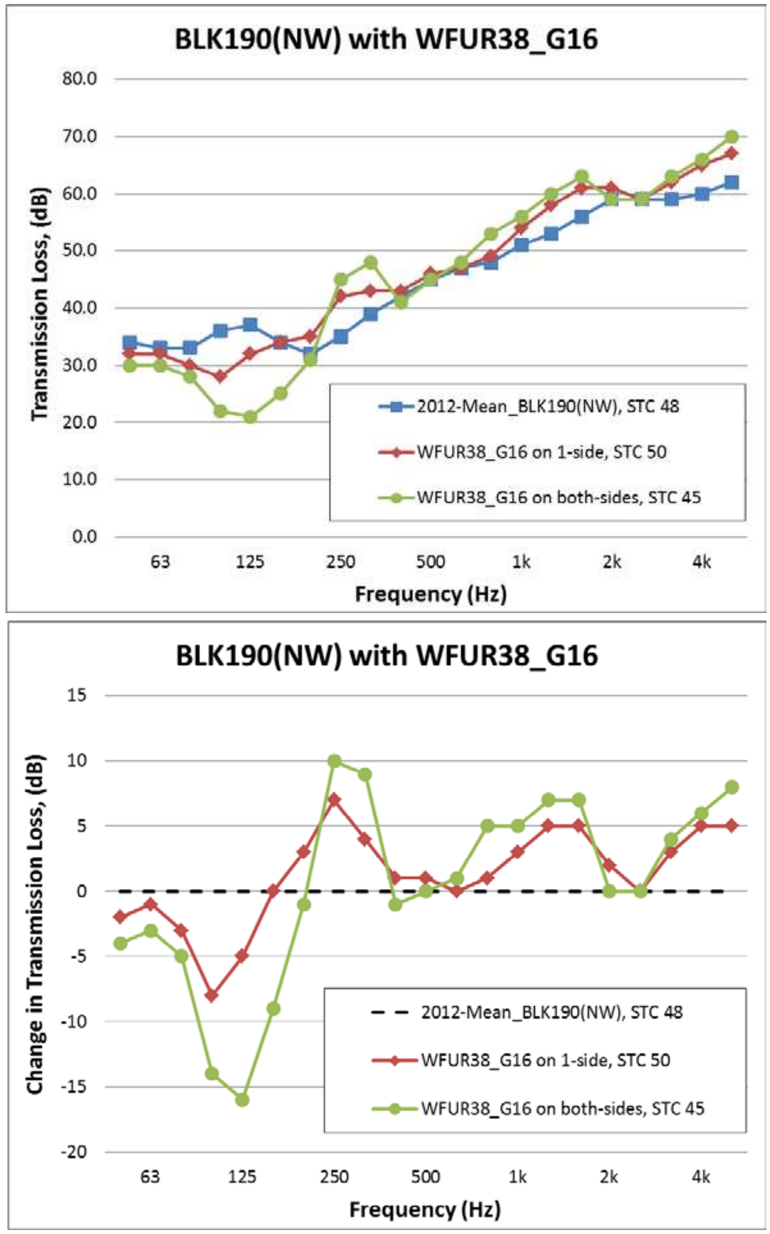
(*= mechanically fastened to concrete blocks, **= 12 mm airspace between blocks and studs)

Figure 2.2.1 presents one example of how adding the gypsum board lining on one side or both sides changes the sound transmission loss.

**Figure 2.2.1:**
The upper graph shows sound transmission loss for a wall specimen of bare, unpainted normal weight concrete block, versus the result for the same block wall with a lining of gypsum board supported on 38 mm thick wood furring covering one or both of the surfaces.

Note that for an examination of the change due to the addition of a lining in this test series, the appropriate reference case for the bare unpainted block is Mean-2012 BLK190(NW) which is the mean result for the same block wall specimen to which these linings were added, as discussed in Section 2.1.

The lower graph shows the corresponding changes in sound transmission loss (ΔTL) due to adding the WFUR38_G16 lining on one side or both sides of the reference specimen, the unsealed concrete block wall Mean-2012 BLK190(NW).




Two features of the changes should be noted:

- The change is not always an improvement. The figure shows that in this case, the change is negative – the TL with the lining is below that for bare BLK190(NW) – at frequencies below about 200 Hz.
- Adding a matching lining on both sides of the wall approximately doubles the change in the TL at each frequency band relative to the change observed for adding a lining to one side of the bare concrete block wall (though measurement uncertainty gives some deviation in individual cases).

Despite the change in the TL due to the addition of the lining on the second side, the change in the STC does NOT usually double. This is because negative, low frequency dips like those due to adding this lining have a strong influence on the STC. Although adding this lining on one side increases the STC from 48 to 50, adding the identical lining on both sides reduces the STC to 45. It is this behaviour that forces the conservative process for calculating ΔSTC presented at the beginning of Chapter 2.

A strong low frequency resonance (evident as a dip in the change in the transmission loss in Figure 2.2.1 and 2.2.2 below 200 Hz) limits the STC rating.

Figure 2.2.2 shows the effect of filling the cavities (spaces between furring elements and between the faces of the concrete block assembly and the gypsum board) with absorptive material. Here again, adding the lining on one side changes the TL relative to that for the bare BLK190(NW) wall, and adding the matching lining on the second side approximately doubles the change of the TL at each frequency.

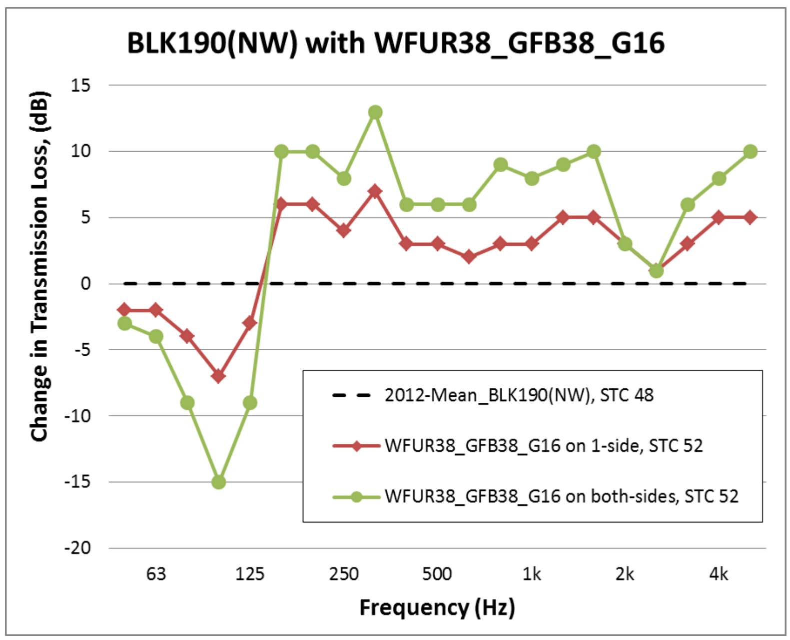



**Figure 2.2.2**:
Change in sound transmission loss for a wall specimen of bare, unpainted normal weight block, due to adding a lining of gypsum board supported on wood furring covering one or both of the surfaces.

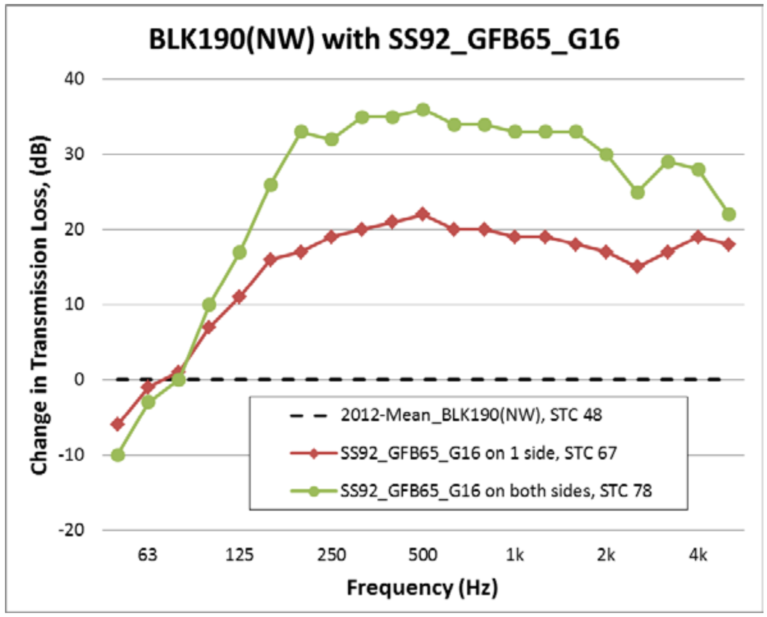
This differs from the preceding case (Fig. 2.2.1) due to the addition of sound absorptive material filling the cavities between the face of the concrete blocks and the gypsum board.

Again, the change due to adding a lining is not always an improvement. The figure shows that in this case, for frequencies below 160 Hz, the change in the TL is negative – the TL with the lining is below that for bare BLK190(NW) – but the dip has less effect on the STC than the case shown in Fig. 2.2.1. For the case in Figure 2.2.2 of the lining applied to both sides of the wall, the low frequency resonance is shifted to a lower frequency by filling the inter-furring cavities with sound absorptive material. A lining on one side increases the STC rating from 48 to 52. Adding the same type of lining on the second side does not further increase the STC rating despite the generally higher TL above 125 Hz.

Increasing the weight of the gypsum board, increasing the depth of the cavity between the faces of the gypsum board and the concrete block, or adding absorptive material in the cavity, can all shift the low frequency dip below the frequency range (125 Hz to 4000 Hz) that determines the STC rating. For example, it can be seen in Figure 2.2.3 that increasing the cavity depth to about 100 mm by mounting the gypsum board on 92 mm lightweight steel studs shifts the frequency at which the TL becomes negative to frequencies below 100 Hz. With the larger cavity depth, the STC rating increases to 67 with the lining on one side and to 78 with linings on both sides.

**Figure 2.2.3**:
Change in the sound transmission loss for wall specimen of bare, unpainted normal weight block, due to adding a lining of gypsum board supported on steel studs covering one or both of the surfaces. Sound absorptive material partly fills the inter-stud cavities (65 mm of material in 92 mm stud depth).

As for other graphs in this section, the reference case is the bare, unsealed 2012-Mean for BLK190(NW).




These results show trends very similar to those reported by Warnock (26–29), despite differences between the studies in regard to the specimen materials (different gypsum board and sound absorptive material) and major changes in the test facility.

**Calculating ΔTL and ΔSTC Values for the Linings:**

The specimens tested in this study demonstrated the change due to adding a given lining in 3 situations:

1. Wall specimens with the lining applied on one side,
2. Wall specimens with the same lining applied on both sides,
3. Wall specimens with the lining applied on one side but a different lining on the other side.

Each type of lining was tested for the first situation with the lining applied on one side (sometimes several tests were performed) and most were tested in one or both of the other situations. For the first situation, the TL for the bare, unsealed BLK190(NW) wall was subtracted from the TL with the added lining. For the second situation, the TL for the bare, unsealed BLK190(NW) wall was subtracted from the TL with added linings on both sides, and the result was divided by 2. For the third situation, the TL for a BLK190(NW) wall with other lining on one side was subtracted from the TL for the wall with the two mismatched linings. Test results significantly compromised by flanking (which limits apparent TL when the specimen TL approaches the facility limit) were eliminated, and a weighted average was used (50% weighting for situation 1 and 50% for the average of situations 2 and 3).

Results are presented and used as follows:

- The averaged 1/3-octave-band changes in sound transmission loss (ΔTL) for each lining applied to the BLK190(NW) concrete block wall test specimens are given in Table A1.2 in Appendix A1. These data are needed for calculation of the ASTC using the Detailed Method, as discussed in RR-331.
- The set of ΔTL data for each lining were used with the standard reference TL curve, as discussed at the beginning of Chapter 2, to determine ΔSTC for each lining when applied to the BLK190(NW) wall specimen. The calculation results are presented in Table 2.2.2 below.

**Table 2.2.2**: ΔSTC values for linings on BLK190(NW) wall specimens. Note that these are referenced as data for worked examples in the calculations of Chapter 4.

| Lining Code | Lining Descriptive Code | Step 3: (1-side lined) $\Delta STC_{1\text{-side}}$ | Step 4: (2-sides lined) $\Delta STC_{2\text{-sides}}$ | Step 5: ΔSTC |
|---|---|---|---|---|
| ΔTL-BLK(NW)-01 | PAINT | 0 | 0 | 0 |
| ΔTL-BLK(NW)-02 | G13 | -1 | -4 | -3 |
| ΔTL-BLK(NW)-21 | FC25_G13 | 0 | -1 | -1 |
| ΔTL-BLK(NW)-22 | FC25_GFB38_G13 | 3 | 3 | 2 |
| ΔTL-BLK(NW)-31 | WFUR38_G13 | 1 | -1 | -1 |
| ΔTL-BLK(NW)-32 | WFUR38_2G13 | 2 | 1 | 1 |
| ΔTL-BLK(NW)-33 | WFUR38_GFB38_G13 | 4 | 6 | 4 |
| ΔTL-BLK(NW)-34 | WFUR38_GFB38_2G13 | 5 | 8 | 5 |
| ΔTL-BLK(NW)-35 | WFUR38_G16 | 1 | -3 | -2 |
| ΔTL-BLK(NW)-36 | WFUR38_GFB38_G16 | 4 | 3 | 2 |
| ΔTL-BLK(NW)-41 | SS41_G13 | 4 | 0 | 0 |
| ΔTL-BLK(NW)-42 | SS41_GFB38_G13 | 9 | 15 | 9 |
| ΔTL-BLK(NW)-61 | SS65_G13 | 7 | 3 | 2 |
| ΔTL-BLK(NW)-62 | SS65_GFB65_G13 | 19 | 33 | 19 |
| ΔTL-BLK(NW)-63 | SS65_GFB65_2G13 | 22 | 43 | 22 |
| ΔTL-BLK(NW)-65 | SS65_GFB65_G16 | 21 | 39 | 21 |
| ΔTL-BLK(NW)-91 | SS92_G13 | 9 | 7 | 5 |
| ΔTL-BLK(NW)-92 | SS92_GFB38_G13 | 17 | 25 | 17 |
| ΔTL-BLK(NW)-93 | SS92_GFB65_G13 | 18 | 31 | 18 |
| ΔTL-BLK(NW)-94 | SS92_GFB92_G13 | 18 | 31 | 18 |
| ΔTL-BLK(NW)-96 | SS92_GFB92_2G13 | 22 | 43 | 22 |

NOTES:

1. Headings “Step 3”, “Step 4” and “Step 5” refer to steps in the calculation procedure in Figure 2.3.
2. All supporting furring or studs are spaced 610 mm on center.
3. The ΔSTC values are based on measurements on wall specimens with unsealed concrete block. However, because of the low porosity of the normal weight aggregate, the results should also be applicable if the face(s) of a BLK190(NW) wall are painted/sealed.
4. The values of ΔSTC in Table 2.2.2 should be appropriate for all walls constructed with blocks of normal weight aggregate, including blocks with different thickness or over 53%-solid content.

Note that if there are negative values of ΔTL within the frequency range that determines the STC rating (as in Figures 2.2.1 and 2.2.2) then adding the lining on the second side may give a combined change $\Delta STC_{2\text{-sides}}$ only slightly exceeding (or even below) $\Delta STC_{1\text{-side}}$. This tends to occur if inter-furring cavities are not largely-filled with absorptive material and/or if the cavity depth is less than 40 mm. In those cases, Steps 4 and 5 of the procedure ensure a value of ΔSTC suitable for the calculations in Chapter 4 with both sides lined.

## 2.3 Adding Linings on Concrete Block Masonry Walls Constructed with Lightweight Units

For concrete block walls constructed with lightweight units[4], the change in the TL due to adding a given lining is quite different from the corresponding results for walls constructed with normal weight units[1].

This study included a variety of gypsum board linings applied to one or both sides of the BLK140(LW) base wall. Most of these linings match one of the linings applied to the normal weight block walls described in the preceding Section.

**Table 2.3.1**: Linings tested on BLK140(LW) base wall. In all cases, the furring or studs are spaced 610 mm on center and the faces of the concrete block are not painted with sealer except where the lining PAINT is explicitly identified.

| Lining Code | Lining Descriptive Code | Description of Lining |
|---|---|---|
| ΔTL-BLK(LW)-01 | PAINT | Paint/sealer covering the surface of the wall |
| ΔTL-BLK(LW)-31 | WFUR38_G13 | 13 mm gypsum board fastened to 38x38 mm wood furring* |
| ΔTL-BLK(LW)-33 | WFUR38_GFB38_G13 | 13 mm gypsum board fastened to 38x38 mm wood furring* with 38mm thick glass fiber batts in cavities |
| ΔTL-BLK(LW)-35 | WFUR38_G16 | 16 mm gypsum board fastened to 38x38 mm wood furring* |
| ΔTL-BLK(LW)-62 | SS65_GFB65_G13 | 13 mm gypsum board fastened to 65 mm steel studs** with 65 mm thick glass fiber batts in cavities |
| ΔTL-BLK(LW)-65 | SS65_GFB65_G16 | 16 mm gypsum board fastened to 65 mm steel studs** with 65 mm thick glass fiber batts in cavities |
| ΔTL-BLK(LW)-66 | SS65_FOAM65_G13 | 13 mm gypsum board fastened to 65 mm steel studs** with spray polyurethane foam filling cavities |
| ΔTL-BLK(LW)-93 | SS92_GFB65+_G13 | 13 mm gypsum board fastened to 92 mm steel studs** with 65 mm or thicker glass fiber batts in cavities |
| ΔTL-BLK(LW)-95 | SS92_GFB65+_G16 | 16 mm gypsum board fastened to 92 mm steel studs** with 65 mm or thicker glass fiber batts in cavities |

(*= mechanically fastened to concrete blocks, **= 12 mm airspace between blocks and studs)

Note that the Lining Codes are subsequently referenced in the worked examples in Chapter 4.

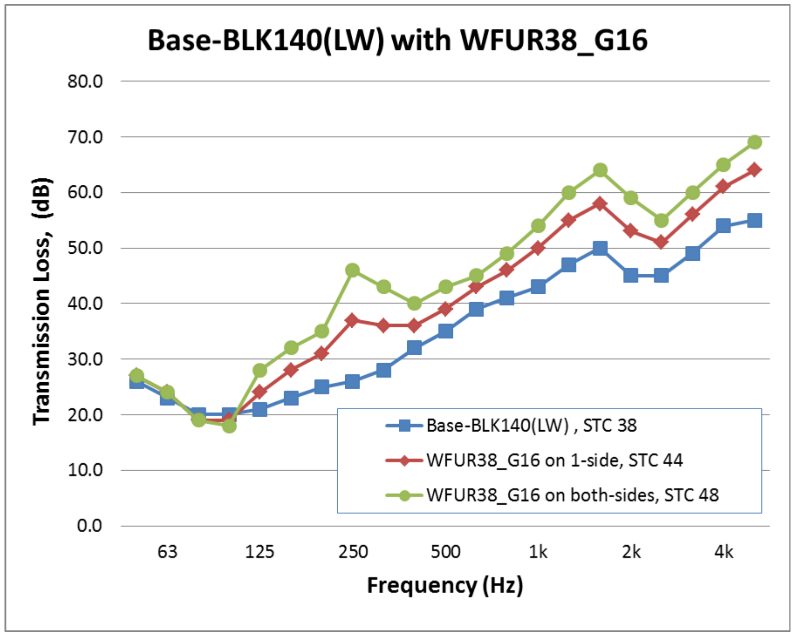
The sound transmission through Base-BLK140(LW) (i.e. the estimate without leakage through the lightweight block wall, as described in Section 2.1) was used as the reference for all of the calculations of the changes due to adding linings to walls of lightweight concrete blocks. This is obviously the appropriate case for flanking paths (since different walls are involved in the source and receiving room, so leakage through one cannot affect the other) and is also appropriate for direct transmission if the separating wall is sealed with paint or a gypsum board lining.

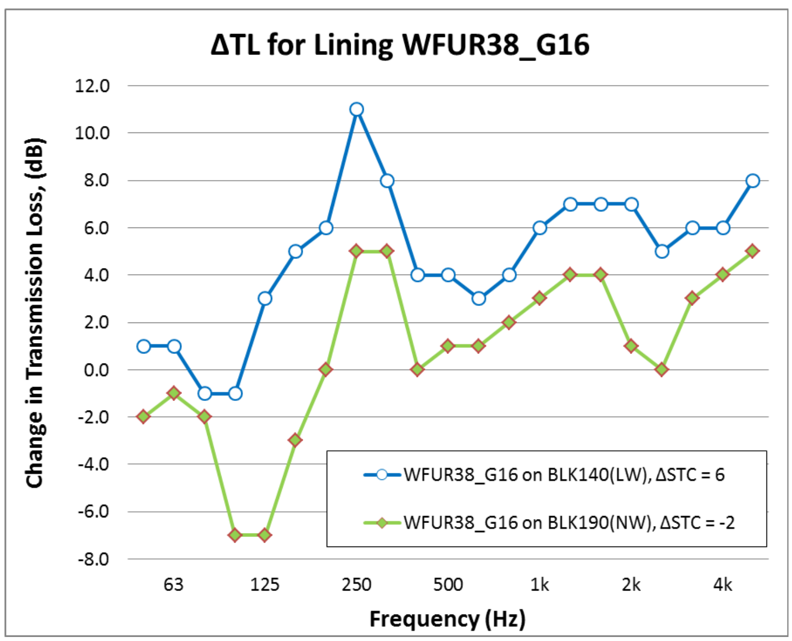
Figure 2.3.1 shows the effect of adding the 'WFUR38_G16" lining to one side or both sides of the lightweight block wall, using Base-BLK140(LW) as the reference case without a lining. Note that adding the lining on one side results in a change in the TL which is very similar to the effect of adding the matching lining on the second side. This mimics the behaviour observed for linings added to normal weight block walls and confirms the selection of Base-BLK140(LW) as a suitable reference curve.

**Figure 2.3.1**:
The upper graph shows sound transmission loss for a wall specimen of unpainted lightweight concrete block with a lining of 16 mm gypsum board supported on wood furring covering one or both of the surfaces.

Note that for examination of the change due to the addition of the lining in this test series, the appropriate reference case for the unsealed block is Base-BLK140(LW) with the effect of leakage removed.

The lower graph compares the changes in the sound transmission loss (ΔTL) due to adding the WFUR38_G16 lining to light-weight concrete block specimens versus adding the same lining to normal weight blocks. In both cases the values of ΔTL are mean values for all specimens tested with this lining.



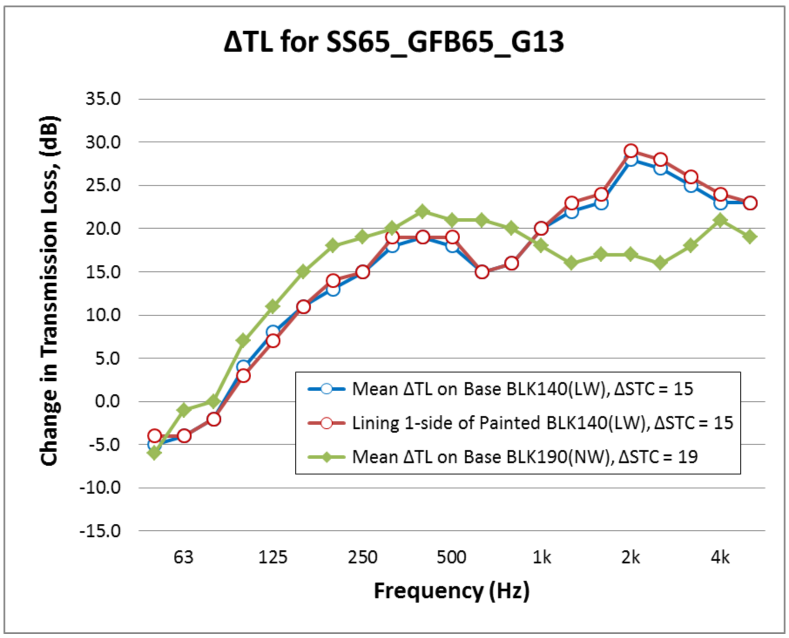

Unlike the changes for the same lining applied to bare BLK190(NW) shown in the previous section in Figure 2.2.1 and in the lower graph of Figure 2.3.1, the changes in the TL observed in the upper graph of Figure 2.3.1 when the lining is added to unsealed lightweight block are consistently positive in the frequency range above 100 Hz. The lower graph provides a comparison between the changes due to this lining when installed on lightweight or normal concrete block walls. Obviously, the improvement is much greater on the unsealed lightweight blocks, and the value of the ΔSTC is higher by 8 points.

If a lining were applied to *sealed* lightweight blocks (i.e. if the face of the block were painted and a lining was installed over the painted face), the improvement would be expected to resemble the result for the lining on normal weight blocks. The enhanced effect of the lining on unsealed lightweight block has been ascribed by Warnock to the porous surface of the lightweight block which provides sound absorption and also a slightly larger effective depth of the cavity between the gypsum board and the face of the concrete blocks. This difference is most significant for small cavity depths, especially when there is little or no absorptive material in the cavity, as can be seen by comparing the ΔSTC values in Tables 2.2.2 (for linings on normal weight blocks) and 2.3.2 (for linings on lightweight blocks).

With a larger cavity depth and absorption filling most of the cavity, the changes due to adding a gypsum board lining become very similar for normal weight block walls and lightweight block walls, and the effect of sealing the blocks is negligible. This is illustrated in Figure 2.3.2 by values of the ΔTL for a gypsum board lining on 65 mm steel studs, with absorptive material filling most of the (nominally 77 mm) cavity. Comparing the change in transmission loss (ΔTL) for applying this lining on the unsealed lightweight block with the corresponding changes observed for the same lining on normal weight block as well as on lightweight block that has been sealed, it can be seen that the curves are similar up to about 1 kHz, and the values of the ΔSTC are similar.

**Figure 2.3.2**:
The change in sound transmission loss (ΔTL) for wall specimens of concrete block due to adding a lining of gypsum board supported on 65 mm steel studs covering one or both of the surfaces. Sound absorptive material nearly filled the inter-stud cavities.

Below about 1kHz, the change is similar for all three types of base walls: normal weight block (green), unsealed lightweight block (blue), and sealed lightweight block (red).




The lining whose effect is shown in Figure 2.3.2 was the only lining tested for all three block conditions. Similar agreement was observed between the ΔTL results on normal weight and unsealed lightweight blocks for linings with 92 mm steel studs supporting the gypsum board. In that case the normal weight block's ΔSTC was higher by 2 points. Comparison of ΔSTC values between Table 2.2.2 (for linings on normal weight blocks) and Table 2.3.2 (for linings on lightweight blocks) shows the differences within ±2 points are typical for absorption-filled cavities greater than 50 mm.

**Calculating ΔSTC Values for the Linings:**
The average 1/3-octave-band changes in the sound transmission loss (ΔTL) for the set of linings applied to the BLK140(LW) concrete block walls were calculated following the same procedures described in Section 2.2 for linings on normal weight blocks. The results are given in Table A1.3 in Appendix A1.

Following the same procedures as in Section 2.2 for walls of BLK190(NW), the ΔTL values for these specimens were used with the standard reference curve to determine the ΔSTC for each lining when applied to one or both sides of the reference specimen. Calculated ΔSTC results are given in Table 2.3.2.

**Table 2.3.2**: The ΔSTC values for linings on BLK140(LW) wall specimens.Note that these are referenced as data for the worked examples in the calculations of Chapter 4.

| Lining Code | Lining Descriptive Code | Step 3: (1-side Lined) $\Delta STC_{1\text{-side}}$ | Step 4: (2-sides Lined) $\Delta STC_{2\text{-sides}}$ | Step 5: ΔSTC |
|---|---|---|---|---|
| ΔTL-BLK(LW)-01 | PAINT | 0 | 0 | 0 |
| ΔTL-BLK(LW)-31 | WFUR38_G13 | 3 | 4 | 3 |
| ΔTL-BLK(LW)-33 | WFUR38_GFB38_G13 | 7 | 14 | 7 |
| ΔTL-BLK(LW)-35 | WFUR38_G16 | 6 | 10 | 6 |
| ΔTL-BLK(LW)-62 | SS65_GFB65_G13 | 15 | 27 | 15 |
| ΔTL-BLK(LW)-65 | SS65_GFB65_G16 | 19 | 35 | 19 |
| ΔTL-BLK(LW)-66 | SS65_FOAM65_G13 | 1 | 0 | 0 |
| ΔTL-BLK(LW)-93 | SS92_GFB65+_G13 | 16 | 29 | 16 |
| ΔTL-BLK(LW)-95 | SS92_GFB65+_G16 | 22 | 39 | 22 |

NOTES:
1. Headings "Step 3", "Step 4" and "Step 5" refer to steps in the calculation procedure in Figure 2.3.
2. The values of ΔSTC in Table 2.3.2 should be appropriate for all walls of concrete block constructed with lightweight units, including blocks of other thickness and blocks with higher than 58%-solid content, when the pertinent face(s) of the concrete blocks is (are) unpainted.
3. If a face of the block assembly is finished with paint or a thin coat of plaster, the effect of sealing the surface may be treated as the addition of lining ΔTL-BLK(LW)-01 (i.e. sealing the face of a lightweight block wall is treated the same as adding a lining).
4. If a gypsum board lining is added to a face of the block assembly that is sealed with paint or plaster, the corresponding value of ΔSTC for gypsum board linings from Table 2.2.2 (i.e. the value for a lining added to normal weight block) should provide a more suitable estimate of the effect of adding the gypsum board lining on the sealed side.

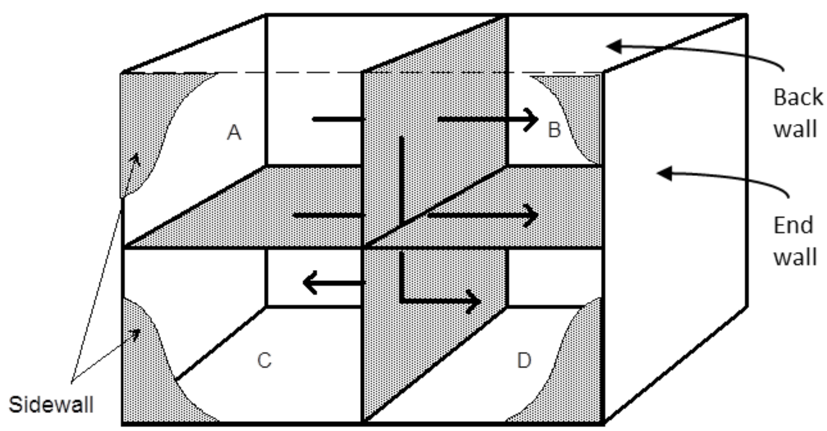
Note that the value of ΔSTC (last column in Table 2.3.2) is equal to the change in the STC rating due to a lining on only one side (center column in Table 2.3.2) for all linings except one on unsealed BLK140(LW) wall specimens. $\Delta STC_{2\text{-sides}}$ is consistently larger than 1.5 x $\Delta STC_{1\text{-side}}$, so these values of ΔSTC should not provide over-optimistic results in the calculations in Chapter 4.

# 3 Flanking Sound Transmission Measurements with Concrete Block Walls

This chapter presents the results of experimental testing on a series of building mock-ups comprising concrete block walls connected to flanking assemblies with lightweight framing. Ideally, the standard ISO 15712-1 would be used to estimate the flanking transmission through the lightweight framing. However, ISO 15712-1 has a number of weaknesses for predicting sound transmission in buildings where some or all of the assemblies are of lightweight wood frame or steel frame construction. The calculation in Section 1.4 for combining direct transmission and flanking transmission is still valid, but transmission via the flanking paths is instead determined by measurements following the appropriate parts of ISO 10848, rather than the calculations described in Section 4.1 for buildings where all the wall and floor assemblies are of heavy masonry and/or concrete.

This introduction provides a brief description of the Flanking Facility TH2 and the standardized test methods used to measure the apparent sound insulation between the various room pairs and to isolate and quantify flanking via specific transmission paths.

**Figure 3.1**: Schematic drawing of the Flanking Facility TH2 showing wall and floor specimens in grey. Arrows show some possible flanking paths.




The wall and floor specimens divide the space in the flanking facility into four rooms (labelled A, B, C, and D in Figure 3.1). The dimensions of the four rooms are given in Table 3.1.

**Table 3.1**: The dimensions of the room in the Flanking Facility TH2.

| Room | Volume ($m^3$) | Length (m) | Width (m) | Height (m) |
|---|---|---|---|---|
| A | 50.7 | 4.60 | 4.54 | 2.43 |
| B | 45.3 | 4.11 | 4.54 | 2.43 |
| C | 40.0 | 4.66 | 4.38 | 2.07 |
| D | 35.3 | 3.96 | 4.38 | 2.07 |

The permanent part of the facility (roof, end walls, foundation floor, and back wall) are constructed of heavy materials and are resiliently isolated from each other as well as from structural support members, with vibration breaks in the permanent surfaces where the specimens are installed. There is also an experimental sidewall covering the front face of the facility. In such a facility, specific construction changes can be systematically introduced so that resulting changes in the sound insulation performance of the experimental surfaces can be accurately determined.

Using custom hardware and software developed at the NRC, the measurement process, from calibration and microphone probe positioning to report generation is performed completely under computer control. This measurement process provides a high degree of precision and repeatability. For standard tests with airborne or impact sources, sound pressure levels are sampled at 9 positions in each room. The robot systems in each room position the microphones (12.5 mm precision condenser microphones with random incidence response), and signals are measured using an automated sound and measurement system for data acquisition and post processing. Note that:

- For an airborne source, the computer directs noise signals to the loudspeakers in each room in turn to measure the noise reduction between each pair of rooms and the rate of sound decay in each room. A sequence of 12 complete measurements (horizontal, vertical and diagonal pairs of rooms, each for 9 microphone positions in each room) are performed. The measurement data presented in the Report for a given room pair (e.g. A-B) are the average of two measurements where each room of the pair was the source room and the other was the receiving room. The airborne sound transmission measurements conform to ISO 10848-3 as well as ASTM E336. The measurements are repeated many times with various combinations of room surfaces masked with heavy panels to determine the transmission via paths involving specific room surfaces, in compliance with ISO 10848-3.
- Impact measurements (conforming to ASTM E1007 (30) and ISO 16283-1 are made using a standard tapping machine in either room A or B, and measuring the resulting sound pressure levels at all microphone positions in each of the other three rooms. The measurements are repeated many times with various combinations of room surfaces masked with heavy panels to determine the transmission via paths involving specific room surfaces in compliance with ISO 10848-3.
- In addition, measurements according to ISO 10848-4 are performed to characterize junction transmission for the combination of concrete block wall assemblies with various flanking wall and floor/ceiling constructions.

Although some impact transmission data will be presented here in Sections 3.1 and 3.2 and in the tables in the appendices to provide a more complete archival record of the project, the calculations presented in the following sections of Chapter 4 deal only with airborne transmission following the concepts of ISO 15712-1. For calculation of transmitted impact sound in a building, the corresponding calculation procedures of ISO 15712-2 should be applied.

As for the STC and ΔSTC results in Chapter 2, this chapter presents single-figure results such as Flanking STC ratings which are used in the Simplified Method calculations of Chapter 4. The corresponding 1/3-octave data needed for calculations by the Detailed Method (as explained in RR-331) are provided in the Appendices.

## 3.1 Concrete Block Walls with Wood-Framed Floors and Walls

The following tables present the Flanking STC values determined from the flanking measurements on a series of 4-room mock-up constructions in the flanking facility at the NRC.

In each case, the table combines a generic description of the connected wall or floor assemblies and the key details of the connection, together with the sound transmission estimates.

Some of the results are worst-case estimates because transmission by facility surfaces and other nominally-masked paths could not be reduced enough to clearly establish the actual attenuation via the path of interest. As further testing is performed, these shortcomings may be resolved, resulting in higher values of path STC ratings for some of the tabulated values in later editions of this Report. In the meanwhile, these limitations should only affect designs with ASTC ratings well above 60.

Each of the tables which present path transmission loss values includes several parts:

1. A generic description of the details of the wall and floor/ceiling assemblies and the connection between them.
2. A drawing showing the general features of the junction. Note that each junction of the concrete block wall with floor/ceiling assemblies can be viewed in several ways: (a) as the wall/floor junction between two side-by-side rooms above the floor, (b) as the wall/ceiling junction between two side-by-side rooms below the ceiling and (c) as junction of a flanking concrete block wall with the floor/ceiling assemblies separating two rooms that are one-above-the-other.
3. Junction cases (a) to (c) are presented in the tables with stylized drawings to identify the paths in each case, the Path STC values (either Direct STC or Flanking STC) for each path and for the combination of flanking paths at that junction. Note that the paths are designated using the notation shown in Figure 1.5.

The junction naming in the tables follows a simple coding. The purpose of the coding is to indicate which elements and materials are involved. An example of the coding is: BLK190-WF-LB-01 where:

- The first segment indicates the separating assembly, for which:
    - BLK indicates a concrete block wall element,
    - WJ indicates a wood-joist floor/ceiling element.
- The second segment indicates the junction type:
    - WF=wall/floor
    - WC=wall/ceiling
    - FW=floor/wall
    - WW=wall/wall
- The third segment of LB or NLB indicates a wall/floor or wall/ceiling that is loadbearing or non-loadbearing, respectively (i.e. is framed with joists perpendicular or parallel to the wall).
- The last segment is a unique number for that junction detail. Because the changes in Path STC due to changing a surface finish depend on the supporting framed constructions, a different number is used for each change of a surface of the framed elements.

Therefore, the example code BLK190-WF-LB-01 represents a separating assembly of 190 mm concrete blocks, the junction type is a wall / floor junction and the wall is loadbearing.

**Table 3.1.01: Transmission Paths**

Wall assembly with:

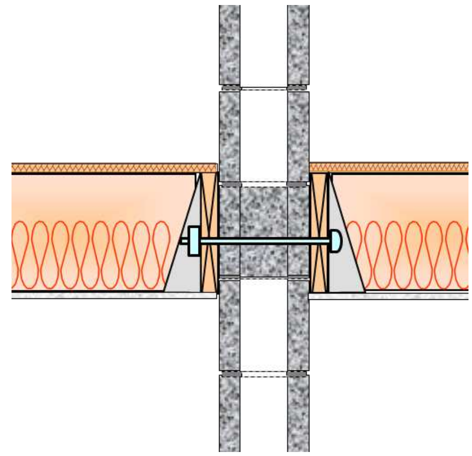
- one wythe of 190 mm hollow concrete blocks of normal weight aggregate[1] with grout-filled block cavities at 1220 mm o.c. to give stiffness and weight like reinforced block wall (mass 238 kg/m$^2$)

Junction of wall with floor/ceiling assembly:

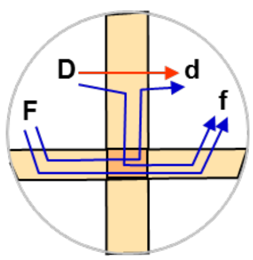
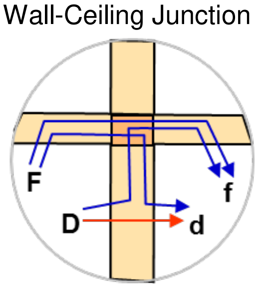
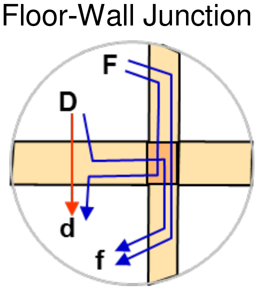
- course of concrete blocks at junction filled with grout
- 2 x 10 (38 mm x 235 mm) wood ledger plate on each side, fastened through with 16 mm diameter bolts spaced 406 mm o.c.

Floor/Ceiling assembly:

- floor deck of 16 mm oriented strand board (OSB) with no floor finish or floor topping
- floor framed with 38 mm x 235 mm wood joists spaced 406 mm o.c., with joists oriented perpendicular to separating (loadbearing) wall and supported from ledger plate on joist hangers, with 150 mm thick absorptive material in the inter-joist cavities
- ceiling with 1 layer of 13 mm gypsum board[3] fastened directly to bottom of floor framing on each side



Junction of loadbearing concrete block wall with wood-framed floor/ceiling assemblies. Illustration not exactly to scale.

| Junction | Path | Path STC | Impact Path | Path IIC |
|---|---|---|---|---|
| **BLK190-WF-LB-01** Wall-Floor Junction   | Dd | 49 | (To be added) | (To be added) |
| | Ff | 59 | “ | “ |
| | Fd | 59 | “ | “ |
| | Df | 59 | “ | “ |
| | Junction (Ff+Fd+Df) | 54 | | |
| **BLK190-WC-LB-01** Wall-Ceiling Junction   | **Path** | **Path STC** | **Impact Path** | **Path IIC** |
| | Dd | 49 | | |
| | Ff | 65 | | |
| | Fd | 65 | | |
| | Df | 65 | | |
| | Junction (Ff+Fd+Df) | 60 | | |
| **WJ235-FW-LB-01** Floor-Wall Junction   | **Path** | **Path STC** | **Impact Path** | **Path IIC** |
| | Dd | 34 | (To be added) | (To be added) |
| | Ff | 59 | “ | “ |
| | Fd | 69 | | |
| | Df | 67 | | |
| | Junction (Ff+Fd+Df) | 58 | | |

(See the footnotes located at the end of the document)

**Table 3.1.02: Transmission Paths**

<u>Wall assembly with:</u>

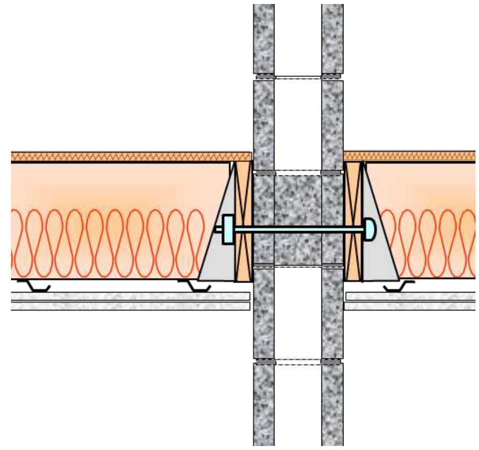
- one wythe of 190 mm hollow concrete blocks of normal weight aggregate[1] with grout-filled block cavities at 1220 mm o.c. to give stiffness and weight like reinforced block wall (mass 238 kg/m$^2$)

<u>Junction of wall with floor/ceiling assembly:</u>

- course of concrete blocks at junction filled with grout
- 2 x 10 (38 mm x 235 mm) wood ledger plate on each side, fastened through with 16 mm diameter bolts spaced 406 mm o.c.

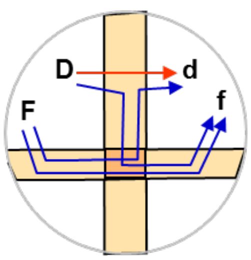
<u>Floor/Ceiling assembly:</u>

- floor deck of 16 mm oriented strand board (OSB) with no floor finish or floor topping
- floor framed with 38 mm x 235 mm wood joists spaced 406 mm o.c., with joists oriented perpendicular to separating (loadbearing) wall and supported from ledger plate on joist hangers, with 150 mm thick absorptive material in the inter-joist cavities
- ceiling with 2 layers of 16 mm gypsum board[3] supported on resilient metal channels (spaced 610 mm o.c.) and fastened directly to bottom of floor framing on each side



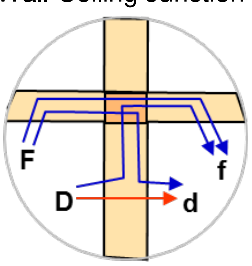
Junction of loadbearing concrete block wall with wood-framed floor. Illustration not exactly to scale.

**BLK190-WF-LB-01**
Wall-Floor Junction



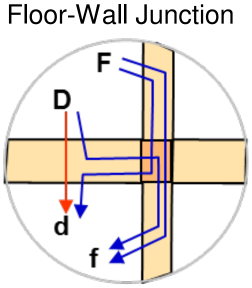

| Path | Path STC | Impact Path | Path IIC |
|---|---|---|---|
| Dd | 49 | (To be added) | (To be added) |
| Ff | 59 | " | " |
| Fd | 59 | " | " |
| Df | 59 | " | " |
| Junction (Ff+Fd+Df) | 54 | | |

**BLK190-WC-LB-02**
Wall-Ceiling Junction




| Path | Path STC | Impact Path | Path IIC |
|---|---|---|---|
| Dd | 49 | | |
| Ff | 82 | | |
| Fd | 69 | | |
| Df | 69 | | |
| Junction (Ff+Fd+Df) | 66 | | |

**WJ235-FW-LB-02**
Floor-Wall Junction




| Path | Path STC | Impact Path | Path IIC |
|---|---|---|---|
| Dd | 52 | (To be added) | (To be added) |
| Ff | 59 | " | " |
| Fd | 73 | | |
| Df | 67 | | |
| Junction (Ff+Fd+Df) | 58 | | |

(See the footnotes located at the end of the document)

**Table 3.1.03A: Transmission Paths**

<u>Wall assembly with:</u>

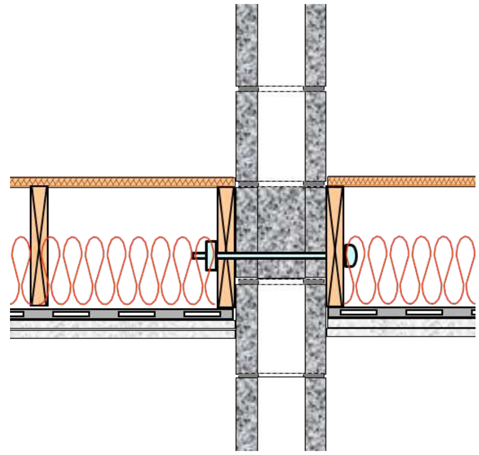
- one wythe of 190 mm hollow concrete blocks of normal weight aggregate[1] with grout-filled block cavities at 1220 mm o.c. to give stiffness and weight like reinforced block wall (mass 238 kg/m$^2$)

<u>Junction of wall with floor/ceiling assembly:</u>

- course of concrete blocks at junction filled with grout
- 2 x 10 (38 mm x 235 mm) wood ledger plate on each side, fastened through with 16 mm diameter bolts spaced 406 mm o.c.

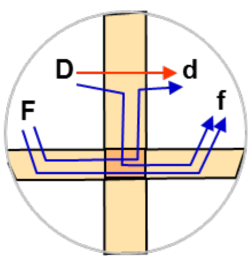
<u>Floor/Ceiling assembly:</u>

- floor deck of 16 mm oriented strand board (OSB) subfloor with no floor finish or floor topping
- floor framed with 38 mm x 235 mm wood joists spaced 406 mm o.c., with joists oriented parallel to separating (non-loadbearing) wall and supported on joist hangers, with 150 mm thick absorptive material in the inter-joist cavities
- ceiling with 2 layers of 16 mm gypsum board supported on resilient metal channels (spaced 610 mm o.c.) and fastened directly to bottom of floor framing on each side



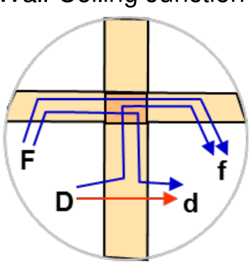
Junction of non-loadbearing concrete block wall with wood-framed floor. Illustration not exactly to scale.

**BLK190-WF-NLB-01**
Wall-Floor Junction



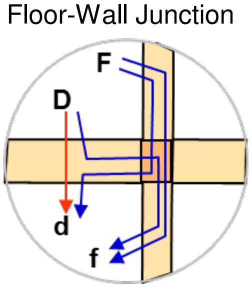

| Path | Path STC | Impact Path | Path IIC |
|---|---|---|---|
| Dd | 49 | (To be added) | (To be added) |
| Ff | 61 | " | " |
| Fd | 60 | " | " |
| Df | 60 | " | " |
| Junction (Ff+Fd+Df) | 56 | | |

**BLK190-WC-NLB-01**
Wall-Ceiling Junction




| Path | Path STC | Impact Path | Path IIC |
|---|---|---|---|
| Dd | 49 | | |
| Ff | 82 | | |
| Fd | 71 | | |
| Df | 71 | | |
| Junction (Ff+Fd+Df) | 68 | | |

**WJ235-FW-NLB-01**
Floor-Wall Junction




| Path | Path STC | Impact Path | Path IIC |
|---|---|---|---|
| Dd | 52 | (To be added) | (To be added) |
| Ff | 59 | " | " |
| Fd | 80 | | |
| Df | 69 | | |
| Junction (Ff+Fd+Df) | 59 | | |

(See the footnotes located at the end of the document)

**Table 3.1.03B: Transmission Paths**

Wall assembly with:

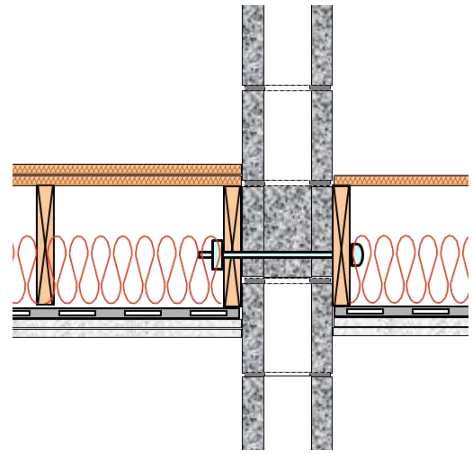
- one wythe of 190 mm hollow concrete blocks of normal weight aggregate[1] with grout-filled cavities at 1220 mm o.c. to give stiffness and weight like reinforced block wall (mass 238 kg/m$^2$)

Junction of wall with floor/ceiling assembly:

- course of concrete blocks at junction filled with grout
- 2 x 10 (38 mm x 235 mm) wood ledger plate on each side, fastened through with 16 mm diameter bolts spaced 406 mm o.c.

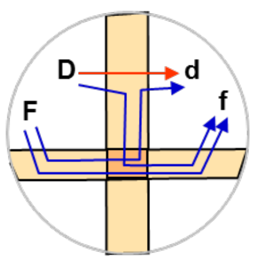
Floor/Ceiling assembly:

- 16 mm thick OSB floor topping (sheets oriented perpendicular to subfloor, joints staggered, fastened with staples)
- 16 mm oriented strand board (OSB) subfloor
- floor framed with 38 mm x 235 mm wood joists spaced 406 mm o.c., with joists oriented parallel to separating (non-loadbearing) wall and supported on joist hangers, with 150 mm thick absorptive material in the inter-joist cavities
- ceiling with 2 layers of 16 mm gypsum board supported on resilient metal channels (spaced 610 mm o.c.) and fastened directly to bottom of floor framing on each side



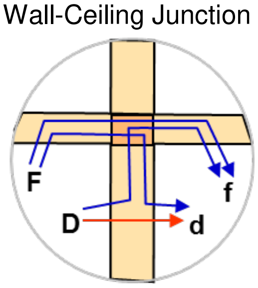
Junction of non-loadbearing concrete block wall with wood-framed floor. Illustration not exactly to scale.

**BLK190-WF-NLB-02**
Wall-Floor Junction



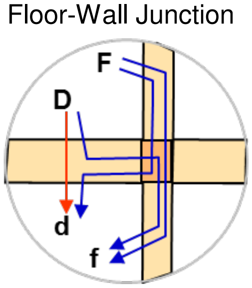

| Path | Path STC | Impact Path | Path IIC |
|---|---|---|---|
| Dd | (To be added) | (To be added) | (To be added) |
| Ff | " | " | " |
| Fd | " | " | " |
| Df | " | " | " |
| Junction (Ff+Fd+Df) | " | | |

**BLK190-WC-NLB-01**
Wall-Ceiling Junction




| Path | Path STC | Impact Path | Path IIC |
|---|---|---|---|
| Dd | (To be added) | | |
| Ff | " | | |
| Fd | " | | |
| Df | " | | |
| Junction (Ff+Fd+Df) | " | | |

**WJ235-FW-NLB-02**
Floor-Wall Junction




| Path | Path STC | Impact Path | Path IIC |
|---|---|---|---|
| Dd | (To be added) | (To be added) | (To be added) |
| Ff | " | " | " |
| Fd | " | | |
| Df | " | | |
| Junction (Ff+Fd+Df) | " | | |

(See the footnotes located at the end of the document)

## Table 3.1.03C: Transmission Paths

<u>Wall assembly with:</u>

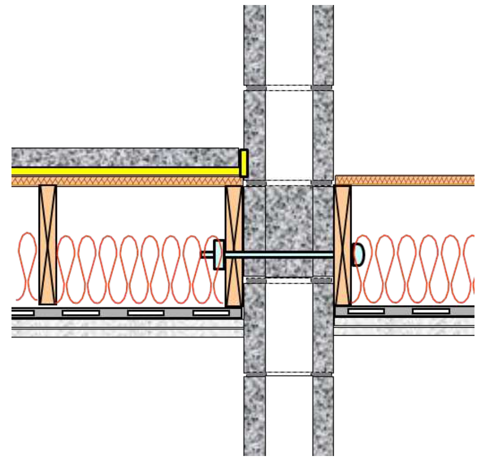
- one wythe of 190 mm hollow concrete blocks of normal weight aggregate[1] with grout-filled block cavities at 1220 mm o.c. to give stiffness and weight like reinforced block wall (mass 238 kg/m$^2$)

<u>Junction of wall with floor/ceiling assembly:</u>

- course of concrete blocks at junction filled with grout
- 2 x 10 (38 mm x 235 mm) wood ledger plate on each side, fastened through with 16 mm diameter bolts spaced 406 mm o.c.

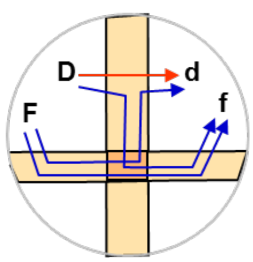
<u>Floor/Ceiling assembly:</u>

- 38 mm thick gypsum concrete floor topping over 9 mm thick closed cell foam resilient layer on the 16 mm oriented strand board (OSB) subfloor
- floor framed with 38 mm x 235 mm wood joists spaced 406 mm o.c., with joists oriented parallel to separating (non-loadbearing) wall and supported on joist hangers, 150 mm thick absorptive material in cavities
- ceiling with 2 layers of 16 mm gypsum board supported on resilient metal channels (spaced 610 mm o.c.) and fastened directly to bottom of floor framing on each side



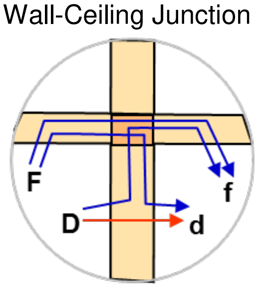
Junction of non-loadbearing concrete block wall with wood-framed floor. Illustration not exactly to scale.

**BLK190-WF-NLB-03**
Wall-Floor Junction



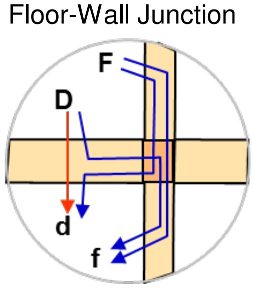

| Path | Path STC | Impact Path | Path IIC |
|---|---|---|---|
| Dd | (To be added) | (To be added) | (To be added) |
| Ff | " | " | " |
| Fd | " | " | " |
| Df | " | " | " |
| Junction (Ff+Fd+Df) | " | | |

**BLK190-WC-NLB-01**
Wall-Ceiling Junction




| Path | Path STC | Impact Path | Path IIC |
|---|---|---|---|
| Dd | (To be added) | | |
| Ff | " | | |
| Fd | " | | |
| Df | " | | |
| Junction (Ff+Fd+Df) | " | | |

**WJ235-FW-NLB-03**
Floor-Wall Junction




| Path | Path STC | Impact Path | Path IIC |
|---|---|---|---|
| Dd | (To be added) | (To be added) | (To be added) |
| Ff | " | " | " |
| Fd | " | | |
| Df | " | | |
| Junction (Ff+Fd+Df) | " | | |

(See the footnotes located at the end of the document)

**Table 3.1.04: Transmission Paths**

Separating Wall assembly with:

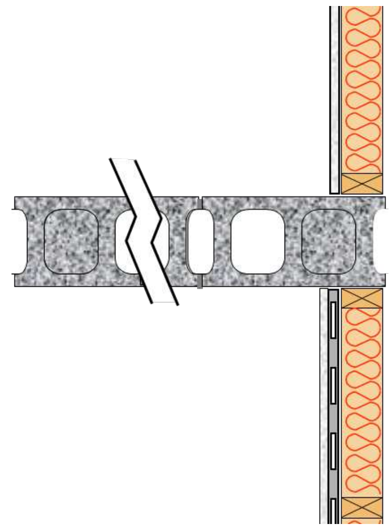
- one wythe of 190 mm hollow concrete blocks of normal weight aggregate[1] with grout-filled cavities at 1220 mm o.c.to give stiffness and weight like reinforced block wall (mass 238 kg/m$^2$)

Junction of separating wall with flanking walls:

- wood studs adjacent to concrete block wall mechanically fastened to concrete blocks with approved fasteners
- concrete blocks at junction filled with grout.

Flanking wall assemblies with:

- flanking walls framed with 38 mm x 89 mm wood studs spaced 406 mm o.c., with studs of flanking walls joined top and bottom by horizontal framing of same cross section, with 89 mm thick sound-absorptive material in the cavities
- wall surface of 1 layer of 13 mm gypsum board[3] either: (a) fastened directly to the studs or (b) supported on resilient metal channels (spaced 610 mm o.c.) that are fastened to the flanking wall framing

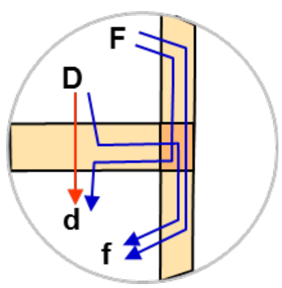


Junction of separating concrete block wall with wood-framed flanking walls. Note the 3 options for attaching gypsum board to flanking walls, presented in the 3 junction cases below. (Drawing shows horizontal section of BLK190-WW-LB-02)

**BLK190-WW-LB-01**

Wall-Wall Junction with gypsum board attached to flanking wood stud wall assemblies as follows:

- Surface F: directly attached
- Surface f: directly attached



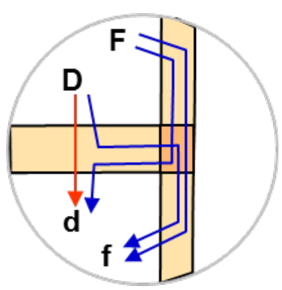

| Path | Flanking STC |
|---|---|
| Dd | 49 |
| Ff | 81 |
| Fd | 71 |
| Df | 71 |

**BLK190-WW-LB-02**

Wall-Wall Junction with gypsum board attached to flanking wood stud wall assemblies as follows:

- Surface F: directly attached
- Surface f: resiliently attached

(as in illustration above)

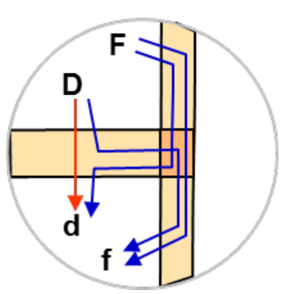



| Path | Flanking STC |
|---|---|
| Dd | (To be added) |
| Ff | “ |
| Fd | “ |
| Df | “ |

**BLK190-WW-LB-03**

Wall-Wall Junction with gypsum board attached to flanking wood stud wall assemblies as follows:

- Surface F: resiliently attached
- Surface f: resiliently attached




| Path | Flanking STC |
|---|---|
| Dd | (To be added) |
| Ff | “ |
| Fd | “ |
| Df | “ |

(See the footnotes located at the end of the document)

## 3.2 Concrete Block Walls with Lightweight Steel-Framed Floors and Walls

(TO BE ADDED LATER)

## 3.3 Concrete Block Walls with Precast Floors

(TO BE ADDED LATER)

# 4 Predicting Sound Transmission in Buildings

This chapter presents the calculation approach for predicting the sound transmission in a building which combines concrete block walls with other assemblies of various kinds.

The calculations are based on the concepts presented in Section 1.4 of this Report. The calculations of the sound transmitted between two rooms include a combination of the airborne sound transmission through the separating assembly and the structure-borne transmission via the set of first-order flanking paths between the rooms.

In this Report, the "Simplified Method" of ISO 15712-1 is applied with some modifications when framed assemblies are involved. This modified method uses the single-number ratings (STC for a separating assembly or Flanking STC for each flanking path) as presented in Equation 1.2. The calculation process is explained in detail in this section. This calculation procedure is less rigorous than the Detailed Method presented in the standard and Guide RR-331, but the calculation process is much less complicated. The differences between results of the two methods can be small, and the simplified calculations use approximations that should ensure the results are slightly more conservative (i.e. the ASTC calculated using the Simplified Method tends to be lower).

The choice of input data and process used to calculate the transmission via each flanking path depends on the type of wall and floor constructions which are combined with the concrete block walls to form the complete building.

For this reason, Chapter 4 is divided into sections suitable for the combination of concrete block walls with other constructions:

- Concrete masonry walls with concrete floors in Section 4.1
- Concrete masonry walls with lightweight wood-framed walls and floors in Section 4.2
- Concrete masonry walls with lightweight steel-framed walls and floors in Section 4.3
- Concrete masonry walls with precast concrete plank floors in Section 4.4

## 4.1 Scenarios for Concrete Block Walls with Structural Concrete Floors

ISO 15712-1 presents a "Simplified model for structure-borne transmission" in Section 4.4 of the standard. This method has some clearly stated limitations, and some implicit cautions including that:

- The simplified method uses a set of ad hoc approximations that are appropriate for buildings with concrete and masonry construction, with or without linings.
- The application of the simplified method "is restricted to primarily homogeneous constructions", further restricted here to homogeneous lightly-damped structural assemblies. Here "lightly-damped" implies a reverberant vibration field that can be characterized by a mean vibration level, and "homogeneous" implies similar bending stiffness in all directions across the surface. This limitation excludes wood-framed and steel-framed assemblies, but includes typical concrete or concrete masonry walls or concrete floors.
- Within that restricted context, the calculation has been structured to predict an ASTC slightly lower than that from the "detailed method" used in the examples presented in Guide RR-331.

The calculation method of Section 4.4 of ISO 15712-1 is based on two main simplifications:

- The most significant simplification is to deal with losses to connected assemblies "in an average way", which requires ignoring the variation of in situ transmission loss due to edge losses to adjoining wall and floor constructions, thereby eliminating much of the calculation process of the detailed method.
- The procedure uses only single number measures. For purposes of this Report, the single number measures are laboratory measured STC ratings for the structural wall and floor assemblies and the ΔSTC values for any linings as the input data. The final output is the overall ASTC rating.

The Simplified Method predicts the overall ASTC rating by following the steps in Figure 4.1.1, which are indicated in the diagram below (and explained in more detail for each step below):

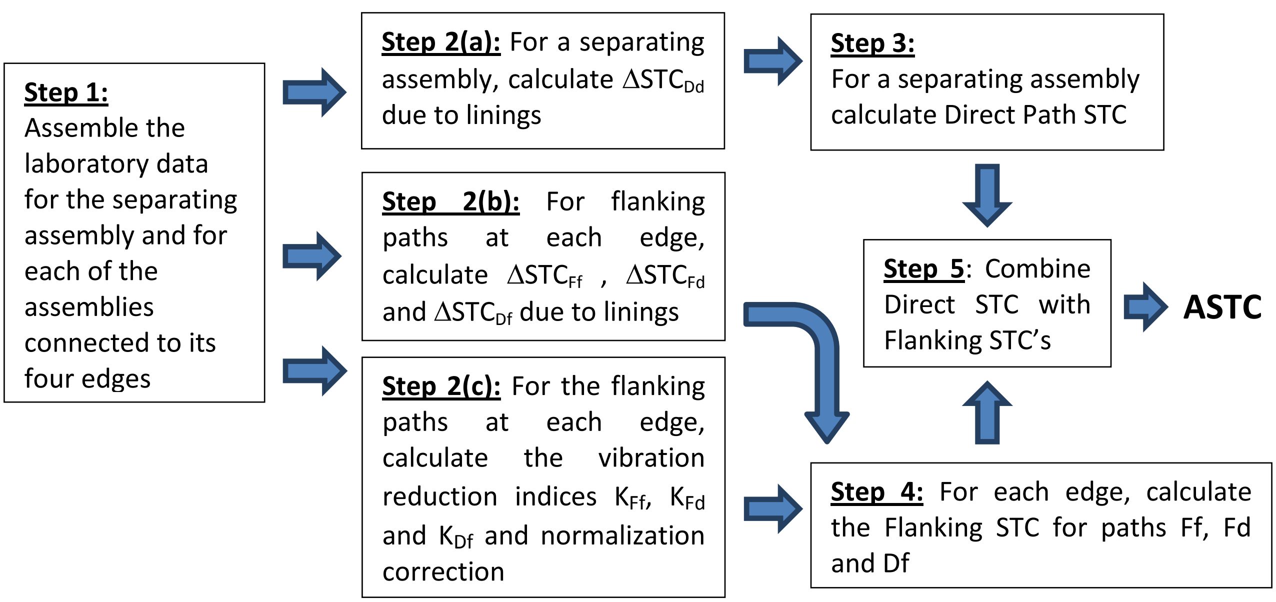



**Figure 4.1.1**: Steps to calculate the Direct STC and the Flanking STC for each flanking path

Step 1: Assemble the required laboratory test data for the constructions including the:
- Laboratory sound transmission class (STC) values based on the TL measured according to ASTM E90 for the structural floor or wall assemblies (of bare concrete or masonry)
- Mass per unit area for these bare assemblies
- Measured change in sound transmission class (ΔSTC) determined according to Sections 2.2 and 2.3 for each lining that will be added to the bare structural floor or wall assemblies.

Step 2: Determine correction terms as follows:

a) For linings on the source and/or receiving side of the separating assembly, the correction $\Delta STC_{Dd}$ is the sum of the larger of the ΔSTC values for these two linings plus half of the smaller value.

b) For each flanking path *ij*, the correction $\Delta STC_{ij}$ for linings on the source surface *i* and/or the receiving surface *j*, is the sum of the larger of the ΔSTC values for these two linings plus half of the smaller value.

c) For each edge of the separating assembly, calculate the vibration reduction indices $K_{Ff}$, $K_{Fd}$, and $K_{Df}$ for the flanking paths between the assembly in the source room (D or F) and the attached assembly in the receiving room (f or d) using the appropriate case from Annex E of ISO 15712-1. These values depend on the junction geometry and the ratio of the mass per unit area for the connected assemblies. Also calculate the normalization correction, which depends on the length of the flanking junction and the area of the separating assembly.

Step 3: Calculate the Direct STC rating for the direct transmission through the separating assembly ($STC_{Dd}$ ) using Eq. 27 of ISO 15712-1:2005 with the inputs:
- Laboratory STC value for the bare structural assembly
- Correction for linings $\Delta STC_{Dd}$ from Step 2(a)

Step 4: Calculate the Flanking STC for transmission via each pair of connected assemblies at each edge of the separating assembly, using Eq. 28a of ISO 15712-1 with inputs:
- Laboratory STC value for each bare structural assembly
- Correction for linings $\Delta STC_{ij}$ from Step 2(b)
- Value of $K_{ij}$ and normalization correction for this path from Step 2(c)

Step 5: Combine the transmission via the direct and flanking paths to determine the ASTC. In the worked examples, the Direct STC and Flanking STC values are rounded to the nearest integer before they are combined, and the ASTC is also rounded to the nearest integer, to match the nominal precision of the ASTM ratings.

**Worked Examples**

Each of the worked examples 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 of the examples in this section conform to the Standard Scenario presented in Section 1.2 of this Report.

Within the table presented for each worked example, the "References" column describes the source of the 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 15712-1:2005 at each stage of the calculation. Symbols and subscripts identifying the corresponding variable from ISO 15712-1 are given in the adjacent column. Equations and figures from the standard are not reproduced here to respect the copyright. However, the worked examples provide values for a set of scenarios with common base constructions and linings.

Under the single heading "STC, ΔSTC", the examples present input data determined in laboratory tests according to ASTM E90, including the:

- STC values of sound transmission loss of wall or floor assemblies
- ΔSTC values calculated from measurements of the change in sound transmission due to adding a given lining to the specified wall or floor assembly. (See pages 14-16.)

Under the heading "ASTC", the examples present the calculated values (rounded to the nearest integer) for transmission via specific paths, including the:

- Direct STC for the calculated in-situ transmission loss of the separating wall or floor assembly
- Flanking STC calculated for each flanking transmission path at each junction
- Apparent STC (ASTC) for the combination of direct and flanking transmission via all paths

When the calculated Flanking STC value for a given path exceeds 90, the value is limited to 90 to allow for the inevitable effect of higher order flanking paths which cause the higher calculated value to be unrepresentative of the true situation. These situations are flagged with the adjacent label "(limit)" and indicate that further enhancements to elements in these paths will give negligible benefit to the ASTC value. The consequence of this limit is that the Junction STC for the set of 3 paths at each edge of the separating assembly cannot exceed 85 and the Total Flanking STC for all 4 edges cannot exceed 79.

The numeric calculations are presented step-by-step in each worked example, using compact notation consistent with the spreadsheet expressions such that:

- For calculation of the Direct STC and the Flanking STC, these expressions are easily recognized as equivalent to Equations 4.1.2 and 4.1.3, respectively. These 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. 1.2 is presented in several stages. Note that in the compact notation, a term for transmitted sound power fraction such as $10^{-0.1 \cdot STC_{ij}}$ becomes $10^{-7.4}$, if $STC_{ij}$ =74.
- At each stage (such as the Flanking STC for the 3 paths at a given junction) the result is converted into decibel form by calculating -10*LOG10( transmitted sound power fraction), to facilitate comparison of each path or junction with the Direct STC and the final ASTC result.

**Example Scenarios**

The set of examples contains 6 groups of room geometries and base structure elements:

| Section | Examples | Room Pair | Concrete Block | Loadbearing Walls | Concrete Floor |
|---|---|---|---|---|---|
| 4.1.1 | H1 to H4<br>V1 to V4 | Horizontal (Side-by-side)<br>Vertical (One-above-other) | BLK190(NW) | Yes<br>Yes | 150 mm |
| 4.1.2 | H1 to H4<br>V1 to V4 | Horizontal (Side-by-side)<br>Vertical (One-above-other) | BLK190(NW) | No<br>No | 150 mm |
| 4.1.3 | H1 to H4<br>V1 to V4 | Horizontal (Side-by-side)<br>Vertical (One-above-other) | BLK140(LW) | No<br>No | 200 mm |

Obviously, other combinations are possible (such as two loadbearing and two non-loadbearing junctions for a pair of rooms one-above-the-other), but the example scenarios are sufficient to illustrate the calculation process for each type of junction.

At the end of each of the three sections 4.1.1 to 4.1.3, there is a brief discussion of the trends in ASTC values for the system and the key sound transmission paths for determining those trends.

### 4.1.1 Loadbearing Normal Weight Concrete Block Walls with Concrete Floors

Note that all of the examples in Section 4.1.1 have rigid mortared junctions between the loadbearing concrete block walls and the concrete floors as well as between abutting concrete block walls.

**EXAMPLE 4.1.1-H1: (SIMPLIFIED METHOD)**

- **Rooms side-by-side**
- **Loadbearing normal weight concrete block walls and concrete floors with rigid junctions**

Separating wall assembly (loadbearing) with:
- one wythe of concrete blocks with mass 238 kg/m$^2$ (e.g. 190 mm hollow blocks with normal weight aggregate[1]) with no lining

Junction 1: Bottom Junction (separating wall / floor) with:
- concrete floor with mass 345 kg/m$^2$ (e.g. normal weight concrete with thickness of 150 mm) with no topping or flooring
- rigid mortared cross junction with concrete block wall assembly

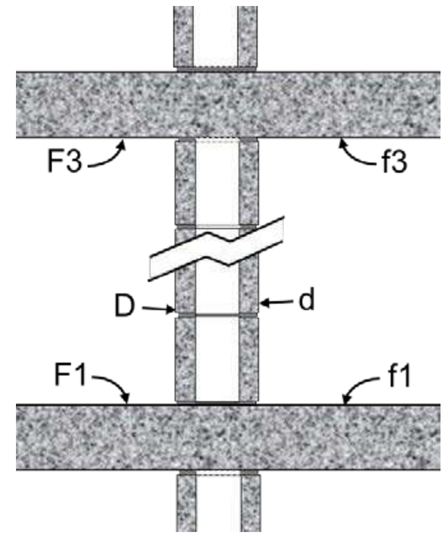
Junction 2 or 4: Each Side (separating wall / abutting side wall) with:
- abutting side wall and separating wall of concrete blocks with mass 238 kg/m$^2$ (e.g. 190 mm hollow blocks with normal weight aggregate[1]), with no lining
- rigid mortared T-junctions

Junction 3: Top Junction (separating wall / ceiling) with:
- concrete ceiling slab with mass 345 kg/m$^2$ (e.g. normal weight concrete with thickness of 150 mm) with no added ceiling lining
- rigid mortared cross junction with concrete block wall assembly

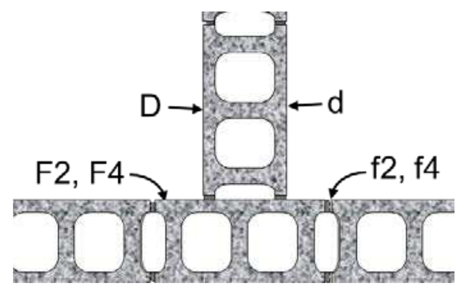
Acoustical Parameters:

| | | |
|---|---|---|
| For 190 mm concrete block walls: | | |
| Mass/unit area (kg/m$^2$ ) = | 238 | (Separating wall) |
| | 238 | (Flanking wall) |
| For 150 mm concrete floor: | | |
| Mass/unit area (kg/m$^2$ ) = | 345 | |
| | | |
| Separating partition area ( m$^2$ ) = | 12.5 | |
| Junction length (m ) = | 5.0 | |
| Separating partition height ( m ) = | 2.5 | |
| 10*log(S_Partition/l_junction 1&3) = | 4.0 | |
| 10*log(S_Partition/l_junction 2&4) = | 7.0 | |

**Illustration for this case**




Junction of 190 mm concrete block separating wall with 150 mm thick concrete floor and ceiling.
(Side view of Junctions 1 and 3)




Junction of separating wall with side wall, both of 190 mm concrete block. (Plan view of Junction 2 or 4).

| Junction | | Mass ratio for Ff | Path Ff<br>Kij(in dB) = | Path Fd | Path Df | Reference |
|---|---|---|---|---|---|---|
| 1 | Rigid-Cross junction | 0.69 | 6.1 | 8.8 | 8.8 | ISO 15712-1, Eq. E.3 |
| 2 | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |
| 3 | Rigid-Cross junction | 0.69 | 6.1 | 8.8 | 8.8 | ISO 15712-1, Eq. E.3 |
| 4 | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | Calculation | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|---|
| **Separating Partition (190 mm concrete block)** | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining on D | ΔR_D,w | No Lining , | | 0 | | |
| ΔSTC change by Lining on d | ΔR_d,w | No Lining , | | 0 | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 49 + MAX(0,0) + MIN(0,0)/2 = | | **49** | |
| | | | | | | |
| **Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor)** | | | | | | |
| Flanking Element F1: | | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_F1,w | No Lining , | | 0 | | |
| Flanking Element f1: | | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_f1,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 6.1 + 4 = | | **62** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 8.8 + 4 = | | **63** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 8.8 + 4 = | | **63** | |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.2 + 10^- 6.3 + 10^- 6.3 ) = | | | **58** |
| | | | | | | |
| **Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F2: | | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F2,w | No Lining , | | 0 | | |
| Flanking Element f2: | | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f2,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 5.7 + 7 = | | **62** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 5.7 + 7 = | | **62** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 5.7 + 7 = | | **62** | |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.2 + 10^- 6.2 + 10^- 6.2 ) = | | | **57** |
| | | | | | | |
| **Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab)** | | | | | | |
| Flanking Element F3: | | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_F3,w | No Lining , | | 0 | | |
| Flanking Element f3: | | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_f3,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 6.1 + 4 = | | **62** | |
| **Flanking STC for path Fd** | R_ Fd,w | | 52/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 8.8 + 4 = | | **63** | |
| **Flanking STC for path Df** | R_ Df,w | | 49/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 8.8 + 4 = | | **63** | |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.2 + 10^- 6.3 + 10^- 6.3 ) = | | | **58** |
| | | | | | | |
| **Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F4: | | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F4,w | No Lining , | | 0 | | |
| Flanking Element f4: | | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f4,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 5.7 + 7 = | | **62** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 5.7 + 7 = | | **62** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 5.7 + 7 = | | **62** | |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.2 + 10^- 6.2 + 10^- 6.2 ) = | | | **57** |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | | **52** |
| | | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | | **47** | |

**EXAMPLE 4.1.1-H2: (SIMPLIFIED METHOD)**

- **Rooms side-by-side**
- **Loadbearing normal weight concrete block walls and concrete floors with rigid junctions (Same structure as 4.1.1-H1, plus lining of walls)**

Separating wall assembly (loadbearing) with:
- one wythe of concrete blocks with mass 238 kg/m$^2$ (e.g. 190 mm hollow blocks with normal weight aggregate[1])
- separating wall lined on both sides with 13 mm gypsum board[3] supported on 65 mm non-loadbearing steel studs spaced 610 mm o.c. with no absorptive material[2] filling inter-stud cavities

Junction 1: Bottom Junction (separating wall / floor) with:
- concrete floor with mass 345 kg/m$^2$ (e.g. normal weight concrete with thickness of 150 mm) with no topping or flooring
- rigid mortared cross junction with concrete block wall assembly

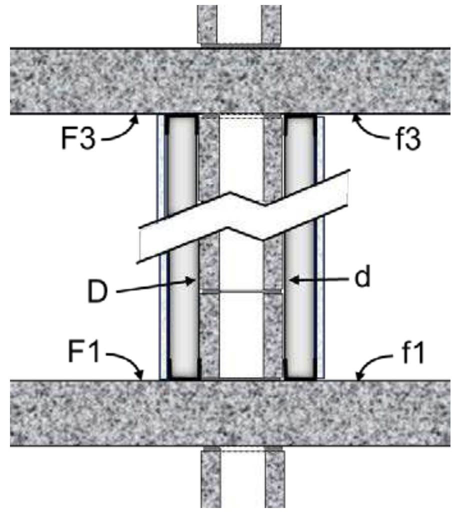
Junction 2 or 4: Each Side (separating wall /abutting side wall) with:
- side wall and separating wall of concrete blocks with mass 238 kg/m$^2$ (e.g. 190 mm hollow blocks with normal weight aggregate[1]) with rigid mortared T-junctions
- flanking walls lined with 13 mm gypsum board[3] supported on 65 mm non-loadbearing steel studs spaced 610 mm o.c. with no absorptive material[2] filling inter-stud cavities

Junction 3: Top Junction (separating wall / ceiling) with:
- concrete ceiling slab with mass 345 kg/m$^2$ (e.g. normal weight concrete with thickness of 150 mm) with no added ceiling lining
- rigid mortared cross junction with concrete block wall assembly

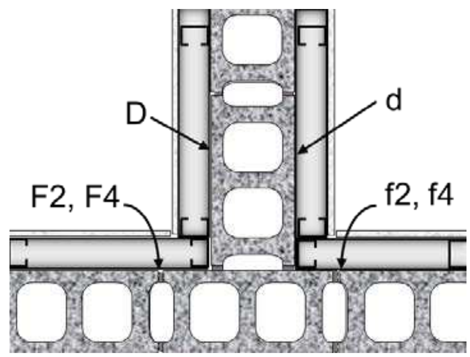
Acoustical Parameters:

| | | |
|---|---|---|
| For 190 mm concrete block walls: | | |
| Mass/unit area (kg/m$^2$ ) = | 238 | (Separating wall) |
| | 238 | (Flanking wall) |
| For 150 mm concrete floor: | | |
| Mass/unit area (kg/m$^2$ ) = | 345 | |
| | | |
| Separating partition area ( m$^2$ ) = | 12.5 | |
| Junction length (m ) = | 5.0 | |
| Separating partition height ( m ) = | 2.5 | |
| 10*log(S_Partition/l_junction 1&3) = | 4.0 | |
| 10*log(S_Partition/l_junction 2&4) = | 7.0 | |

**Illustration for this case**




Junction of 190 mm concrete block separating wall (with gypsum board lining) with 150 mm thick concrete floor and ceiling. (Side view of Junctions 1 and 3)




Junction of separating wall with flanking side wall, both of 190 mm concrete block with gypsum board linings. (Plan view of Junction 2 or 4).

| Junction | | Mass ratio for Ff | Path Ff | Path Fd | Path Df | Reference |
|---|---|---|---|---|---|---|
| | | | Kij(in dB) = | | | |
| 1 | Rigid-Cross junction | 0.69 | 6.1 | 8.8 | 8.8 | ISO 15712-1, Eq. E.3 |
| 2 | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |
| 3 | Rigid-Cross junction | 0.69 | 6.1 | 8.8 | 8.8 | ISO 15712-1, Eq. E.3 |
| 4 | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|---|
| **Separating Partition (190 mm concrete block)** | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining on D | ΔR_D,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| ΔSTC change by Lining on d | ΔR_d,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 49 + MAX(2,2) + MIN(2,2)/2 = | | **52** | |
| | | | | | | |
| **Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor)** | | | | | | |
| Flanking Element F1: | | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_F1,w | No Lining , | | 0 | | |
| Flanking Element f1: | | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_f1,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 6.1 + 4 = | | **62** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 49/2 + MAX(0,2) + MIN(0,2)/2 + 8.8 + 4 = | | **65** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(2,0) + MIN(2,0)/2 + 8.8 + 4 = | | **65** | |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.2 + 10^- 6.5 + 10^- 6.5 ) = | | | **59** |
| | | | | | | |
| **Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F2: | | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F2,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| Flanking Element f2: | | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f2,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(2,2) + MIN(2,2)/2 + 5.7 + 7 = | | **65** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(2,2) + MIN(2,2)/2 + 5.7 + 7 = | | **65** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(2,2) + MIN(2,2)/2 + 5.7 + 7 = | | **65** | |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.5 + 10^- 6.5 + 10^- 6.5 ) = | | | **60** |
| | | | | | | |
| **Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab)** | | | | | | |
| Flanking Element F3: | | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_F3,w | No Lining , | | 0 | | |
| Flanking Element f3: | | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_f3,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 6.1 + 4 = | | **62** | |
| **Flanking STC for path Fd** | R_ Fd,w | | 52/2 + 49/2 + MAX(0,2) + MIN(0,2)/2 + 8.8 + 4 = | | **65** | |
| **Flanking STC for path Df** | R_ Df,w | | 49/2 + 52/2 + MAX(2,0) + MIN(2,0)/2 + 8.8 + 4 = | | **65** | |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.2 + 10^- 6.5 + 10^- 6.5 ) = | | | **59** |
| | | | | | | |
| **Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F4: | | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F4,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| Flanking Element f4: | | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f4,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(2,2) + MIN(2,2)/2 + 5.7 + 7 = | | **65** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(2,2) + MIN(2,2)/2 + 5.7 + 7 = | | **65** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(2,2) + MIN(2,2)/2 + 5.7 + 7 = | | **65** | |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.5 + 10^- 6.5 + 10^- 6.5 ) = | | | **60** |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | | **54** |
| | | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | | **50** | |

**EXAMPLE 4.1.1-H3: (SIMPLIFIED METHOD)**

- **Rooms side-by-side**
- **Loadbearing normal weight concrete block walls and concrete floors with rigid junctions (Same structure as 4.1.1-H1, with enhanced lining of walls)**

Separating wall assembly (loadbearing) with:

- one wythe of concrete blocks with mass 238 kg/m$^2$ (e.g. 190 mm hollow blocks with normal weight aggregate[1])
- separating wall lined both sides with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c., with absorptive material[2] filling inter-stud cavities

Junction 1: Bottom Junction (separating wall / floor) with:

- concrete floor with mass 345 kg/m$^2$ (e.g. normal weight concrete with thickness of 150 mm) with no topping or flooring
- rigid mortared cross junction with concrete block wall assembly

Junction 2 or 4: Each Side (separating wall /abutting side wall) with:

- rigid mortared T-junctions of abutting side wall and separating wall of concrete blocks with mass 238 kg/m$^2$ (e.g. 190 mm hollow blocks with normal weight aggregate[1])
- flanking walls lined with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c., with absorptive material[2] filling inter-stud cavities

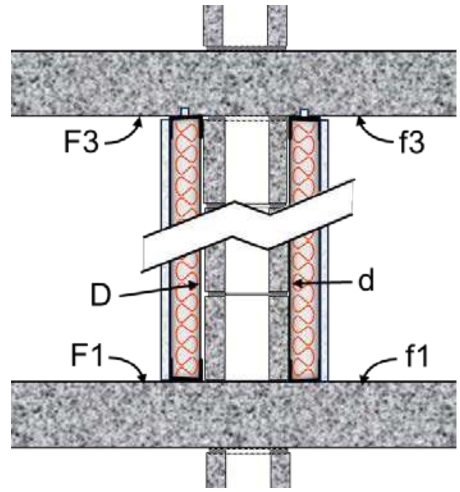
Junction 3: Top Junction (separating wall / ceiling) with:

- concrete ceiling slab with mass 345 kg/m$^2$ (e.g. normal weight concrete with thickness of 150 mm) with no added ceiling lining
- rigid mortared cross junction with concrete block wall assembly

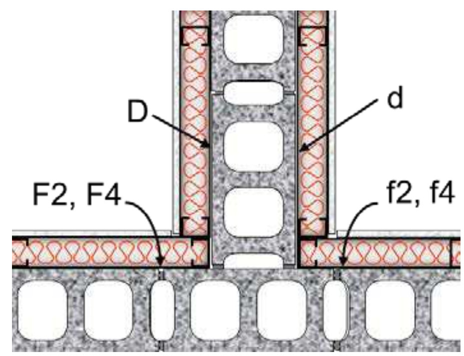
Acoustical Parameters:

| | | |
|---|---|---|
| For 190 mm concrete block walls: | | |
| Mass/unit area (kg/m$^2$ ) = | 238 | (Separating wall) |
| | 238 | (Flanking wall) |
| For 150 mm concrete floor: | | |
| Mass/unit area (kg/m$^2$ ) = | | 345 |
| | | |
| Separating partition area ( m$^2$ ) = | | 12.5 |
| Junction length (m ) = | | 5.0 |
| Separating partition height ( m ) = | | 2.5 |
| 10*log(S_Partition/l_junction 1&3) = | | 4.0 |
| 10*log(S_Partition/l_junction 2&4) = | | 7.0 |

**Illustration for this case**




Junction of 190 mm concrete block separating wall (with enhanced gypsum board lining) with 150 mm thick concrete floor and ceiling. (Side view of Junctions 1 and 3)




Junction of separating wall with flanking side wall, both of 190 mm concrete block with enhanced gypsum board linings. (Plan view of Junction 2 or 4).

| | | | Path Ff | Path Fd | Path Df | |
|---|---|---|---|---|---|---|
| **Junction** | | Mass ratio for Ff | Kij(in dB) = | | | Reference |
| **1** | Rigid-Cross junction | 0.69 | 6.1 | 8.8 | 8.8 | ISO 15712-1, Eq. E.3 |
| **2** | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |
| **3** | Rigid-Cross junction | 0.69 | 6.1 | 8.8 | 8.8 | ISO 15712-1, Eq. E.3 |
| **4** | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | Calculation | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|---|
| **Separating Partition (190 mm concrete block)** | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining on D | ΔR_D,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| ΔSTC change by Lining on d | ΔR_d,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 49 + MAX(19,19) + MIN(19,19)/2 = | | **78** | |
| | | | | | | |
| **Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor)** | | | | | | |
| Flanking Element F1: | | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_F1,w | No Lining , | | 0 | | |
| Flanking Element f1: | | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_f1,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 6.1 + 4 = | | **62** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 49/2 + MAX(0,19) + MIN(0,19)/2 + 8.8 + 4 = | | **82** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(19,0) + MIN(19,0)/2 + 8.8 + 4 = | | **82** | |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.2 + 10^- 8.2 + 10^- 8.2 ) = | | **62** | |
| | | | | | | |
| **Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F2: | | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F2,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| Flanking Element f2: | | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f2,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 9 + 10^- 9 ) = | | **85** | |
| | | | | | | |
| **Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab)** | | | | | | |
| Flanking Element F3: | | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_F3,w | No Lining , | | 0 | | |
| Flanking Element f3: | | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_f3,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 6.1 + 4 = | | **62** | |
| **Flanking STC for path Fd** | R_ Fd,w | | 52/2 + 49/2 + MAX(0,19) + MIN(0,19)/2 + 8.8 + 4 = | | **82** | |
| **Flanking STC for path Df** | R_ Df,w | | 49/2 + 52/2 + MAX(19,0) + MIN(19,0)/2 + 8.8 + 4 = | | **82** | |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.2 + 10^- 8.2 + 10^- 8.2 ) = | | **62** | |
| | | | | | | |
| **Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F4: | | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F4,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| Flanking Element f4: | | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f4,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 9 + 10^- 9 ) = | | **85** | |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | **59** | |
| | | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | | **59** | |

**EXAMPLE 4.1.1-H4: (SIMPLIFIED METHOD)**

- **Rooms side-by-side**
- **Loadbearing normal weight concrete block walls and concrete floors with rigid junctions (Same structure as 4.1.1-H1, with lining of walls & ceiling)**

Separating wall assembly (loadbearing) with:
- one wythe of concrete blocks with mass 238 kg/m$^2$ (e.g. 190 mm hollow blocks with normal weight aggregate[1])
- separating wall lined both sides with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c., with absorptive material[2] filling inter-stud cavities

Junction 1: Bottom Junction (separating wall / floor) with:
- concrete floor with mass 345 kg/m$^2$ (e.g. normal weight concrete with thickness of 150 mm) with no topping or flooring
- rigid mortared cross junction with concrete block wall assembly

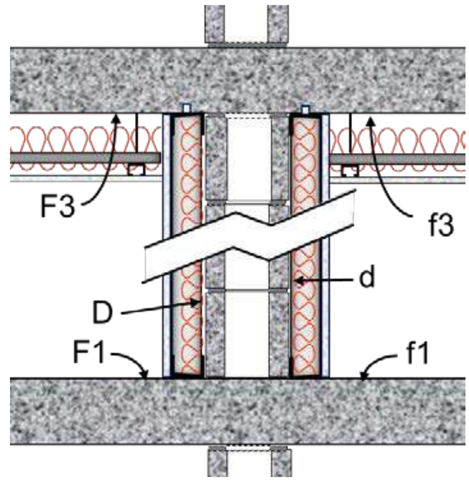
Junction 2 or 4: Each Side (separating wall /abutting side wall) with:
- rigid mortared T-junctions of abutting side wall and separating wall of concrete blocks with mass 238 kg/m$^2$ (e.g. 190 mm hollow blocks with normal weight aggregate[1])
- flanking walls lined with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c., with absorptive material[2] filling inter-stud cavities

Junction 3: Top Junction (separating wall / ceiling) with:
- concrete ceiling slab with mass 345 kg/m$^2$ (e.g. normal weight concrete with thickness of 150 mm)
- ceiling lining of 16 mm gypsum board[3] fastened to hat-channels supported on cross-channels hung on wires, with 150 mm cavity between concrete and ceiling, with 150 mm absorptive material[2].
- rigid mortared cross junction with concrete block wall assembly

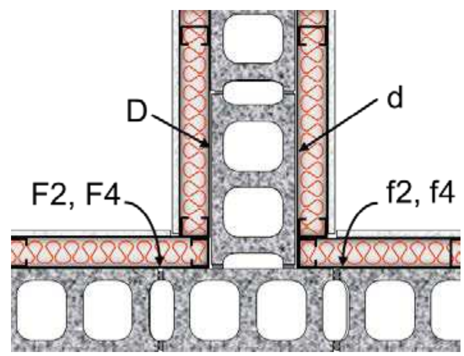
Acoustical Parameters:

| | | |
|---|---|---|
| For 190 mm concrete block walls: | | |
| Mass/unit area (kg/m$^2$ ) = | 238 | (Separating wall) |
| | 238 | (Flanking wall) |
| For 150 mm concrete floor: | | |
| Mass/unit area (kg/m$^2$ ) = | | 345 |
| | | |
| Separating partition area ( m$^2$ ) = | | 12.5 |
| Junction length (m ) = | | 5.0 |
| Separating partition height ( m ) = | | 2.5 |
| 10*log(S_Partition/l_junction 1&3) = | | 4.0 |
| 10*log(S_Partition/l_junction 2&4) = | | 7.0 |

**Illustration for this case**




Junction of 190 mm concrete block separating wall (with enhanced gypsum board lining) with 150 mm thick concrete floor and ceiling. (Side view of Junctions 1 and 3)




Junction of separating wall with flanking side wall, both of 190 mm concrete block with enhanced gypsum board linings. (Plan view of Junction 2 or 4).

| Junction | | Mass ratio for Ff | Path Ff Kij(in dB) = | Path Fd | Path Df | Reference |
|---|---|---|---|---|---|---|
| 1 | Rigid-Cross junction | 0.69 | 6.1 | 8.8 | 8.8 | ISO 15712-1, Eq. E.3 |
| 2 | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |
| 3 | Rigid-Cross junction | 0.69 | 6.1 | 8.8 | 8.8 | ISO 15712-1, Eq. E.3 |
| 4 | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|---|
| Separating Partition (190 mm concrete block) | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining on D | ΔR_D,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| ΔSTC change by Lining on d | ΔR_d,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 49 + MAX(19,19) + MIN(19,19)/2 = | | **78** | |
| | | | | | | |
| Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor) | | | | | | |
| Flanking Element F1: | | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_F1,w | No Lining , | | 0 | | |
| Flanking Element f1: | | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_f1,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 6.1 + 4 = | | **62** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 49/2 + MAX(0,19) + MIN(0,19)/2 + 8.8 + 4 = | | **82** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(19,0) + MIN(19,0)/2 + 8.8 + 4 = | | **82** | |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.2 + 10^- 8.2 + 10^- 8.2 ) = | | **62** | |
| | | | | | | |
| Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall) | | | | | | |
| Flanking Element F2: | | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F2,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| Flanking Element f2: | | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f2,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 9 + 10^- 9 ) = | | **85** | |
| | | | | | | |
| Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab) | | | | | | |
| Flanking Element F3: | | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_F3,w | RR-333, ΔTLF-CON150-01, SUS150_GFB150_G16 | | 19 | | |
| Flanking Element f3: | | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_f3,w | RR-333, ΔTLF-CON150-01, SUS150_GFB150_G16 | | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 52/2 + MAX(19,19) + MIN(19,19)/2 + 6.1 + 4 = | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | | 52/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 8.8 + 4 = | | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | | 49/2 + 52/2 + MAX(19,19) + MIN(19,19)/2 + 8.8 + 4 = | | **90** | (limit) |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 9 + 10^- 9 ) = | | **85** | |
| | | | | | | |
| Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall) | | | | | | |
| Flanking Element F4: | | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F4,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| Flanking Element f4: | | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f4,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 9 + 10^- 9 ) = | | **85** | |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | **62** | |
| | | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | | **62** | |

**EXAMPLE 4.1.1-V1: (SIMPLIFIED METHOD)**

- **Rooms one-above-the-other**
- **Loadbearing normal weight concrete block walls and concrete floors with rigid junctions**

Separating floor/ceiling assembly with:
- concrete floor with mass 345 kg/m$^2$ (e.g. normal weight concrete with thickness of 150 mm) with no topping / flooring on top, or ceiling lining below

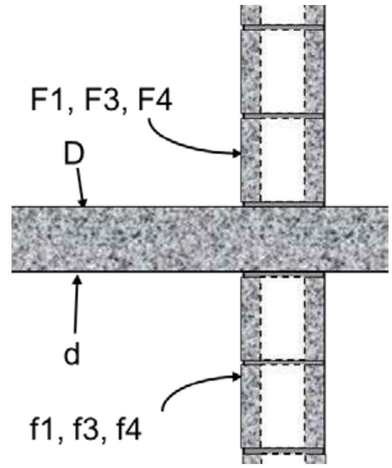
Junction 1, 3, 4: Cross Junction of separating floor / flanking wall with:
- rigid mortared cross junction with concrete block wall assemblies
- wall above and below floor of one wythe of concrete blocks with mass 238 kg/m$^2$ (e.g. 190 mm hollow blocks with normal weight aggregate[1]) with no lining of walls

Junction 2: T-Junction of separating floor / flanking wall with:
- rigid mortared T-junctions with concrete block wall assemblies
- wall above and below floor of one wythe of concrete blocks with mass 238 kg/m$^2$ (e.g. 190 mm hollow blocks with normal weight aggregate[1]) with no lining of walls

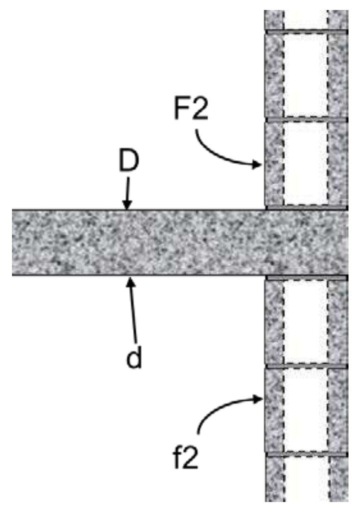
Acoustical Parameters:

| | | |
|---|---|---|
| For 190 mm concrete block walls: | | |
| Mass/unit area (kg/m$^2$ ) = | 238 | (Wall at junctions 1&3) |
| | 238 | (Wall at junctions 2&4) |
| For 150 mm concrete floor: | | |
| Mass/unit area (kg/m$^2$ ) = | | 345 |
| | | |
| Separating partition area ( m$^2$ ) = | | 20 |
| Junction 1 and 3 length (m ) = | | 5.0 |
| Junction 2 and 4 length (m ) = | | 4.0 |
| 10*log(S_Partition/l_junction 1&3) = | | 6.0 |
| 10*log(S_Partition/l_junction2 &4) = | | 7.0 |

**Illustration for this case**




Cross junction of separating floor of 150 mm thick concrete with 190 mm concrete block wall. (Side view of Junctions 1, 3, 4)




T-Junction of separating floor of 150 mm thick concrete floor with 190 mm concrete block wall. (Side view of Junction 2).

| | | | Path Ff | Path Fd | Path Df | |
|---|---|---|---|---|---|---|
| **Junction** | | Mass ratio for Ff | Kij (in dB) = | | | Reference |
| 1 | Rigid-Cross junction | 1.45 | 11.6 | 8.8 | 8.8 | ISO 15712-1, Eq. E.3 |
| 2 | Rigid-T junction | 1.45 | 8.1 | 5.8 | 5.8 | ISO 15712-1, Eq. E.4 |
| 3 | Rigid-Cross junction | 1.45 | 11.6 | 8.8 | 8.8 | ISO 15712-1, Eq. E.3 |
| 4 | Rigid-Cross junction | 1.45 | 11.6 | 8.8 | 8.8 | ISO 15712-1, Eq. E.3 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | | STC, Δ_STC | ASTC |
|---|---|---|---|---|---|
| **Separating Partition (190 mm concrete block)** | | | | | |
| Laboratory STC for Dd | R_s,w | RR-333, TLF-97-107a | | 52 | |
| ΔSTC change by Lining on D | ΔR_D,w | No Lining , | | 0 | |
| ΔSTC change by Lining on d | ΔR_d,w | No Lining , | | 0 | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 52 + MAX(0,0) + MIN(0,0)/2 = | | **52** |
| | | | | | |
| **Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor)** | | | | | |
| Flanking Element F1: | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-334, NRC-Mean BLK190(NW) | | 49 | |
| ΔSTC change by Lining | ΔR_F1,w | No Lining , | | 0 | |
| Flanking Element f1: | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-334, NRC-Mean BLK190(NW) | | 49 | |
| ΔSTC change by Lining | ΔR_f1,w | No Lining , | | 0 | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 11.6 + 6 = | | **67** |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 8.8 + 6 = | | **65** |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 8.8 + 6 = | | **65** |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.7 + 10^- 6.5 + 10^- 6.5 ) = | | **61** |
| | | | | | |
| **Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | |
| Flanking Element F2: | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | |
| ΔSTC change by Lining | ΔR_F2,w | No Lining , | | 0 | |
| Flanking Element f2: | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | |
| ΔSTC change by Lining | ΔR_f2,w | No Lining , | | 0 | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 8.1 + 7 = | | **64** |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 5.8 + 7 = | | **63** |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 5.8 + 7 = | | **63** |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.4 + 10^- 6.3 + 10^- 6.3 ) = | | **59** |
| | | | | | |
| **Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab)** | | | | | |
| Flanking Element F3: | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-334, NRC-Mean BLK190(NW) | | 49 | |
| ΔSTC change by Lining | ΔR_F3,w | No Lining , | | 0 | |
| Flanking Element f3: | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-334, NRC-Mean BLK190(NW) | | 49 | |
| ΔSTC change by Lining | ΔR_f3,w | No Lining , | | 0 | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 11.6 + 6 = | | **67** |
| **Flanking STC for path Fd** | R_ Fd,w | | 49/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 8.8 + 6 = | | **65** |
| **Flanking STC for path Df** | R_ Df,w | | 52/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 8.8 + 6 = | | **65** |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.7 + 10^- 6.5 + 10^- 6.5 ) = | | **61** |
| | | | | | |
| **Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | |
| Flanking Element F4: | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | |
| ΔSTC change by Lining | ΔR_F4,w | No Lining , | | 0 | |
| Flanking Element f4: | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | |
| ΔSTC change by Lining | ΔR_f4,w | No Lining , | | 0 | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 11.6 + 7 = | | **68** |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 8.8 + 7 = | | **66** |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 8.8 + 7 = | | **66** |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.8 + 10^- 6.6 + 10^- 6.6 ) = | | **62** |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | **54** |
| | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | | **50** |

**EXAMPLE 4.1.1-V2: (SIMPLIFIED METHOD)**

- **Rooms one-above-the-other**
- **Loadbearing normal weight concrete block walls and concrete floors with rigid junctions**
  **(Same structure as 4.1.1-V1, plus lining of walls)**

Separating floor/ceiling assembly with:
- concrete floor with mass 345 kg/m$^2$ (e.g. normal weight concrete with thickness of 150 mm) with no topping / flooring on top, or ceiling lining below

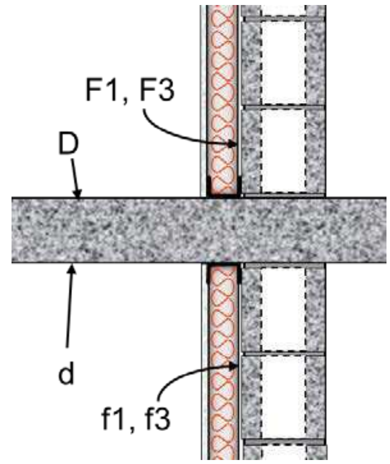
Junction 1, 3, 4: Cross Junction of separating floor / flanking wall with:
- rigid mortared cross junction with concrete block wall assemblies.
- wall above and below floor of one wythe of 190 mm hollow concrete blocks with normal weight aggregate[1], with mass 238 kg/m$^2$
- flanking walls lined with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c. with absorptive material[2] filling inter-stud cavities

Junction 2: T-Junction of separating floor / flanking wall with:
- rigid mortared T-junctions with concrete block wall assemblies
- wall above and below floor of one wythe of 190 mm hollow concrete blocks with normal weight aggregate[1], with mass 238 kg/m$^2$
- flanking walls lined with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c. with absorptive material[2] filling inter-stud cavities

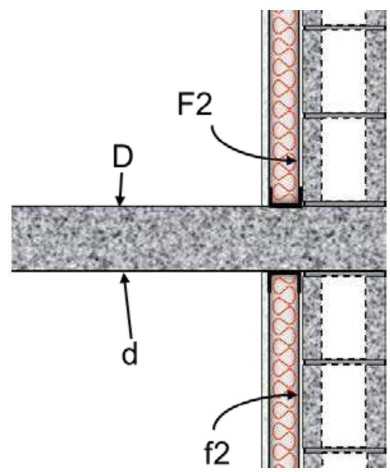
Acoustical Parameters:

| | | |
|---|---|---|
| For 190 mm concrete block walls: | | |
| Mass/unit area (kg/m$^2$ ) = | 238 | (Wall at junctions 1&3) |
| | 238 | (Wall at junctions 2&4) |
| For 150 mm concrete floor: | | |
| Mass/unit area (kg/m$^2$ ) = | | 345 |
| | | |
| Separating partition area ( m$^2$ ) = | | 20 |
| Junction 1 and 3 length (m ) = | | 5.0 |
| Junction 2 and 4 length (m ) = | | 4.0 |
| 10*log(S_Partition/l_junction 1&3) = | | 6.0 |
| 10*log(S_Partition/l_junction2 &4) = | | 7.0 |

**Illustration for this case**




Cross junction of separating floor of 150 mm thick concrete with 190 mm concrete block wall. (Side view of Junctions 1 or 3)




T-Junction of separating floor of 150 mm thick concrete with 190 mm concrete block wall. (Side view of Junction 2. Junction 4 has same lining details, but cross junction)

| | | | Path Ff | Path Fd | Path Df | |
|---|---|---|---|---|---|---|
| **Junction** | | Mass ratio for Ff | Kij (in dB) = | | | Reference |
| **1** | Rigid-Cross junction | 1.45 | 11.6 | 8.8 | 8.8 | ISO 15712-1, Eq. E.3 |
| **2** | Rigid-T junction | 1.45 | 8.1 | 5.8 | 5.8 | ISO 15712-1, Eq. E.4 |
| **3** | Rigid-Cross junction | 1.45 | 11.6 | 8.8 | 8.8 | ISO 15712-1, Eq. E.3 |
| **4** | Rigid-Cross junction | 1.45 | 11.6 | 8.8 | 8.8 | ISO 15712-1, Eq. E.3 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | Calculation | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|---|
| **Separating Partition (190 mm concrete block)** | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining on D | ΔR_D,w | No Lining , | | 0 | | |
| ΔSTC change by Lining on d | ΔR_d,w | No Lining , | | 0 | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 52 + MAX(0,0) + MIN(0,0)/2 = | | **52** | |
| | | | | | | |
| **Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor)** | | | | | | |
| Flanking Element F1: | | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F1,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | | 19 | | |
| Flanking Element f1: | | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f1,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 11.6 + 6 = | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(19,0) + MIN(19,0)/2 + 8.8 + 6 = | | **84** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 49/2 + MAX(0,19) + MIN(0,19)/2 + 8.8 + 6 = | | **84** | |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 8.4 + 10^- 8.4 ) = | | **80** | |
| | | | | | | |
| **Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F2: | | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F2,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | | 19 | | |
| Flanking Element f2: | | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f2,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 8.1 + 7 = | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(19,0) + MIN(19,0)/2 + 5.8 + 7 = | | **82** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 49/2 + MAX(0,19) + MIN(0,19)/2 + 5.8 + 7 = | | **82** | |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 8.2 + 10^- 8.2 ) = | | **79** | |
| | | | | | | |
| **Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab)** | | | | | | |
| Flanking Element F3: | | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F3,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | | 19 | | |
| Flanking Element f3: | | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f3,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 11.6 + 6 = | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | | 49/2 + 52/2 + MAX(19,0) + MIN(19,0)/2 + 8.8 + 6 = | | **84** | |
| **Flanking STC for path Df** | R_ Df,w | | 52/2 + 49/2 + MAX(0,19) + MIN(0,19)/2 + 8.8 + 6 = | | **84** | |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 8.4 + 10^- 8.4 ) = | | **80** | |
| | | | | | | |
| **Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F4: | | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F4,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | | 19 | | |
| Flanking Element f4: | | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f4,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 11.6 + 7 = | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(19,0) + MIN(19,0)/2 + 8.8 + 7 = | | **85** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 49/2 + MAX(0,19) + MIN(0,19)/2 + 8.8 + 7 = | | **85** | |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 8.5 + 10^- 8.5 ) = | | **81** | |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | **74** | |
| | | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | | **52** | |

**EXAMPLE 4.1.1-V3: (SIMPLIFIED METHOD)**

- **Rooms one-above-the-other**
- **Loadbearing normal weight concrete block walls and concrete floors with rigid junctions (Same structure as 4.1.1-V1, with lining of walls and ceiling)**

Separating floor/ceiling assembly with:
- concrete floor with mass 345 kg/$m^2$ (e.g. normal weight concrete with thickness of 150 mm) with no topping / flooring on top
- ceiling lining below: 16 mm gypsum board[3] fastened to hat-channels supported on cross-channels hung on wires, cavity of 150 mm between concrete and ceiling, with 150 mm absorptive material[2]

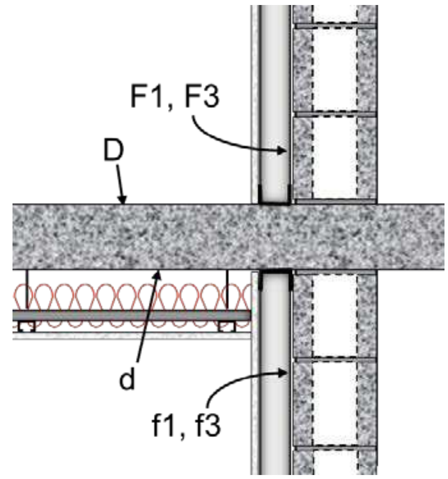
Junction 1, 3 or 4: Cross Junction of separating floor / flanking wall with:
- rigid mortared cross junction with concrete block wall assemblies
- wall above and below floor of one wythe of 190 mm hollow concrete blocks with normal weight aggregate[1], with mass 238 kg/$m^2$
- flanking walls lined with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c. with no absorptive material[2] in inter-stud cavities

Junction 2: T-Junction of separating floor / flanking wall with:
- rigid mortared T-junctions with concrete block wall assemblies
- wall above and below floor of one wythe of 190 mm hollow concrete blocks with normal weight aggregate[1], with mass 238 kg/$m^2$
- flanking walls lined with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c. with no absorptive material[2] in inter-stud cavities

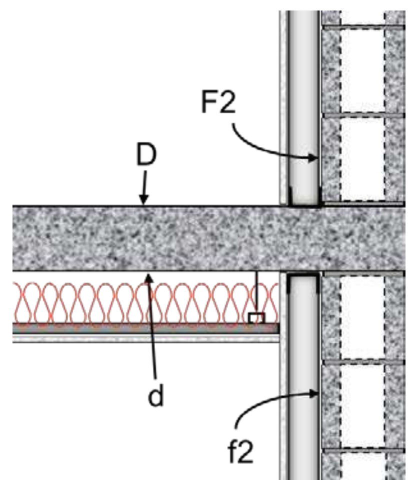
Acoustical Parameters:

| | | |
|---|---|---|
| For 190 mm concrete block walls: | | |
| Mass/unit area (kg/$m^2$ ) = | 238 | (Wall at junctions 1&3) |
| | 238 | (Wall at junctions 2&4) |
| For 150 mm concrete floor: | | |
| Mass/unit area (kg/$m^2$ ) = | | 345 |
| | | |
| Separating partition area ( $m^2$ ) = | | 20 |
| Junction 1 and 3 length (m ) = | | 5.0 |
| Junction 2 and 4 length (m ) = | | 4.0 |
| 10*log(S_Partition/l_junction 1&3) = | | 6.0 |
| 10*log(S_Partition/l_junction2 &4) = | | 7.0 |

**Illustration for this case**




Cross junction of separating floor of 150 mm thick concrete with 190 mm concrete block wall. (Side view of Junctions 1 & 3)




T-Junction of separating floor of 150 mm thick concrete with 190 mm concrete block wall. (Side view of Junction 2. Junction 4 has same lining details, but cross junction)

| **Junction** | | Mass ratio for Ff | Path Ff<br>Kij (in dB) = | Path Fd | Path Df | Reference |
|---|---|---|---|---|---|---|
| **1** | Rigid-Cross junction | 1.45 | 11.6 | 8.8 | 8.8 | ISO 15712-1, Eq. E.3 |
| **2** | Rigid-T junction | 1.45 | 8.1 | 5.8 | 5.8 | ISO 15712-1, Eq. E.4 |
| **3** | Rigid-Cross junction | 1.45 | 11.6 | 8.8 | 8.8 | ISO 15712-1, Eq. E.3 |
| **4** | Rigid-Cross junction | 1.45 | 11.6 | 8.8 | 8.8 | ISO 15712-1, Eq. E.3 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|---|
| Separating Partition (190 mm concrete block) | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining on D | ΔR_D,w | No Lining , | | 0 | | |
| ΔSTC change by Lining on d | ΔR_d,w | RR-333, ΔTLF-CON150-01, SUS150_GFB150_G16 | | 19 | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 52 + MAX(0,19) + MIN(0,19)/2 = | | **71** | |
| | | | | | | |
| Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor) | | | | | | |
| Flanking Element F1: | | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F1,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| Flanking Element f1: | | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f1,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(2,2) + MIN(2,2)/2 + 11.6 + 6 = | | **70** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(2,19) + MIN(2,19)/2 + 8.8 + 6 = | | **85** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 49/2 + MAX(0,2) + MIN(0,2)/2 + 8.8 + 6 = | | **67** | |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-7 + 10^- 8.5 + 10^- 6.7 ) = | | | **65** |
| | | | | | | |
| Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall) | | | | | | |
| Flanking Element F2: | | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F2,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| Flanking Element f2: | | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f2,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(2,2) + MIN(2,2)/2 + 8.1 + 7 = | | **67** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(2,19) + MIN(2,19)/2 + 5.8 + 7 = | | **83** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 49/2 + MAX(0,2) + MIN(0,2)/2 + 5.8 + 7 = | | **65** | |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.7 + 10^- 8.3 + 10^- 6.5 ) = | | | **63** |
| | | | | | | |
| Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab) | | | | | | |
| Flanking Element F3: | | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F3,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| Flanking Element f3: | | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f3,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(2,2) + MIN(2,2)/2 + 11.6 + 6 = | | **70** | |
| **Flanking STC for path Fd** | R_ Fd,w | | 49/2 + 52/2 + MAX(2,19) + MIN(2,19)/2 + 8.8 + 6 = | | **85** | |
| **Flanking STC for path Df** | R_ Df,w | | 52/2 + 49/2 + MAX(0,2) + MIN(0,2)/2 + 8.8 + 6 = | | **67** | |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-7 + 10^- 8.5 + 10^- 6.7 ) = | | | **65** |
| | | | | | | |
| Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall) | | | | | | |
| Flanking Element F4: | | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F4,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| Flanking Element f4: | | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f4,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(2,2) + MIN(2,2)/2 + 11.6 + 7 = | | **71** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(2,19) + MIN(2,19)/2 + 8.8 + 7 = | | **86** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 49/2 + MAX(0,2) + MIN(0,2)/2 + 8.8 + 7 = | | **68** | |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-7.1 + 10^- 8.6 + 10^- 6.8 ) = | | | **66** |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | | **59** |
| | | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | | **58** | |

**EXAMPLE 4.1.1-V4: (SIMPLIFIED METHOD)**

- **Rooms one-above-the-other**
- **Loadbearing normal weight concrete block walls and concrete floors with rigid junctions (Same structure as 4.1.1-V3, with lining of walls and ceiling)**

Separating floor/ceiling assembly with:
- concrete floor with mass 345 kg/m² (e.g. normal weight concrete with thickness of 150 mm) with no topping / flooring on top
- ceiling lining below: 16 mm gypsum board[3] fastened to hat-channels supported on cross-channels hung on wires, cavity of 150 mm between concrete and ceiling, with 150 mm absorptive material[2]

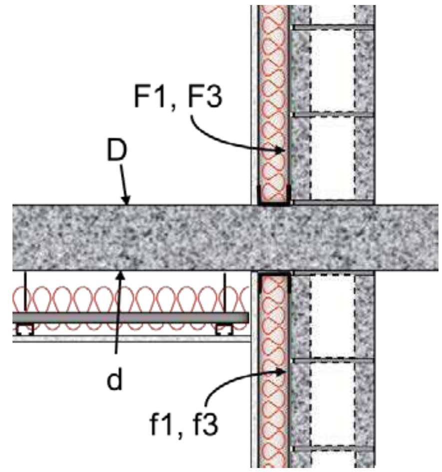
Junction 1, 3 or 4: Cross Junction of separating floor / flanking wall with:
- rigid mortared cross junction with concrete block wall assemblies.
- wall above and below floor of one wythe of 190 mm hollow concrete blocks with normal weight aggregate[1], with mass 238 kg/m²
- flanking walls lined with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c. with absorptive material[2] filling inter-stud cavities

Junction 2: T-Junction of separating floor / flanking wall with:
- rigid mortared T-junctions with concrete block wall assemblies
- wall above and below floor of one wythe of 190 mm hollow concrete blocks with normal weight aggregate[1], with mass 238 kg/m²
- flanking walls lined with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c. with absorptive material[2] filling inter-stud cavities

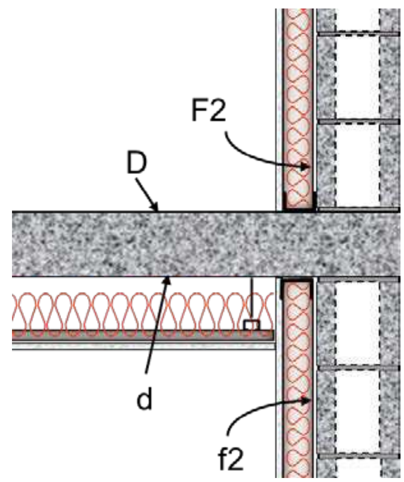
Acoustical Parameters:

| | | |
|---|---|---|
| For 190 mm concrete block walls: | | |
| Mass/unit area (kg/m$^2$) = | 238 | (Wall at junctions 1&3) |
| | 238 | (Wall at junctions 2&4) |
| For 150 mm concrete floor: | | |
| Mass/unit area (kg/m$^2$) = | 345 | |
| | | |
| Separating partition area (m$^2$) = | 20 | |
| Junction 1 and 3 length (m) = | 5.0 | |
| Junction 2 and 4 length (m) = | 4.0 | |
| 10*log(S_Partition/l_junction 1&3) = | 6.0 | |
| 10*log(S_Partition/l_junction2 &4) = | 7.0 | |

**Illustration for this case**




Cross junction of separating floor of 150 mm thick concrete with 190 mm concrete block wall. (Side view of Junctions 1 & 3)




T-Junction of separating floor of 150 mm thick concrete with 190 mm concrete block wall. (Side view of Junction 2. Junction 4 has same lining details, but cross junction)

| | | | Path Ff | Path Fd | Path Df | |
|---|---|---|---|---|---|---|
| Junction | | Mass ratio for Ff | Kij (in dB) = | | | Reference |
| 1 | Rigid-Cross junction | 1.45 | 11.6 | 8.8 | 8.8 | ISO 15712-1, Eq. E.3 |
| 2 | Rigid-T junction | 1.45 | 8.1 | 5.8 | 5.8 | ISO 15712-1, Eq. E.4 |
| 3 | Rigid-Cross junction | 1.45 | 11.6 | 8.8 | 8.8 | ISO 15712-1, Eq. E.3 |
| 4 | Rigid-Cross junction | 1.45 | 11.6 | 8.8 | 8.8 | ISO 15712-1, Eq. E.3 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|---|
| **Separating Partition (190 mm concrete block)** | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining on D | ΔR_D,w | No Lining , | | 0 | | |
| ΔSTC change by Lining on d | ΔR_d,w | RR-333, ΔTLF-CON150-01, SUS150_GFB150_G16 | | 19 | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 52 + MAX(0,19) + MIN(0,19)/2 = | | **71** | |
| | | | | | | |
| **Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor)** | | | | | | |
| Flanking Element F1: | | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F1,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | | 19 | | |
| Flanking Element f1: | | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f1,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 11.6 + 6 = | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(19,19) + MIN(19,19)/2 + 8.8 + 6 = | | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 49/2 + MAX(0,19) + MIN(0,19)/2 + 8.8 + 6 = | | **84** | |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 9 + 10^- 8.4 ) = | | **82** | |
| | | | | | | |
| **Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F2: | | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F2,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | | 19 | | |
| Flanking Element f2: | | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f2,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 8.1 + 7 = | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(19,19) + MIN(19,19)/2 + 5.8 + 7 = | | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 49/2 + MAX(0,19) + MIN(0,19)/2 + 5.8 + 7 = | | **82** | |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 9 + 10^- 8.2 ) = | | **81** | |
| | | | | | | |
| **Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab)** | | | | | | |
| Flanking Element F3: | | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F3,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | | 19 | | |
| Flanking Element f3: | | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f3,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 11.6 + 6 = | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | | 49/2 + 52/2 + MAX(19,19) + MIN(19,19)/2 + 8.8 + 6 = | | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | | 52/2 + 49/2 + MAX(0,19) + MIN(0,19)/2 + 8.8 + 6 = | | **84** | |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 9 + 10^- 8.4 ) = | | **82** | |
| | | | | | | |
| **Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F4: | | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F4,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | | 19 | | |
| Flanking Element f4: | | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f4,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 11.6 + 7 = | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(19,19) + MIN(19,19)/2 + 8.8 + 7 = | | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 49/2 + MAX(0,19) + MIN(0,19)/2 + 8.8 + 7 = | | **85** | |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 9 + 10^- 8.5 ) = | | **83** | |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | **76** | |
| | | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | | **70** | |

**Summary for Section 4.1.1: Masonry and Concrete Constructions with Rigid Junctions**

The worked examples 4.1.1-H1 and 4.1.1-V1 illustrate the basic process for calculating the sound transmission between rooms in a building which incorporates rigid junctions at all of the intersections between assemblies of bare concrete masonry walls and concrete floors. Here, “bare” means the assembly of masonry or concrete without a lining (i.e. an added gypsum board finish on the walls or ceiling or a flooring over the concrete slab). Note that for a concrete block wall constructed using normal weight units, tests have shown that the surface could be painted or sealed or have a thin coat of plaster without having an effect on the wall’s STC rating. This absence of gypsum board surface linings is not typical of occupied buildings in North America, but presenting the “bare” case gives a clear example of the basic structure-borne transmission for a building with such wall and floor subsystems. When linings are added, the linings simply alter the transfer of sound from the underlying “bare” systems to/from the rooms.

For both the bare assembly and the assembly with linings, the Apparent Sound Transmission Class (ASTC) rating is slightly lower than the STC rating of the separating assembly because the total flanking transmission (via the combination of 12 flanking paths) is of similar magnitude to the Direct Transmission Loss through the separating assembly.

**For the side-by-side pair of rooms**

The effect of adding linings is shown in Examples 4.1.1-H2 to H4 and the following trends were found:

- Adding a minimal lining with no sound absorptive material in the inter-stud cavities (ΔSTC=2) to all the wall surfaces raises the ASTC rating from 47 to 50.
- Adding a better wall lining with ΔSTC=19 in example 4.1.1-H3 raises the ASTC to 59, but further improvements are limited by the transmission through the bare concrete surfaces of the floor and ceiling.
- Significant further improvement requires treatment of both the floor and ceiling surfaces – treating just the ceiling in Example 4.1.1-H4 increases the ASTC rating by only 3 points relative to the preceding example.

**For one room above the other**

The effect of added linings is shown in Examples 4.1.1-V2 to V4 and the following trends were found:

- As shown in example 4.1.1-V2, adding a good lining to all the flanking wall surfaces increases the ASTC rating by only 2 from 50 to 52 because direct transmission through the separating floor/ceiling is the strongest path even without linings. Therefore, improving the Flanking STC has limited effect.
- This is easily remedied by adding a gypsum board ceiling with sound absorptive material in the cavity under the concrete ceiling slab, which raises the direct path STC rating from 52 to 71.
- With a ceiling in place as shown in example 4.1.1-V3., a quite good system performance of ASTC 58 is possible even with a minimal (ΔSTC=2) lining of the flanking walls.
- Filling the inter-stud cavities with absorptive material to provide a more effective lining of the walls raises the performance to ASTC 70 in example 4.1.1-V4.

### 4.1.2 Non-Loadbearing Normal Weight Concrete Block Walls with Concrete Floors

This section presents worked examples for adjacent rooms in a building which has structural floors of concrete and walls of normal weight concrete blocks, but includes some non-rigid junctions.

All of the examples in Section 4.1.2 have rigid mortared junctions between the concrete floor surface and the concrete block walls above it (that is, at the joint supporting the concrete block masonry wall on top of the concrete slab) but soft junctions between the bottom surface of the concrete slab and the top of the non-loadbearing concrete block wall below. The soft junctions provide negligible vibration transmission. This significantly alters the paths for the transfer of structure-borne flanking sound to the adjoining rooms relative to the cases in Section 4.1.1 where all of the connecting edges had rigid mortared junctions.

As in Section 4.1.1, the calculations follow the Simplified Procedure of ISO 15712-1 with simple adaptations to deal with the non-rigid junctions:

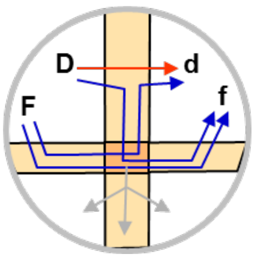
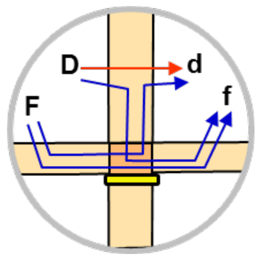
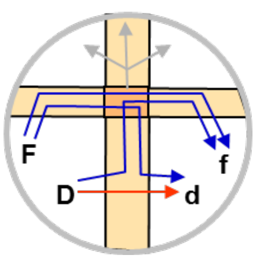
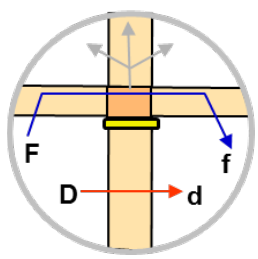
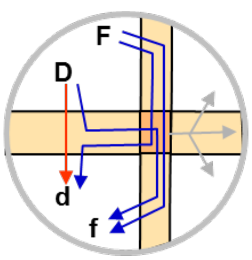
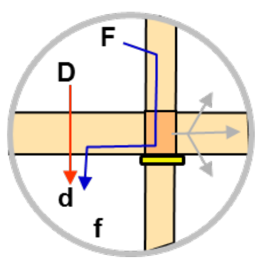
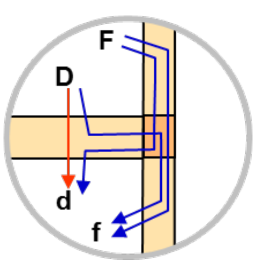
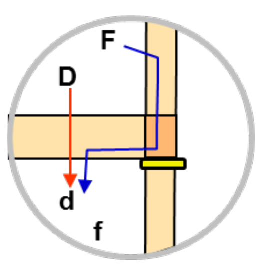
- Non-loadbearing masonry walls would normally have a fire stop installed between the top of the masonry wall assembly and the underside of the concrete floor above, as shown in the detail drawings in examples in this section. A common type of fire stop would comprise compressible fibrous insulation faced with pliable sealant.
- Such fire stops would transmit negligible vibration between the top of the wall and the concrete ceiling above (or vice versa) so they do not match the criteria for the junction attenuation calculation (Equations E.4 or E.5 in ISO 15712-1:2005).

The assumption that there is minimal vibration transmission through the “soft” seal at the top of the non-loadbearing concrete block wall assembly changes the effective geometry of the junctions, and hence the appropriate equation (from Annex E of ISO 15712-1) needed to calculate the junction attenuation for transmission via the remaining rigid connections.

- With this change, a rigid cross junction between the floor and the concrete block walls above and below is transformed into a rigid T-junction between the floor on both sides of the wall and the wall above.
- Similarly, a rigid T-junction between the edge of a concrete floor and the concrete block walls above and below is transformed into a rigid corner between the floor and the wall above.
- The “soft” junctions are treated in the calculation by assuming that any path through the soft junction (i.e. through fire stop) has minimal transmission, so the Flanking STC for paths via the soft joint is simply set to the maximum value (90).

The resulting sets of paths are illustrated in Figure 4.1.2.1, which also identifies the new equation from Annex E of ISO 15712-1 to be used for each modified case. As discussed in the summary at the end of this section, switching from rigid junctions to non-loadbearing junctions alters the overall calculated ASTC, but the changes are not significant.

**Figure 4.1.2.1:** Changes in flanking paths at junctions with soft junctions, defined with reference to, but not explicitly defined in Annex E of ISO 15712-1. The yellow element shown in the figures in the second column represents the soft junction which changes the flow of structure-borne sound as compared to the rigid cross junction shown in the first column.

| **Loadbearing Walls ( in 4.1.1)** | **Non-Loadbearing Walls (in 4.1.2 and 4.1.3)** | **Path** | **Change in Calculation (Equation in ISO 15712-1)** |
|---|---|---|---|
| RIGID CROSS JUNCTION for separating wall with floor   | RIGID T-JUNCTION for separating wall with floor   | Ff | From path 1-3 in Eq. E.3, to path 1-3 in Eq. E.4 |
| | | Fd | From path 1-2 in Eq. E.3, to path 1-2 in Eq. E.4 |
| | | Df | From path 2-3 in Eq. E.3, to path 2-3 in Eq. E.4 |
| RIGID CROSS JUNCTION for separating wall with ceiling   | RIGID T-JUNCTION: wall above with ceiling   | Ff | From path 1-3 in Eq. E.3, to path 1-3 in Eq. E.4 |
| | | Fd | Minimal transmission |
| | | Df | Minimal transmission |
| RIGID CROSS JUNCTION for: walls above & below with separating floor/ceiling   | RIGID T-JUNCTION for wall above with separating floor/ceiling   | Ff | Minimal transmission |
| | | Fd | From path 1-2 in Eq. E.3, to path 2-1 in Eq. E.4 |
| | | Df | Minimal transmission |
| RIGID T-JUNCTION for walls above & below with separating floor/ceiling   | RIGID CORNER for wall above with separating floor/ceiling   | Ff | Minimal transmission |
| | | Fd | From path 1-2 in Eq. E.4, to path 1-2 in Eq. E.9 |
| | | Df | Minimal transmission |

**Worked Examples**

Each of the worked examples 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. These are almost the same as for the preceding section, with simple changes to deal with the non-rigid connections at the fire stops at the top of each concrete block wall.

Within the table for each worked example, the “References” column presents the source of the input data (combining the NRC report number and identifier for each laboratory test result or derived result), or identifies the applicable equations and sections of ISO 15712-1:2005 at each stage of the calculation. Symbols and subscripts identifying the corresponding variable from ISO 15712-1 are given in the adjacent column. Equations and figures from the standard are not reproduced here to respect the copyright, but the description of the equations in Section 4.1.1 explains the adaptations to use ASTM input data.

All of the examples in this section conform to the Standard Scenario presented in Section 1.2 of this Guide.

Under the single heading “STC, ΔSTC”, the examples present input data determined in laboratory tests according to ASTM E90, including the:

- STC values for the laboratory sound transmission loss of wall or floor assemblies
- ΔSTC values measured in the laboratory for the change in the STC rating due to adding a lining to the specified wall or floor assembly

Under the heading “ASTC”, the examples present the calculated values for the transmission via specific paths, including the:

- Direct STC rating for the calculated in-situ transmission loss of the separating wall or floor assembly
- Flanking STC rating calculated for each flanking transmission path at each junction
- Apparent STC (ASTC) rating for the combination of direct and flanking transmission via all paths

When the calculated Flanking STC for a given path exceeds 90, the value is limited to 90 to allow for the inevitable effect of higher order flanking paths which make the higher value to be unrepresentative of the true situation. These situations are flagged with the adjacent label “(limit)” and indicate that further enhancements to elements in these paths will give negligible benefit to the ASTC rating.

The numeric calculations are presented step-by-step in each worked example using compact notation consistent with spreadsheet expressions such that:

- For calculation of Direct STC and Flanking STC, these expressions are easily recognized as equivalent to Equations 4.1.2 and 4.1.3 respectively.
- ***For paths crossing the soft joint, transmission is assumed to be negligible, so the Flanking STC for paths via the soft joint is set to the maximum limit (90).***
- For combining sound power transmitted via specific paths, the calculation of Eq. 1.1 is broken down into several stages. Note that in the compact notation, a term for transmitted sound power fraction such as $10^{-0.1 \cdot TL_{ij}}$ becomes 10^-7.4, if $TL_{ij}$ =74.
- At each stage (such as the Flanking STC for a given junction) the result is converted into decibel form by calculating -10*LOG10( transmitted sound power fraction), to facilitate the comparison of each path or junction with the Direct STC and the final ASTC result.

**EXAMPLE 4.1.2-H1: (SIMPLIFIED METHOD)**

- **Rooms side-by-side**
- **Concrete floors and normal weight concrete block walls with rigid junctions except at top of non-loadbearing walls**

Separating wall assembly (non-loadbearing) with:
- one wythe of concrete blocks with mass 238 kg/m$^2$ (e.g. 190 mm hollow blocks with normal weight aggregate[1]) with no lining
- soft seal at top of wall, rigid junction at bottom

Junction 1: Bottom Junction (separating wall / floor) with:
- concrete floor with mass 345 kg/m$^2$ (e.g. normal weight concrete with thickness of 150 mm) with no topping or flooring
- rigid mortared T-junction with concrete block wall assembly above, soft seal with wall below

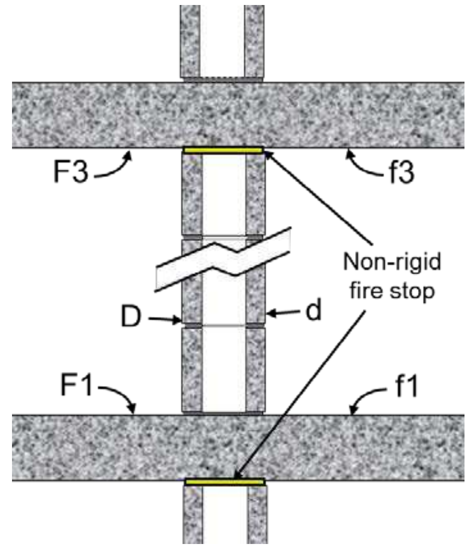
Junction 2 or 4: Each Side (separating wall / abutting side wall) with:
- abutting side wall and separating wall of concrete blocks with mass 238 kg/m$^2$ (e.g. 190 mm hollow blocks with normal weight aggregate[1]), with no lining
- rigid mortared T-junctions with separating wall
- soft seal at top of flanking walls, rigid mortared junction at bottom

Junction 3: Top Junction (separating wall / ceiling) with:
- concrete ceiling slab with mass 345 kg/m$^2$ (e.g. normal weight concrete with thickness of 150 mm) with no added ceiling lining
- rigid mortared T-junction with concrete block wall assembly above, soft seal with wall below

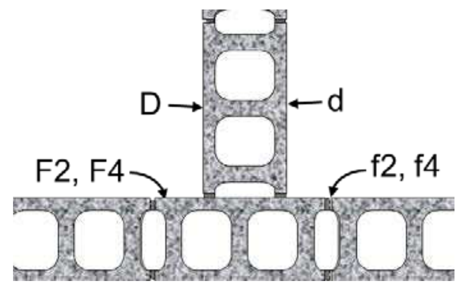
Acoustical Parameters:

| | | |
|---|---|---|
| For 190 mm concrete block walls: | | |
| Mass/unit area (kg/m$^2$) = | 238 | (Separating wall) |
| | 238 | (Flanking wall) |
| For 150 mm concrete floor: | | |
| Mass/unit area (kg/m$^2$) = | | 345 |
| | | |
| Separating partition area ( m$^2$ ) = | | 12.5 |
| Junction length (m ) = | | 5.0 |
| Separating partition height ( m ) = | | 2.5 |
| 10*log(S_Partition/l_junction 1&3) = | | 4.0 |
| 10*log(S_Partition/l_junction 2&4) = | | 7.0 |

**Illustration for this case**




Junction of 190 mm concrete block separating wall with 150 mm thick concrete floor and ceiling. (Side view of Junctions 1 and 3)




Junction of separating wall with side wall, both of 190 mm concrete block. (Plan view of Junction 2 or 4).

| Junction | | Mass ratio for Ff | Path Ff Kij(in dB) = | Path Fd | Path Df | Reference |
|---|---|---|---|---|---|---|
| 1 | Rigid-T/soft | 0.69 | 3.6 | 5.8 | 5.8 | ISO 15712-1, Eq. E.4 |
| 2 | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |
| 3 | Rigid-T/soft | 0.69 | 3.6 | SOFT | SOFT | ISO 15712-1, Eq. E.4 |
| 4 | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|---|
| **Separating Partition (190 mm concrete block)** | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining on D | ΔR_D,w | No Lining , | | 0 | | |
| ΔSTC change by Lining on d | ΔR_d,w | No Lining , | | 0 | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 49 + MAX(0,0) + MIN(0,0)/2 = | | **49** | |
| | | | | | | |
| **Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor)** | | | | | | |
| Flanking Element F1: | | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_F1,w | No Lining , | | 0 | | |
| Flanking Element f1: | | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_f1,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 3.6 + 4 = | | **60** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 5.8 + 4 = | | **60** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 5.8 + 4 = | | **60** | |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6 + 10^- 6 + 10^- 6 ) = | | **55** | |
| | | | | | | |
| **Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F2: | | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F2,w | No Lining , | | 0 | | |
| Flanking Element f2: | | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f2,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 5.7 + 7 = | | **62** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 5.7 + 7 = | | **62** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 5.7 + 7 = | | **62** | |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.2 + 10^- 6.2 + 10^- 6.2 ) = | | **57** | |
| | | | | | | |
| **Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab)** | | | | | | |
| Flanking Element F3: | | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_F3,w | No Lining , | | 0 | | |
| Flanking Element f3: | | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_f3,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 3.6 + 4 = | | **60** | |
| **Flanking STC for path Fd** | R_ Fd,w | | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6 + 10^- 9 + 10^- 9 ) = | | **60** | |
| | | | | | | |
| **Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F4: | | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F4,w | No Lining , | | 0 | | |
| Flanking Element f4: | | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f4,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 5.7 + 7 = | | **62** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 5.7 + 7 = | | **62** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(0,0) + MIN(0,0)/2 + 5.7 + 7 = | | **62** | |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.2 + 10^- 6.2 + 10^- 6.2 ) = | | **57** | |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | **51** | |
| | | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | | **47** | |

**EXAMPLE 4.1.2-H2: (SIMPLIFIED METHOD)**

- **Rooms side-by-side**
- **Concrete floors and normal weight concrete block walls with rigid junctions except at top of non-loadbearing walls (Same structure as 4.1.2-H1, plus lining of walls)**

Separating wall assembly (non-loadbearing) with:
- one wythe of concrete blocks with mass 238 kg/m$^2$ (e.g. 190 mm hollow blocks with normal weight aggregate[1])
- soft seal at top of wall, rigid junction at bottom
- separating wall lined on both sides with 13 mm gypsum board[3] supported on 65 mm non-loadbearing steel studs spaced 610 mm o.c. with no absorptive material[2] filling inter-stud cavities

Junction 1: Bottom Junction (separating wall / floor) with:
- concrete floor with mass 345 kg/m$^2$ (e.g. normal weight concrete with thickness of 150 mm) with no topping or flooring
- rigid mortared T-junction with concrete block wall assembly above, soft seal with wall below

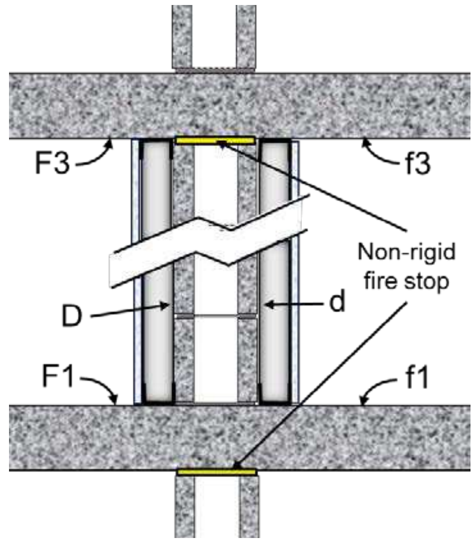
Junction 2 or 4: Each Side (separating wall /abutting side wall) with:
- side wall and separating wall of concrete blocks with mass 238 kg/m$^2$ (e.g. 190 mm hollow blocks with normal weight aggregate[1]) with rigid mortared T-junctions
- soft seal at top of flanking walls, rigid mortared junction at bottom
- flanking side walls lined with 13 mm gypsum board[3] supported on 65 mm non-loadbearing steel studs spaced 610 mm o.c. with no absorptive material[2] filling inter-stud cavities

Junction 3: Top Junction (separating wall / ceiling) with:
- concrete ceiling slab with mass 345 kg/m$^2$ (e.g. normal weight concrete with thickness of 150 mm) with no added ceiling lining
- rigid mortared T-junction with concrete block wall assembly above, soft seal with wall below

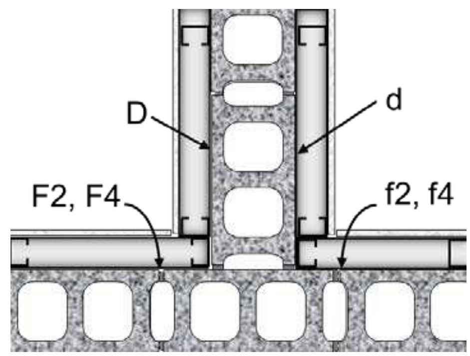
Acoustical Parameters:

| | | |
|---|---|---|
| For 190 mm concrete block walls: | | |
| Mass/unit area (kg/m$^2$ ) = | 238 | (Separating wall) |
| | 238 | (Flanking wall) |
| For 150 mm concrete floor: | | |
| Mass/unit area (kg/m$^2$ ) = | | 345 |
| | | |
| Separating partition area ( m$^2$ ) = | | 12.5 |
| Junction length (m ) = | | 5.0 |
| Separating partition height ( m ) = | | 2.5 |
| 10*log(S_Partition/l_junction 1&3) = | | 4.0 |
| 10*log(S_Partition/l_junction 2&4) = | | 7.0 |

**Illustration for this case**




Junction of 190 mm concrete block separating wall (with gypsum board lining) with 150 mm thick concrete floor and ceiling. (Side view of Junctions 1 and 3)




Junction of separating wall with flanking side wall, both of 190 mm concrete block with gypsum board linings. (Plan view of Junction 2 or 4).

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | Path Ff | Path Fd | Path Df | |
| **Junction** | | Mass ratio for Ff | Kij(in dB) = | | | Reference |
| **1** | Rigid-T/soft | 0.69 | 3.6 | 5.8 | 5.8 | ISO 15712-1, Eq. E.4 |
| **2** | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |
| **3** | Rigid-T/soft | 0.69 | 3.6 | SOFT | SOFT | ISO 15712-1, Eq. E.4 |
| **4** | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|---|
| **Separating Partition (190 mm concrete block)** | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining on D | ΔR_D,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| ΔSTC change by Lining on d | ΔR_d,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 49 + MAX(2,2) + MIN(2,2)/2 = | | **52** | |
| | | | | | | |
| **Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor)** | | | | | | |
| Flanking Element F1: | | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_F1,w | No Lining , | | 0 | | |
| Flanking Element f1: | | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_f1,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 3.6 + 4 = | | **60** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 49/2 + MAX(0,2) + MIN(0,2)/2 + 5.8 + 4 = | | **62** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(2,0) + MIN(2,0)/2 + 5.8 + 4 = | | **62** | |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6 + 10^- 6.2 + 10^- 6.2 ) = | | **56** | |
| | | | | | | |
| **Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F2: | | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F2,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| Flanking Element f2: | | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f2,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(2,2) + MIN(2,2)/2 + 5.7 + 7 = | | **65** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(2,2) + MIN(2,2)/2 + 5.7 + 7 = | | **65** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(2,2) + MIN(2,2)/2 + 5.7 + 7 = | | **65** | |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.5 + 10^- 6.5 + 10^- 6.5 ) = | | **60** | |
| | | | | | | |
| **Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab)** | | | | | | |
| Flanking Element F3: | | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_F3,w | No Lining , | | 0 | | |
| Flanking Element f3: | | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_f3,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 3.6 + 4 = | | **60** | |
| **Flanking STC for path Fd** | R_ Fd,w | | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6 + 10^- 9 + 10^- 9 ) = | | **60** | |
| | | | | | | |
| **Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F4: | | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F4,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| Flanking Element f4: | | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f4,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(2,2) + MIN(2,2)/2 + 5.7 + 7 = | | **65** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(2,2) + MIN(2,2)/2 + 5.7 + 7 = | | **65** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(2,2) + MIN(2,2)/2 + 5.7 + 7 = | | **65** | |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.5 + 10^- 6.5 + 10^- 6.5 ) = | | 60 | |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | **53** | |
| | | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | | **49** | |

**EXAMPLE 4.1.2-H3: (SIMPLIFIED METHOD)**

- **Rooms side-by-side**
- **Concrete floors and normal weight concrete block walls with rigid junctions except at top of non-loadbearing walls (Same structure as 4.1.2-H1, enhanced lining of walls)**

Separating wall assembly (non-loadbearing) with:

- one wythe of concrete blocks with mass 238 kg/m² (e.g. 190 mm hollow blocks with normal weight aggregate[1])
- soft seal at top of wall, rigid junction at bottom
- separating wall lined both sides with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c., with absorptive material[2] filling inter-stud cavities

Junction 1: Bottom Junction (separating wall / floor) with:

- concrete floor with mass 345 kg/m² (e.g. normal weight concrete with thickness of 150 mm) with no topping or flooring
- rigid mortared T-junction with concrete block wall assembly above, soft seal with wall below

Junction 2 or 4: Each Side (separating wall /abutting side wall) with:

- rigid mortared T-junctions of abutting side wall and separating wall of concrete blocks with mass 238 kg/m² (e.g. 190 mm hollow blocks with normal weight aggregate[1])
- soft seal at top of flanking walls, rigid mortared junction at bottom
- flanking walls lined with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c., with absorptive material[2] filling inter-stud cavities

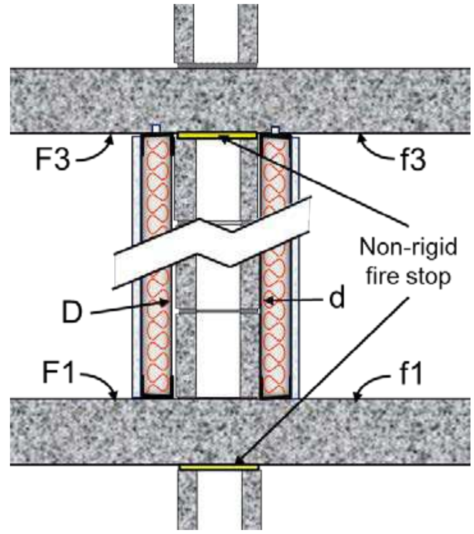
Junction 3: Top Junction (separating wall / ceiling) with:

- concrete ceiling slab with mass 345 kg/m² (e.g. normal weight concrete with thickness of 150 mm) with no added ceiling lining
- rigid mortared T-junction with concrete block wall assembly above, soft seal with wall below

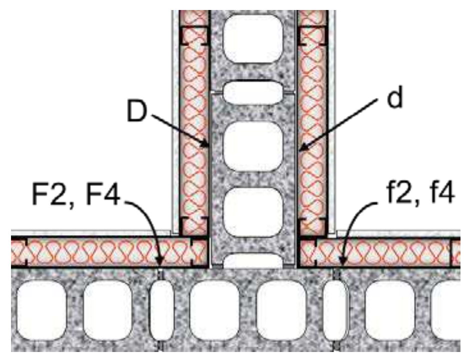
Acoustical Parameters:

| | | |
|---|---|---|
| For 190 mm concrete block walls: | | |
| Mass/unit area (kg/m² ) = | 238 | (Separating wall) |
| | 238 | (Flanking wall) |
| For 150 mm concrete floor: | | |
| Mass/unit area (kg/m² ) = | 345 | |
| | | |
| Separating partition area ( m² ) = | 12.5 | |
| Junction length (m ) = | 5.0 | |
| Separating partition height ( m ) = | 2.5 | |
| 10*log(S_Partition/l_junction 1&3) = | 4.0 | |
| 10*log(S_Partition/l_junction 2&4) = | 7.0 | |

**Illustration for this case**




Junction of 190 mm concrete block separating wall (with enhanced gypsum board lining) with 150 mm thick concrete floor and ceiling. (Side view of Junctions 1 and 3)




Junction of separating wall with flanking side wall, both of 190 mm concrete block with enhanced gypsum board linings. (Plan view of Junction 2 or 4).

| Junction | | Mass ratio for Ff | Path Ff | Path Fd | Path Df | Reference |
|---|---|---|---|---|---|---|
| | | | Kij(in dB) = | | | |
| 1 | Rigid-T/soft | 0.69 | 3.6 | 5.8 | 5.8 | ISO 15712-1, Eq. E.4 |
| 2 | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |
| 3 | Rigid-T/soft | 0.69 | 3.6 | SOFT | SOFT | ISO 15712-1, Eq. E.4 |
| 4 | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|---|
| **Separating Partition (190 mm concrete block)** | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining on D | ΔR_D,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| ΔSTC change by Lining on d | ΔR_d,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 49 + MAX(19,19) + MIN(19,19)/2 = | | **78** | |
| | | | | | | |
| **Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor)** | | | | | | |
| Flanking Element F1: | | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_F1,w | No Lining , | | 0 | | |
| Flanking Element f1: | | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_f1,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 3.6 + 4 = | | **60** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 49/2 + MAX(0,19) + MIN(0,19)/2 + 5.8 + 4 = | | **79** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(19,0) + MIN(19,0)/2 + 5.8 + 4 = | | **79** | |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6 + 10^- 7.9 + 10^- 7.9 ) = | | **60** | |
| | | | | | | |
| **Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F2: | | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F2,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| Flanking Element f2: | | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f2,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 9 + 10^- 9 ) = | | **85** | |
| | | | | | | |
| **Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab)** | | | | | | |
| Flanking Element F3: | | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_F3,w | No Lining , | | 0 | | |
| Flanking Element f3: | | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_f3,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 3.6 + 4 = | | **60** | |
| **Flanking STC for path Fd** | R_ Fd,w | | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6 + 10^- 9 + 10^- 9 ) = | | **60** | |
| | | | | | | |
| **Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F4: | | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F4,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| Flanking Element f4: | | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f4,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 9 + 10^- 9 ) = | | **85** | |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | **57** | |
| | | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | | **57** | |

**EXAMPLE 4.1.2-H4: (SIMPLIFIED METHOD)**

- **Rooms side-by-side**
- **Concrete floors and normal weight concrete block walls with rigid junctions except at top of non-loadbearing walls (Same structure as 4.1.2-H1, enhanced lining of walls)**

Separating wall assembly (non-loadbearing) with:
- one wythe of concrete blocks with mass 238 kg/m$^2$ (e.g. 190 mm hollow blocks with normal weight aggregate[1])
- soft seal at top of wall, rigid junction at bottom
- separating wall lined both sides with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c., with absorptive material[2] filling inter-stud cavities

Junction 1: Bottom Junction (separating wall / floor) with:
- concrete floor with mass 345 kg/m$^2$ (e.g. normal weight concrete with thickness of 150 mm) with no topping or flooring
- rigid mortared T-junction with concrete block wall assembly above, soft seal with wall below

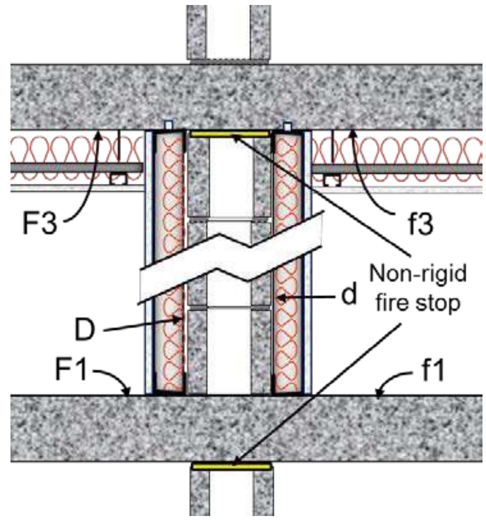
Junction 2 or 4: Each Side (separating wall /abutting side wall) with:
- rigid mortared T-junctions of abutting side wall and separating wall of concrete blocks with mass 238 kg/m$^2$ (e.g. 190 mm hollow blocks with normal weight aggregate[1])
- soft seal at top of flanking walls, rigid mortared junction at bottom
- flanking walls lined with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c., with absorptive material[2] filling inter-stud cavities

Junction 3: Top Junction (separating wall / ceiling) with:
- concrete ceiling slab with mass 345 kg/m$^2$ (e.g. normal weight concrete with thickness of 150 mm) with rigid mortared T-junction to concrete block wall assembly above, soft seal with wall below
- ceiling lining of 16 mm gypsum board[3] fastened to hat-channels supported on cross-channels hung on wires, with 150 mm cavity between concrete and ceiling, with 150 mm absorptive material[2]

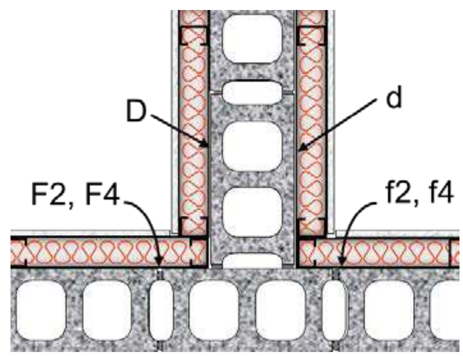
Acoustical Parameters:

| | | |
|---|---|---|
| For 190 mm concrete block walls: | | |
| Mass/unit area (kg/m$^2$ ) = | 238 | (Separating wall) |
| | 238 | (Flanking wall) |
| For 150 mm concrete floor: | | |
| Mass/unit area (kg/m$^2$ ) = | | 345 |
| | | |
| Separating partition area ( m$^2$ ) = | | 12.5 |
| Junction length (m ) = | | 5.0 |
| Separating partition height ( m ) = | | 2.5 |
| 10*log(S_Partition/l_junction 1&3) = | | 4.0 |
| 10*log(S_Partition/l_junction 2&4) = | | 7.0 |

**Illustration for this case**




Junction of 190 mm concrete block separating wall (with enhanced gypsum board lining) with 150 mm thick concrete floor and ceiling. (Side view of Junctions 1 and 3)




Junction of separating wall with flanking side wall, both of 190 mm concrete block with enhanced gypsum board linings. (Plan view of Junction 2 or 4).

| Junction | | Mass ratio for Ff | Path Ff | Path Fd | Path Df | Reference |
|---|---|---|---|---|---|---|
| | | | Kij(in dB) = | | | |
| 1 | Rigid-T/soft | 0.69 | 3.6 | 5.8 | 5.8 | ISO 15712-1, Eq. E.4 |
| 2 | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |
| 3 | Rigid-T/soft | 0.69 | 3.6 | SOFT | SOFT | ISO 15712-1, Eq. E.4 |
| 4 | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|---|
| Separating Partition (190 mm concrete block) | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining on D | ΔR_D,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| ΔSTC change by Lining on d | ΔR_d,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 49 + MAX(19,19) + MIN(19,19)/2 = | | **78** | |
| | | | | | | |
| Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor) | | | | | | |
| Flanking Element F1: | | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_F1,w | No Lining , | | 0 | | |
| Flanking Element f1: | | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_f1,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 3.6 + 4 = | | **60** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 49/2 + MAX(0,19) + MIN(0,19)/2 + 5.8 + 4 = | | **79** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(19,0) + MIN(19,0)/2 + 5.8 + 4 = | | **79** | |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6 + 10^- 7.9 + 10^- 7.9 ) = | | **60** | |
| | | | | | | |
| Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall) | | | | | | |
| Flanking Element F2: | | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F2,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| Flanking Element f2: | | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f2,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 9 + 10^- 9 ) = | | **85** | |
| | | | | | | |
| Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab) | | | | | | |
| Flanking Element F3: | | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_F3,w | RR-333, ΔTLF-CON150-01, SUS150_GFB150_G16 | | 19 | | |
| Flanking Element f3: | | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining | ΔR_f3,w | RR-333, ΔTLF-CON150-01, SUS150_GFB150_G16 | | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 52/2 + 52/2 + MAX(19,19) + MIN(19,19)/2 + 3.6 + 4 = | | **88** | |
| **Flanking STC for path Fd** | R_ Fd,w | | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-8.8 + 10^- 9 + 10^- 9 ) = | | **84** | |
| | | | | | | |
| Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall) | | | | | | |
| Flanking Element F4: | | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F4,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| Flanking Element f4: | | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f4,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB65_G13 | | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 49/2 + MAX(19,19) + MIN(19,19)/2 + 5.7 + 7 = | | **90** | (limit) |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 9 + 10^- 9 ) = | | **85** | |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | **60** | |
| | | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | | **60** | |

**EXAMPLE 4.1.2-V1: (SIMPLIFIED METHOD)**

- **Rooms one-above-the-other**
- **Concrete floors and normal weight concrete block walls with rigid junctions except at top of non-loadbearing walls**

Separating floor/ceiling assembly with:

- concrete floor with mass 345 kg/m² (e.g. normal weight concrete with thickness of 150 mm) with no topping / flooring on top, or ceiling lining below

Junction 1, 3, 4: Cross Junction of separating floor / flanking wall with:

- rigid mortared T junction with concrete block wall assemblies above, soft joint with walls below
- wall above and below floor of one wythe of concrete blocks with mass 238 kg/m² (e.g. 190 mm hollow blocks with normal weight aggregate[1]) with no lining of walls

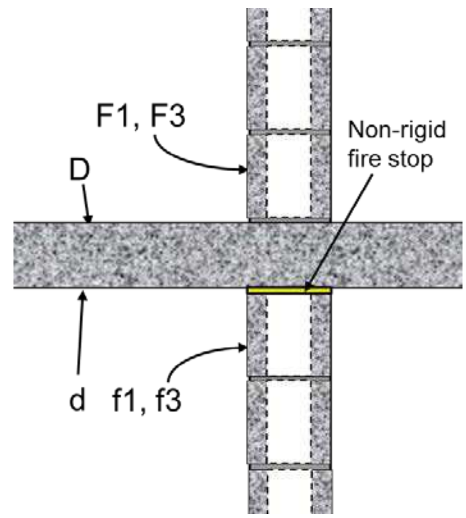
Junction 2: T-Junction of separating floor / flanking wall with:

- rigid mortared T junction with concrete block wall assemblies above, soft joint with walls below
- wall above and below floor of one wythe of concrete blocks with mass 238 kg/m² (e.g. 190 mm hollow blocks with normal weight aggregate[1]) with no lining of walls

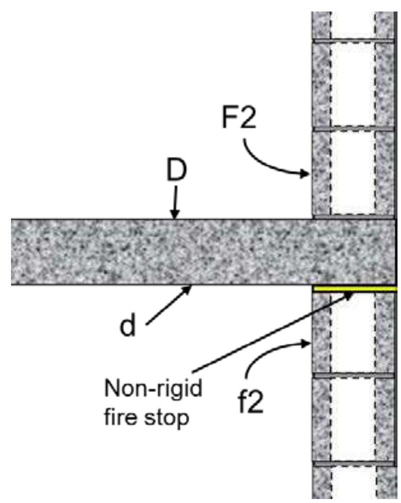
Acoustical Parameters:

| | | |
|---|---|---|
| For 190 mm concrete block walls: | | |
| Mass/unit area (kg/m²) = | 238 | (Wall at junctions 1&3) |
| | 238 | (Wall at junctions 2&4) |
| For 150 mm concrete floor: | | |
| Mass/unit area (kg/m²) = | | 345 |
| | | |
| Separating partition area ( m² ) = | | 20 |
| Junction 1 and 3 length (m ) = | | 5.0 |
| Junction 2 and 4 length (m ) = | | 4.0 |
| 10*log(S_Partition/l_junction 1&3) = | | 6.0 |
| 10*log(S_Partition/l_junction2 &4) = | | 7.0 |

**Illustration for this case**




Cross junction of separating floor of 150 mm thick concrete with 190 mm concrete block wall. (Side view of Junctions 1, 3, 4)




T-Junction of separating floor of 150 mm thick concrete floor with 190 mm concrete block wall. (Side view of Junction 2).

| | | | Path Ff | Path Fd | Path Df | |
|---|---|---|---|---|---|---|
| **Junction** | | Mass ratio for Ff | Kij (in dB) = | | | Reference |
| 1 | Rigid-T/soft | 1.45 | SOFT | 5.8 | SOFT | ISO 15712-1, Eq. E.4 |
| 2 | Rigid-Corner/soft | 1.45 | SOFT | -0.6 | SOFT | ISO 15712-1, Eq. E.9 |
| 3 | Rigid-T/soft | 1.45 | SOFT | 5.8 | SOFT | ISO 15712-1, Eq. E.4 |
| 4 | Rigid-T/soft | 1.45 | SOFT | 5.8 | SOFT | ISO 15712-1, Eq. E.4 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | Calculation | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|---|
| **Separating Partition (190 mm concrete block)** | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining on D | ΔR_D,w | No Lining , | | 0 | | |
| ΔSTC change by Lining on d | ΔR_d,w | No Lining , | | 0 | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 52 + MAX(0,0) + MIN(0,0)/2 = | | **52** | |
| | | | | | | |
| **Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor)** | | | | | | |
| Flanking Element F1: | | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F1,w | No Lining , | | 0 | | |
| Flanking Element f1: | | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f1,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 5.8 + 6 = | | **62** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 6.2 + 10^- 9 ) = | | **62** | |
| | | | | | | |
| **Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F2: | | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F2,w | No Lining , | | 0 | | |
| Flanking Element f2: | | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f2,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + -0.6 + 7 = | | **57** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 5.7 + 10^- 9 ) = | | **57** | |
| | | | | | | |
| **Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab)** | | | | | | |
| Flanking Element F3: | | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F3,w | No Lining , | | 0 | | |
| Flanking Element f3: | | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f3,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | | 49/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 5.8 + 6 = | | **62** | |
| **Flanking STC for path Df** | R_ Df,w | | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 6.2 + 10^- 9 ) = | | **62** | |
| | | | | | | |
| **Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F4: | | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F4,w | No Lining , | | 0 | | |
| Flanking Element f4: | | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f4,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(0,0) + MIN(0,0)/2 + 5.8 + 7 = | | **63** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 6.3 + 10^- 9 ) = | | **63** | |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | **54** | |
| | | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | | **50** | |

**EXAMPLE 4.1.2-V2: (SIMPLIFIED METHOD)**

- **Rooms one-above-the-other**
- **Concrete floors and normal weight concrete block walls with rigid junctions except at top of non-loadbearing walls (Same structure as 4.1.2-V1, with lining of walls)**

Separating floor/ceiling assembly with:
- concrete floor with mass 345 kg/m$^2$ (e.g. normal weight concrete with thickness of 150 mm) with no topping / flooring on top, or ceiling lining below

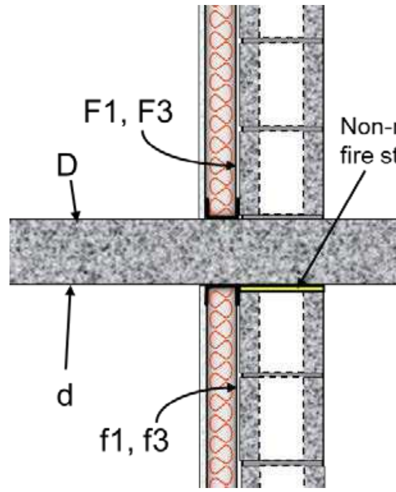
Junction 1, 3, 4: Cross Junction of separating floor / flanking wall with:
- rigid mortared T junction with concrete block wall assemblies above, soft joint with walls below
- wall above and below floor of one wythe of 190 mm hollow concrete blocks with normal weight aggregate[1], with mass 238 kg/m$^2$
- flanking walls lined with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c. with absorptive material[2] filling inter-stud cavities

Junction 2: T-Junction of separating floor / flanking wall with:
- rigid mortared T junction with concrete block wall assemblies above, soft joint with walls below
- wall above and below floor of one wythe of 190 mm hollow concrete blocks with normal weight aggregate[1], with mass 238 kg/m$^2$
- flanking walls lined with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c. with absorptive material[2] filling inter-stud cavities

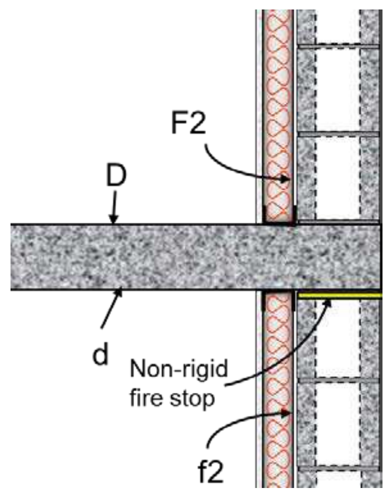
Acoustical Parameters:

| | | |
|---|---|---|
| For 190 mm concrete block walls: | | |
| Mass/unit area (kg/m$^2$ ) = | 238 | (Wall at junctions 1&3) |
| | 238 | (Wall at junctions 2&4) |
| For 150 mm concrete floor: | | |
| Mass/unit area (kg/m$^2$ ) = | | 345 |
| | | |
| Separating partition area ( m$^2$ ) = | | 20 |
| Junction 1 and 3 length (m ) = | | 5.0 |
| Junction 2 and 4 length (m ) = | | 4.0 |
| 10*log(S_Partition/l_junction 1&3) = | | 6.0 |
| 10*log(S_Partition/l_junction2 &4) = | | 7.0 |

**Illustration for this case**




Cross junction of separating floor of 150 mm thick concrete with 190 mm concrete block wall. (Side view of Junctions 1 or 3)




T-Junction of separating floor of 150 mm thick concrete with 190 mm concrete block wall. (Side view of Junction 2. Junction 4 has same lining details, but cross junction)

| Junction | | Mass ratio for Ff | Path Ff<br>Kij (in dB) = | Path Fd | Path Df | Reference |
|---|---|---|---|---|---|---|
| 1 | Rigid-T/soft | 1.45 | SOFT | 5.8 | SOFT | ISO 15712-1, Eq. E.4 |
| 2 | Rigid-Corner/soft | 1.45 | SOFT | -0.6 | SOFT | ISO 15712-1, Eq. E.9 |
| 3 | Rigid-T/soft | 1.45 | SOFT | 5.8 | SOFT | ISO 15712-1, Eq. E.4 |
| 4 | Rigid-T/soft | 1.45 | SOFT | 5.8 | SOFT | ISO 15712-1, Eq. E.4 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|
| **Separating Partition (190 mm concrete block)** | | | | | |
| Laboratory STC for Dd | R_s,w | RR-333, TLF-97-107a | 52 | | |
| ΔSTC change by Lining on D | ΔR_D,w | No Lining , | 0 | | |
| ΔSTC change by Lining on d | ΔR_d,w | No Lining , | 0 | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 52 + MAX(0,0) + MIN(0,0)/2 = | **52** | |
| | | | | | |
| **Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor)** | | | | | |
| Flanking Element F1: | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-334, NRC-Mean BLK190(NW) | 49 | | |
| ΔSTC change by Lining | ΔR_F1,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | 19 | | |
| Flanking Element f1: | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-334, NRC-Mean BLK190(NW) | 49 | | |
| ΔSTC change by Lining | ΔR_f1,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(19,0) + MIN(19,0)/2 + 5.8 + 6 = | **81** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | **90** | (limit) |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 8.1 + 10^- 9 ) = | **80** | |
| | | | | | |
| **Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | |
| Flanking Element F2: | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, NRC-Mean BLK190(NW) | 49 | | |
| ΔSTC change by Lining | ΔR_F2,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | 19 | | |
| Flanking Element f2: | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, NRC-Mean BLK190(NW) | 49 | | |
| ΔSTC change by Lining | ΔR_f2,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(19,0) + MIN(19,0)/2 + -0.6 + 7 = | **76** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | **90** | (limit) |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 7.6 + 10^- 9 ) = | **76** | |
| | | | | | |
| **Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab)** | | | | | |
| Flanking Element F3: | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-334, NRC-Mean BLK190(NW) | 49 | | |
| ΔSTC change by Lining | ΔR_F3,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | 19 | | |
| Flanking Element f3: | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-334, NRC-Mean BLK190(NW) | 49 | | |
| ΔSTC change by Lining | ΔR_f3,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | | 49/2 + 52/2 + MAX(19,0) + MIN(19,0)/2 + 5.8 + 6 = | **81** | |
| **Flanking STC for path Df** | R_ Df,w | | Negligible transmission via fire stop | **90** | (limit) |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 8.1 + 10^- 9 ) = | **80** | |
| | | | | | |
| **Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | |
| Flanking Element F4: | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, NRC-Mean BLK190(NW) | 49 | | |
| ΔSTC change by Lining | ΔR_F4,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | 19 | | |
| Flanking Element f4: | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, NRC-Mean BLK190(NW) | 49 | | |
| ΔSTC change by Lining | ΔR_f4,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(19,0) + MIN(19,0)/2 + 5.8 + 7 = | **82** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | **90** | (limit) |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 8.2 + 10^- 9 ) = | **81** | |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | **73** | |
| | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | **52** | |

**EXAMPLE 4.1.2-V3: (SIMPLIFIED METHOD)**

- **Rooms one-above-the-other**
- **Concrete floors and normal weight concrete block walls with rigid junctions except at top of non-loadbearing walls (Same structure as 4.1.2-V1, with lining of walls and ceiling)**

Separating floor/ceiling assembly with:
- concrete floor with mass 345 kg/m$^2$ (e.g. normal weight concrete with thickness of 150 mm) with no topping / flooring on top
- ceiling lining below: 16 mm gypsum board[3] fastened to hat-channels supported on cross-channels hung on wires, cavity of 150 mm between concrete and ceiling, with 150 mm absorptive material[2]

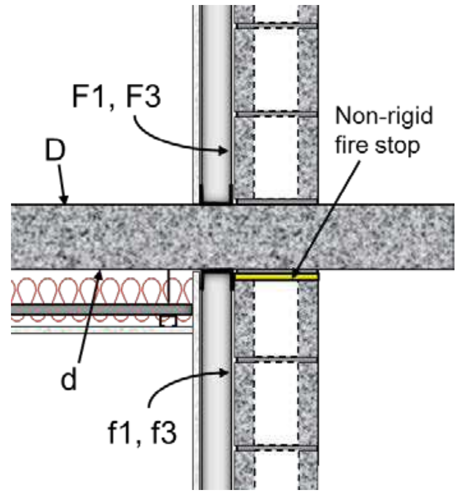
Junction 1, 3 or 4: Cross Junction of separating floor / flanking wall with:
- rigid mortared T junction with concrete block wall assemblies above, soft joint with walls below
- wall above and below floor of one wythe of 190 mm hollow concrete blocks with normal weight aggregate[1], with mass 238 kg/m$^2$
- flanking walls lined with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c. with no absorptive material[2] in inter-stud cavities

Junction 2: T-Junction of separating floor / flanking wall with:
- rigid mortared T junction with concrete block wall assemblies above, soft joint with walls below
- wall above and below floor of one wythe of 190 mm hollow concrete blocks with normal weight aggregate[1], with mass 238 kg/m$^2$
- flanking walls lined with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c. with no absorptive material[2] in inter-stud cavities

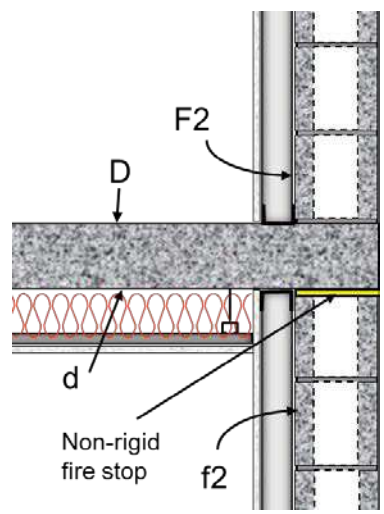
Acoustical Parameters:

| | | |
|---|---|---|
| For 190 mm concrete block walls: | | |
| Mass/unit area (kg/m$^2$ ) = | 238 | (Wall at junctions 1&3) |
| | 238 | (Wall at junctions 2&4) |
| For 150 mm concrete floor: | | |
| Mass/unit area (kg/m$^2$ ) = | | 345 |
| | | |
| Separating partition area ( m$^2$ ) = | | 20 |
| Junction 1 and 3 length (m ) = | | 5.0 |
| Junction 2 and 4 length (m ) = | | 4.0 |
| 10*log(S_Partition/l_junction 1&3) = | | 6.0 |
| 10*log(S_Partition/l_junction2 &4) = | | 7.0 |

**Illustration for this case**




Cross junction of separating floor of 150 mm thick concrete with 190 mm concrete block wall. (Side view of Junctions 1 & 3)




T-Junction of separating floor of 150 mm thick concrete with 190 mm concrete block wall. (Side view of Junction 2. Junction 4 has same lining details, but cross junction)

| Junction | | Mass ratio for Ff | Path Ff<br>Kij (in dB) = | Path Fd | Path Df | Reference |
|---|---|---|---|---|---|---|
| 1 | Rigid-T/soft | 1.45 | SOFT | 5.8 | SOFT | ISO 15712-1, Eq. E.4 |
| 2 | Rigid-Corner/soft | 1.45 | SOFT | -0.6 | SOFT | ISO 15712-1, Eq. E.9 |
| 3 | Rigid-T/soft | 1.45 | SOFT | 5.8 | SOFT | ISO 15712-1, Eq. E.4 |
| 4 | Rigid-T/soft | 1.45 | SOFT | 5.8 | SOFT | ISO 15712-1, Eq. E.4 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|---|
| **Separating Partition (190 mm concrete block)** | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-333, TLF-97-107a | | 52 | | |
| ΔSTC change by Lining on D | ΔR_D,w | No Lining , | | 0 | | |
| ΔSTC change by Lining on d | ΔR_d,w | RR-333, ΔTLF-CON150-01, SUS150_GFB150_G16 | | 19 | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 52 + MAX(0,19) + MIN(0,19)/2 = | | **71** | |
| | | | | | | |
| **Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor)** | | | | | | |
| Flanking Element F1: | | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F1,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| Flanking Element f1: | | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f1,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(2,19) + MIN(2,19)/2 + 5.8 + 6 = | | **82** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 8.2 + 10^- 9 ) = | | **81** | |
| | | | | | | |
| **Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F2: | | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F2,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| Flanking Element f2: | | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f2,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(2,19) + MIN(2,19)/2 + -0.6 + 7 = | | **77** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 7.7 + 10^- 9 ) = | | **77** | |
| | | | | | | |
| **Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab)** | | | | | | |
| Flanking Element F3: | | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F3,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| Flanking Element f3: | | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f3,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | | 49/2 + 52/2 + MAX(2,19) + MIN(2,19)/2 + 5.8 + 6 = | | **82** | |
| **Flanking STC for path Df** | R_ Df,w | | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 8.2 + 10^- 9 ) = | | **81** | |
| | | | | | | |
| **Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F4: | | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_F4,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| Flanking Element f4: | | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, NRC-Mean BLK190(NW) | | 49 | | |
| ΔSTC change by Lining | ΔR_f4,w | RR-334, ΔTL-BLK(NW)-61, SS65_G13 | | 2 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(2,19) + MIN(2,19)/2 + 5.8 + 7 = | | **83** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 8.3 + 10^- 9 ) = | | **82** | |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | **73** | |
| | | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | | **69** | |

**EXAMPLE 4.1.2-V4: (SIMPLIFIED METHOD)**

- **Rooms one-above-the-other**
- **Concrete floors and normal weight concrete block walls with rigid junctions except at top of non-loadbearing walls (Same structure as 4.1.2-V1, with lining of walls and ceiling)**

Separating floor/ceiling assembly with:

- concrete floor with mass 345 kg/m$^2$ (e.g. normal weight concrete with thickness of 150 mm) with no topping / flooring on top
- ceiling lining below: 16 mm gypsum board[3] fastened to hat-channels supported on cross-channels hung on wires, cavity of 150 mm between concrete and ceiling, with 150 mm absorptive material[2]

Junction 1, 3 or 4: Cross Junction of separating floor / flanking wall with:

- rigid mortared T junction with concrete block wall assemblies above, soft joint with walls below
- wall above and below floor of one wythe of 190 mm hollow concrete blocks with normal weight aggregate[1], with mass 238 kg/m$^2$
- flanking walls lined with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c. with absorptive material[2] filling inter-stud cavities

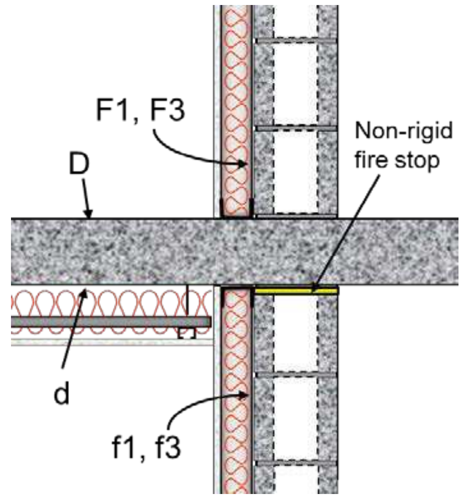
Junction 2: T-Junction of separating floor / flanking wall with:

- rigid mortared T junction with concrete block wall assemblies above, soft joint with walls below
- wall above and below floor of one wythe of 190 mm hollow concrete blocks with normal weight aggregate[1], with mass 238 kg/m$^2$
- flanking walls lined with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c. with absorptive material[2] filling inter-stud cavities

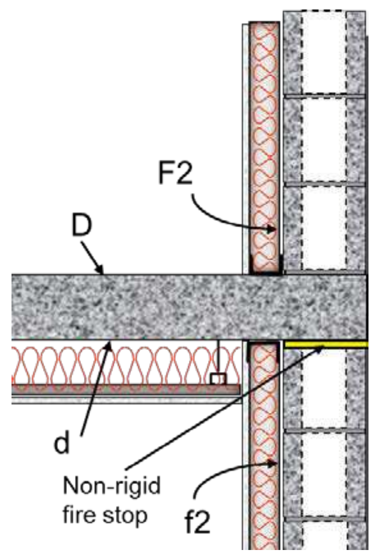
Acoustical Parameters:

| | | |
|---|---|---|
| For 190 mm concrete block walls: | | |
| Mass/unit area (kg/m$^2$ ) = | 238 | (Wall at junctions 1&3) |
| | 238 | (Wall at junctions 2&4) |
| For 150 mm concrete floor: | | |
| Mass/unit area (kg/m$^2$ ) = | | 345 |
| | | |
| Separating partition area ( m$^2$ ) = | | 20 |
| Junction 1 and 3 length (m ) = | | 5.0 |
| Junction 2 and 4 length (m ) = | | 4.0 |
| 10*log(S_Partition/l_junction 1&3) = | | 6.0 |
| 10*log(S_Partition/l_junction2 &4) = | | 7.0 |

**Illustration for this case**




Cross junction of separating floor of 150 mm thick concrete with 190 mm concrete block wall. (Side view of Junctions 1 & 3)




T-Junction of separating floor of 150 mm thick concrete with 190 mm concrete block wall. (Side view of Junction 2. Junction 4 has same lining details, but cross junction)

| | | | Path Ff | Path Fd | Path Df | |
|---|---|---|---|---|---|---|
| Junction | | Mass ratio for Ff | Kij (in dB) = | | | Reference |
| 1 | Rigid-T/soft | 1.45 | SOFT | 5.8 | SOFT | ISO 15712-1, Eq. E.4 |
| 2 | Rigid-Corner/soft | 1.45 | SOFT | -0.6 | SOFT | ISO 15712-1, Eq. E.9 |
| 3 | Rigid-T/soft | 1.45 | SOFT | 5.8 | SOFT | ISO 15712-1, Eq. E.4 |
| 4 | Rigid-T/soft | 1.45 | SOFT | 5.8 | SOFT | ISO 15712-1, Eq. E.4 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|
| <u>Separating Partition (190 mm concrete block)</u> | | | | | |
| Laboratory STC for Dd | R_s,w | RR-333, TLF-97-107a | 52 | | |
| ΔSTC change by Lining on D | ΔR_D,w | No Lining , | 0 | | |
| ΔSTC change by Lining on d | ΔR_d,w | RR-333, ΔTLF-CON150-01, SUS150_GFB150_G16 | 19 | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 52 + MAX(0,19) + MIN(0,19)/2 = | **71** | |
| | | | | | |
| <u>**Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor)**</u> | | | | | |
| <u>Flanking Element F1:</u> | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-334, NRC-Mean BLK190(NW) | 49 | | |
| ΔSTC change by Lining | ΔR_F1,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | 19 | | |
| <u>Flanking Element f1:</u> | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-334, NRC-Mean BLK190(NW) | 49 | | |
| ΔSTC change by Lining | ΔR_f1,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(19,19) + MIN(19,19)/2 + 5.8 + 6 = | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | **90** | (limit) |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 9 + 10^- 9 ) = | **85** | |
| | | | | | |
| <u>**Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall)**</u> | | | | | |
| <u>Flanking Element F2:</u> | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, NRC-Mean BLK190(NW) | 49 | | |
| ΔSTC change by Lining | ΔR_F2,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | 19 | | |
| <u>Flanking Element f2:</u> | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, NRC-Mean BLK190(NW) | 49 | | |
| ΔSTC change by Lining | ΔR_f2,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(19,19) + MIN(19,19)/2 + -0.6 + 7 = | **85** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | **90** | (limit) |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 8.5 + 10^- 9 ) = | **83** | |
| | | | | | |
| <u>**Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab)**</u> | | | | | |
| <u>Flanking Element F3:</u> | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-334, NRC-Mean BLK190(NW) | 49 | | |
| ΔSTC change by Lining | ΔR_F3,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | 19 | | |
| <u>Flanking Element f3:</u> | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-334, NRC-Mean BLK190(NW) | 49 | | |
| ΔSTC change by Lining | ΔR_f3,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | | 49/2 + 52/2 + MAX(19,19) + MIN(19,19)/2 + 5.8 + 6 = | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | | Negligible transmission via fire stop | **90** | (limit) |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 9 + 10^- 9 ) = | **85** | |
| | | | | | |
| <u>**Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall)**</u> | | | | | |
| <u>Flanking Element F4:</u> | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, NRC-Mean BLK190(NW) | 49 | | |
| ΔSTC change by Lining | ΔR_F4,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | 19 | | |
| <u>Flanking Element f4:</u> | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, NRC-Mean BLK190(NW) | 49 | | |
| ΔSTC change by Lining | ΔR_f4,w | RR-334, ΔTL-BLK(NW)-62, SS65_GFB_G13 | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 49/2 + 52/2 + MAX(19,19) + MIN(19,19)/2 + 5.8 + 7 = | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | **90** | (limit) |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 9 + 10^- 9 ) = | **85** | |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | **78** | |
| | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | **70** | |

**Summary for Section 4.1.2: Non-loadbearing Normal Weight Concrete Block Walls with Concrete Floors**

The worked examples 4.1.2-H1 and 4.1.2-V1, both of which did not include linings on the masonry or concrete surfaces, illustrate the basic process for calculating sound transmission between rooms in a building with bare, non-loadbearing concrete masonry walls and concrete floors (i.e. without added gypsum board finish on the walls or ceiling, or flooring over the concrete slab).

In both cases with no linings, the Apparent Sound Transmission Class (ASTC) rating is lower than the STC rating of the separating assembly because the flanking transmission (via the combination of the 12 flanking paths) is of similar magnitude as the Direct Transmission Loss through the separating assembly. Comparing these examples with the loadbearing cases in Section 4.1.1 shows no change in the ASTC rating (47 for the side-by-side case and 50 with one room above the other).

Looking at the individual paths, it becomes clear that the soft connections between the top of the non-loadbearing walls and the ceiling eliminate some flanking paths, but the flanking transmission along the remaining paths become stronger. When linings are added, these differences become more obvious.

**For the side-by-side pair of rooms**

The effect of added linings is shown in examples 4.1.2-H2 to H4 and the following trends are shown:

- Adding a minimal lining with no sound absorptive material in the cavities (ΔSTC=2) to all of the wall surfaces raises the ASTC rating from 47 to 49.
- Adding a better wall lining with ΔSTC=19 in example 4.1.2-H3 raises the ASTC rating to 57, but further improvements are limited by the transmission through the bare concrete surfaces of the floor and ceiling (which have a combined Flanking STC of 57 versus the value of 59 with the rigid junctions in the previous section).
- Significant further improvement requires treatment of both the floor and ceiling surfaces – treating just the ceiling in example 4.1.2-H4 increases the ASTC rating by only 3 points to 60.

Therefore, for constructions with soft junctions at the top of the non-loadbearing concrete block walls, adding an effective floor treatment becomes more critical to achieving a high ASTC rating between side-by-side rooms. [Example(s) will be added when Report RR-333 becomes available.]

**For one room above the other**

The effect of adding linings is shown in examples 4.1.2-V2 to V4 and the following trends are shown:

- As shown in example 4.1.2-V2, adding a good lining to all of the flanking wall surfaces increases the ASTC rating from 50 to 52 because direct transmission through the separating floor/ceiling is the strongest path, so improving the Flanking STC paths via the wall surfaces has limited effect.
- This limitation is easily remedied by adding a gypsum board ceiling with sound absorptive material in the cavity under the concrete ceiling assembly, which raises the direct path from 52 to 71.
- With an effective ceiling lining in place, as shown in example 4.1.2-V3., a very good system performance of ASTC 69 is possible even with a minimal (ΔSTC=2) lining of the flanking walls. This happens because the only effective flanking paths (those not blocked by the fire stops) involve transmission via the ceiling surface, and hence, benefit from the ceiling lining.
- Filling the inter-stud cavities with absorptive material to provide a more effective lining of the walls in example 4.1.2-V4 raises the system performance only slightly to ASTC 70. Further improvement would require better linings for the ceiling and the floor above.

### 4.1.3 Non-Loadbearing Lightweight Concrete Block Walls with Concrete Floors

All of the examples in Section 4.1.3 have rigid mortared junctions between the concrete floors and the lightweight concrete block walls above the floor, but soft connections (non-loadbearing) between the concrete ceiling and the walls below.

This gives a pattern of structure-borne flanking sound transfer to adjoining rooms similar to the cases illustrated in the preceding section. Hence, the changes in the flanking paths for this section are the same as those illustrated in Figure 4.1.2.1 at the beginning of the preceding Section 4.1.2.

However, in this section, the flanking transmission is altered by substituting lighter masonry walls (having 140 mm thickness and constructed of lightweight block units) and combining them with a heavier 200 mm concrete floor. The resulting change (in ratio of mass per unit area of the separating surface relative to that of the flanking surface) alters the calculated values for the vibration reduction indices $K_{Ff}$, $K_{Fd}$, and $K_{Df}$ for the flanking paths between the surfaces in the source room (D or F) and the attached surfaces in the receiving room (f or d).

Note that all of the worked examples in this section pertain to lightweight blocks that have not been sealed by painting the surfaces of the blocks. The effect on the sound transmission loss of leakage through the lightweight blocks has been included where appropriate:

- Leakage through the unlined concrete block walls should not have any effect for flanking paths, since different assemblies are involved in the source and receiving room and leakage through the wall exposed in the source room will not emerge from the attached flanking assembly in the receiving room. Thus, sound transmission paths via the unlined wall assemblies of lightweight concrete block have the STC value for ***Base***-BLK140(LW), as discussed in Section 2.1.
- Direct transmission through a separating wall of unsealed and unlined lightweight concrete blocks should have the STC value for ***Bare***-BLK140(LW), since the leakage is a legitimate part of the performance of such a wall. In effect, the leakage creates an extra flanking path for the direct transmission, reducing the wall's STC value from the Base case (STC 38) to the Bare case (STC 35). However, this leakage transmission is blocked if the separating wall is covered on one side or both sides with paint or a gypsum board lining.

The appropriate correction for leakage is explicitly identified in the worked examples in Section 4.1.3.

The ΔSTC changes (which are given in Table 2.3.2) have been calculated as improvements using ***Base***-BLK140(LW) as the reference case without lining(s). This is obviously the appropriate reference for flanking paths (since different walls are involved in the source and receiving room, so leakage through one cannot affect the other) and is also appropriate for direct transmission through a lined separating wall because the addition of the lining(s) blocks the leakage transmission.

A description of the steps in the calculation process is given at the beginning of Section 4.1 with all of the needed references to the pertinent expressions in ISO 15712-1. The worked examples provide values for a set of realistic scenarios.

**EXAMPLE 4.1.3-H1: (SIMPLIFIED METHOD)**

- **Rooms side-by-side**
- **Concrete floors and lightweight concrete block walls with rigid junctions except at top of non-loadbearing walls**

Separating wall assembly (non-loadbearing) with:
- one wythe of unsealed non-loadbearing concrete blocks with mass 134 kg/m$^2$ (e.g. 140 mm hollow blocks of lightweight aggregate[2])
- soft seal at top of wall, rigid junction at bottom
- no lining of wall surfaces

Junction 1: Bottom Junction (separating wall / floor) with:
- concrete floor with mass 460 kg/m$^2$ (e.g. normal weight concrete with thickness of 200 mm) with no topping or flooring
- rigid mortared junction with concrete block wall assembly above

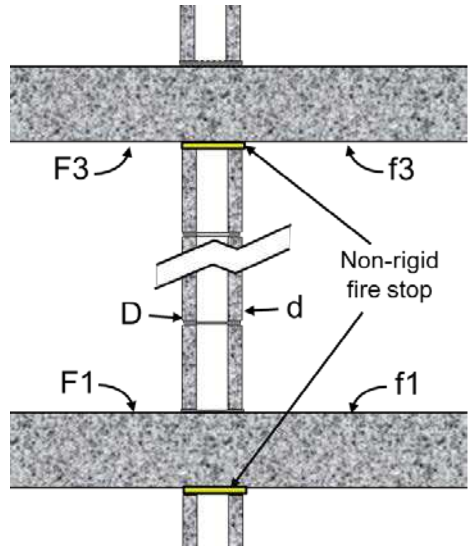
Junction 2 or 4: Each Side (separating wall /abutting side wall) with:
- abutting flanking side wall of unsealed concrete blocks with mass 134 kg/m$^2$ (e.g. 140 mm hollow blocks with lightweight aggregate[4])
- soft seal at top of flanking walls, rigid junction at bottom
- rigid mortared T-junctions between separating and flanking walls
- no lining of flanking wall surfaces

Junction 3: Top Junction (separating wall / ceiling) with:
- concrete ceiling slab with mass 460 kg/m$^2$ (e.g. normal weight concrete with thickness of 200 mm) with no added ceiling lining
- soft seal at junction with concrete block wall assembly below

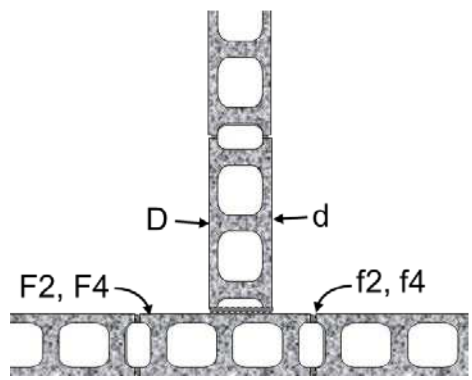
Acoustical Parameters:

| | | |
|---|---|---|
| For 140 mm lightweight concrete block walls: | | |
| Mass/unit area (kg/m$^2$ ) = | 134 | (Separating wall) |
| | 134 | (Flanking wall) |
| For 200 mm concrete floor: | | |
| Mass/unit area (kg/m$^2$ ) = | | 460 |
| | | |
| Separating partition area ( m$^2$ ) = | | 12.5 |
| Junction length (m ) = | | 5.0 |
| Separating partition height ( m ) = | | 2.5 |
| 10*log(S_Partition/l_junction 1&3) = | | 4.0 |
| 10*log(S_Partition/l_junction 2&4) = | | 7.0 |

**Illustration for this case**




Junction of 140 mm concrete block separating wall with 200 mm thick concrete floor and ceiling. (Side view of Junctions 1 and 3)




Junction of separating wall with side wall, both of 140 mm concrete block. (Plan view of Junction 2 or 4).

| Junction | | Mass ratio for Ff | Path Ff<br>Kij (in dB) = | Path Fd | Path Df | Reference |
|---|---|---|---|---|---|---|
| 1 | Rigid-T/soft | 0.29 | -0.2 | 7.3 | 7.3 | ISO 15712-1, Eq. E.4 |
| 2 | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |
| 3 | Rigid-T/soft | 0.29 | -0.2 | SOFT | SOFT | ISO 15712-1, Eq. E.4 |
| 4 | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | | STC, Δ_STC | ASTC | | |
|---|---|---|---|---|---|---|---|
| Separating Partition (190 mm concrete block) | | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-334, Base BLK140(LW) | | 38 | | | |
| Leakage if no lining | | RR-334, Bare BLK140(LW) | | -3 | | | |
| ΔSTC change by Lining on D | ΔR_D,w | No Lining , | | 0 | | | |
| ΔSTC change by Lining on d | ΔR_d,w | No Lining , | | 0 | | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 35 + MAX(0,0) + MIN(0,0)/2 = | | **35** | | |
| | | | | | | | |
| Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor) | | | | | | | |
| Flanking Element F1: | | | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-333, TLF-12-013 | | 58 | | | |
| ΔSTC change by Lining | ΔR_F1,w | No Lining , | | 0 | | | |
| Flanking Element f1: | | | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-333, TLF-12-013 | | 58 | | | |
| ΔSTC change by Lining | ΔR_f1,w | No Lining , | | 0 | | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 58/2 + 58/2 + MAX(0,0) + MIN(0,0)/2 + -0.2 + 4 = | | **62** | | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 58/2 + 38/2 + MAX(0,0) + MIN(0,0)/2 + 7.3 + 4 = | | **59** | | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 58/2 + MAX(0,0) + MIN(0,0)/2 + 7.3 + 4 = | | **59** | | |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.2 + 10^- 5.9 + 10^- 5.9 ) = | | | **55** | |
| | | | | | | | |
| Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall) | | | | | | | |
| Flanking Element F2: | | | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, Base BLK140(LW) | | 38 | | | |
| ΔSTC change by Lining | ΔR_F2,w | No Lining , | | 0 | | | |
| Flanking Element f2: | | | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, Base BLK140(LW) | | 38 | | | |
| ΔSTC change by Lining | ΔR_f2,w | No Lining , | | 0 | | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(0,0) + MIN(0,0)/2 + 5.7 + 7 = | | **51** | | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(0,0) + MIN(0,0)/2 + 5.7 + 7 = | | **51** | | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(0,0) + MIN(0,0)/2 + 5.7 + 7 = | | **51** | | |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-5.1 + 10^- 5.1 + 10^- 5.1 ) = | | | **46** | |
| | | | | | | | |
| Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab) | | | | | | | |
| Flanking Element F3: | | | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-333, TLF-12-013 | | 58 | | | |
| ΔSTC change by Lining | ΔR_F3,w | No Lining , | | 0 | | | |
| Flanking Element f3: | | | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-333, TLF-12-013 | | 58 | | | |
| ΔSTC change by Lining | ΔR_f3,w | No Lining , | | 0 | | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 58/2 + 58/2 + MAX(0,0) + MIN(0,0)/2 + -0.2 + 4 = | | **62** | | |
| **Flanking STC for path Fd** | R_ Fd,w | | Negligible transmission via fire stop | | **90** | | (limit) |
| **Flanking STC for path Df** | R_ Df,w | | Negligible transmission via fire stop | | **90** | | (limit) |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.2 + 10^- 9 + 10^- 9 ) = | | | **62** | |
| | | | | | | | |
| Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall) | | | | | | | |
| Flanking Element F4: | | | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, Base BLK140(LW) | | 38 | | | |
| ΔSTC change by Lining | ΔR_F4,w | No Lining , | | 0 | | | |
| Flanking Element f4: | | | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, Base BLK140(LW) | | 38 | | | |
| ΔSTC change by Lining | ΔR_f4,w | No Lining , | | 0 | | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(0,0) + MIN(0,0)/2 + 5.7 + 7 = | | **51** | | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(0,0) + MIN(0,0)/2 + 5.7 + 7 = | | **51** | | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(0,0) + MIN(0,0)/2 + 5.7 + 7 = | | **51** | | |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-5.1 + 10^- 5.1 + 10^- 5.1 ) = | | | **46** | |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | | **43** | |
| | | | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | | **34** | | |

**EXAMPLE 4.1.3-H2: (SIMPLIFIED METHOD)**

- **Rooms side-by-side**
- **Concrete floors and lightweight concrete block walls with rigid junctions except at top of non-loadbearing walls (Same structure as 4.1.3-H1, with lining of walls)**

Separating wall assembly (non-loadbearing) with:

- one wythe of unsealed non-loadbearing concrete blocks with mass 134 kg/m$^2$ (e.g. 140 mm hollow blocks of lightweight aggregate[4])
- soft seal at top of wall, rigid junction at bottom
- separating wall lined on both sides with 13 mm gypsum board[3] supported on 38 mm wood furring spaced 610 mm o.c. with absorptive material[2] filling inter-stud cavities

Junction 1: Bottom Junction (separating wall / floor) with:

- concrete floor with mass 460 kg/m$^2$ (e.g. normal weight concrete with thickness of 200 mm) with no topping or flooring
- rigid mortared junction with concrete block wall assembly above

Junction 2 or 4: Each Side (separating wall /abutting side wall) with:

- abutting flanking side wall of unsealed concrete blocks with mass 134 kg/m$^2$ (e.g. 140 mm hollow blocks with lightweight aggregate[4])
- soft seal at top of flanking walls, rigid junction at bottom
- rigid mortared T-junctions between separating and flanking walls
- flanking walls lined with 13 mm gypsum board[3] supported on 38 mm wood furring spaced 610 mm o.c. with absorptive material[2] filling inter-stud cavities

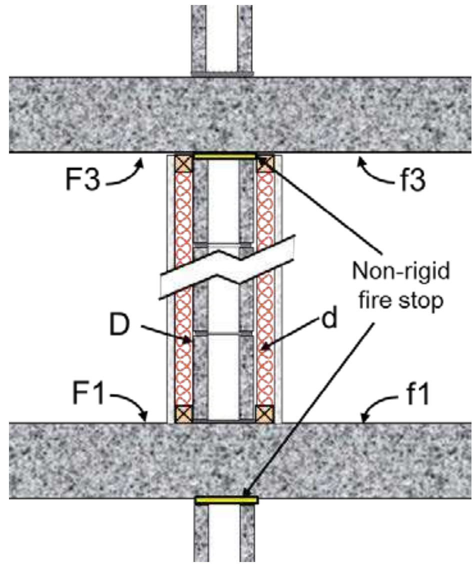
Junction 3: Top Junction (separating wall / ceiling) with:

- concrete ceiling slab with mass 460 kg/m$^2$ (e.g. normal weight concrete with thickness of 200 mm) with no added ceiling lining
- soft seal at junction with concrete block wall assembly below

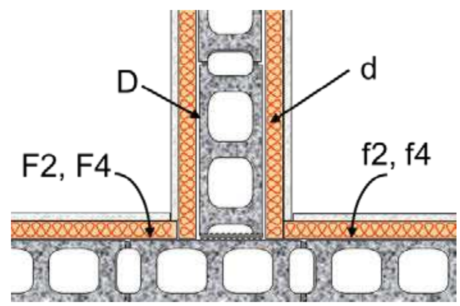
Acoustical Parameters:

| | | |
|---|---|---|
| For 140 mm lightweight concrete block walls: | | |
| Mass/unit area (kg/m$^2$ ) = | 134 | (Separating wall) |
| | 134 | (Flanking wall) |
| For 200 mm concrete floor: | | |
| Mass/unit area (kg/m$^2$ ) = | | 460 |
| | | |
| Separating partition area ( m$^2$ ) = | | 12.5 |
| Junction length (m ) = | | 5.0 |
| Separating partition height ( m ) = | | 2.5 |
| 10*log(S_Partition/l_junction 1&3) = | | 4.0 |
| 10*log(S_Partition/l_junction 2&4) = | | 7.0 |

**Illustration for this case**




Junction of 140 mm concrete block separating wall (with gypsum board lining) with 200 mm thick concrete floor and ceiling. (Side view of Junctions 1 and 3)




Junction of separating wall with flanking side wall, both of 140 mm concrete block with gypsum board linings. (Plan view of Junction 2 or 4).

| Junction | | Mass ratio for Ff | Path Ff<br>Kij (in dB) = | Path Fd | Path Df | Reference |
|---|---|---|---|---|---|---|
| 1 | Rigid-T/soft | 0.29 | -0.2 | 7.3 | 7.3 | ISO 15712-1, Eq. E.4 |
| 2 | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |
| 3 | Rigid-T/soft | 0.29 | -0.2 | SOFT | SOFT | ISO 15712-1, Eq. E.4 |
| 4 | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|---|
| <u>Separating Partition (190 mm concrete block)</u> | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-334, Base BLK140(LW) | | 38 | | |
| Leakage if no lining | | N/A | | 0 | | |
| ΔSTC change by Lining on D | ΔR_D,w | RR-334, ΔTL-BLK( LW)-33, WFUR38_GFB38_G13 | | 7 | | |
| ΔSTC change by Lining on d | ΔR_d,w | RR-334, ΔTL-BLK( LW)-33, WFUR38_GFB38_G13 | | 7 | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 38 + MAX(7,7) + MIN(7,7)/2 = | | **49** | |
| | | | | | | |
| <u>**Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor)**</u> | | | | | | |
| <u>Flanking Element F1:</u> | | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-333, TLF-12-013 | | 58 | | |
| ΔSTC change by Lining | ΔR_F1,w | No Lining , | | 0 | | |
| <u>Flanking Element f1:</u> | | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-333, TLF-12-013 | | 58 | | |
| ΔSTC change by Lining | ΔR_f1,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 58/2 + 58/2 + MAX(0,0) + MIN(0,0)/2 + -0.2 + 4 = | | **62** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 58/2 + 38/2 + MAX(0,7) + MIN(0,7)/2 + 7.3 + 4 = | | **66** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 58/2 + MAX(7,0) + MIN(7,0)/2 + 7.3 + 4 = | | **66** | |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.2 + 10^- 6.6 + 10^- 6.6 ) = | | **59** | |
| | | | | | | |
| <u>**Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall)**</u> | | | | | | |
| <u>Flanking Element F2:</u> | | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_F2,w | RR-334, ΔTL-BLK( LW)-33, WFUR38_GFB38_G13 | | 7 | | |
| <u>Flanking Element f2:</u> | | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_f2,w | RR-334, ΔTL-BLK( LW)-33, WFUR38_GFB38_G13 | | 7 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(7,7) + MIN(7,7)/2 + 5.7 + 7 = | | **61** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(7,7) + MIN(7,7)/2 + 5.7 + 7 = | | **61** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(7,7) + MIN(7,7)/2 + 5.7 + 7 = | | **61** | |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.1 + 10^- 6.1 + 10^- 6.1 ) = | | **56** | |
| | | | | | | |
| <u>**Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab)**</u> | | | | | | |
| <u>Flanking Element F3:</u> | | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-333, TLF-12-013 | | 58 | | |
| ΔSTC change by Lining | ΔR_F3,w | No Lining , | | 0 | | |
| <u>Flanking Element f3:</u> | | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-333, TLF-12-013 | | 58 | | |
| ΔSTC change by Lining | ΔR_f3,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 58/2 + 58/2 + MAX(0,0) + MIN(0,0)/2 + -0.2 + 4 = | | **62** | |
| **Flanking STC for path Fd** | R_ Fd,w | | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.2 + 10^- 9 + 10^- 9 ) = | | **62** | |
| | | | | | | |
| <u>**Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall)**</u> | | | | | | |
| <u>Flanking Element F4:</u> | | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_F4,w | RR-334, ΔTL-BLK( LW)-33, WFUR38_GFB38_G13 | | 7 | | |
| <u>Flanking Element f4:</u> | | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_f4,w | RR-334, ΔTL-BLK( LW)-33, WFUR38_GFB38_G13 | | 7 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(7,7) + MIN(7,7)/2 + 5.7 + 7 = | | **61** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(7,7) + MIN(7,7)/2 + 5.7 + 7 = | | **61** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(7,7) + MIN(7,7)/2 + 5.7 + 7 = | | **61** | |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.1 + 10^- 6.1 + 10^- 6.1 ) = | | **56** | |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | **52** | |
| | | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | | **47** | |

**EXAMPLE 4.1.3-H3: (SIMPLIFIED METHOD)**

- **Rooms side-by-side**
- **Concrete floors and lightweight concrete block walls with rigid junctions except at top of non-loadbearing walls (Same structure as 4.1.3-H1, with enhanced lining of walls)**

Separating wall assembly (non-loadbearing) with:
- one wythe of unsealed non-loadbearing concrete blocks with mass 134 kg/m$^2$ (e.g. 140 mm hollow blocks of lightweight aggregate[4])
- soft seal at top of wall, rigid junction at bottom
- separating wall lined both sides with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c., with absorptive material[2] filling inter-stud cavities

Junction 1: Bottom Junction (separating wall / floor) with:
- concrete floor with mass 460 kg/m$^2$ (e.g. normal weight concrete with thickness of 200 mm) with no topping or flooring
- rigid mortared junction with concrete block wall assembly above

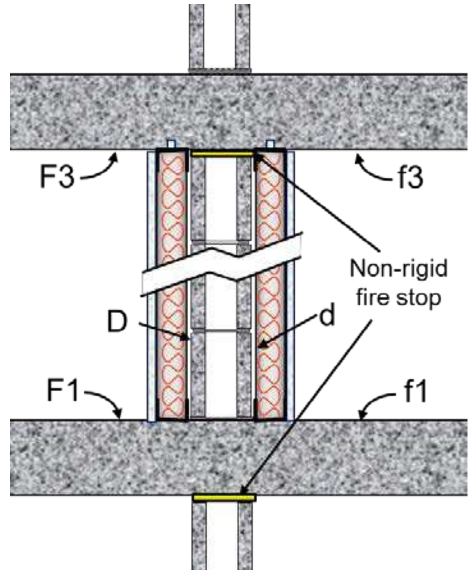
Junction 2 or 4: Each Side (separating wall /abutting side wall) with:
- abutting flanking side wall of unsealed concrete blocks with mass 134 kg/m$^2$ (e.g. 140 mm hollow blocks with lightweight aggregate[4])
- soft seal at top of flanking walls, rigid junction at bottom
- rigid mortared T-junctions between separating and flanking walls
- flanking walls lined with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c., with absorptive material[2] filling inter-stud cavities

Junction 3: Top Junction (separating wall / ceiling) with:
- concrete ceiling slab with mass 460 kg/m$^2$ (e.g. normal weight concrete with thickness of 200 mm) with no added ceiling lining
- soft seal at junction with concrete block wall assembly below

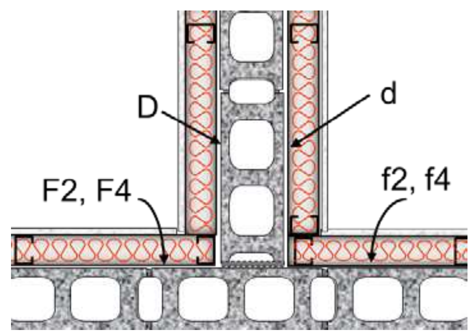
Acoustical Parameters:

| | | |
|---|---|---|
| For 140 mm lightweight concrete block walls: | | |
| Mass/unit area (kg/m$^2$ ) = | 134 | (Separating wall) |
| | 134 | (Flanking wall) |
| For 200 mm concrete floor: | | |
| Mass/unit area (kg/m$^2$ ) = | | 460 |
| | | |
| Separating partition area ( m$^2$ ) = | | 12.5 |
| Junction length (m ) = | | 5.0 |
| Separating partition height ( m ) = | | 2.5 |
| 10*log(S_Partition/l_junction 1&3) = | | 4.0 |
| 10*log(S_Partition/l_junction 2&4) = | | 7.0 |

**Illustration for this case**




Junction of 140 mm concrete block separating wall (with enhanced gypsum board lining) with 200 mm thick concrete floor and ceiling.
(Side view of Junctions 1 and 3)




Junction of separating wall with flanking side wall, both of 140 mm concrete block with enhanced gypsum board linings. (Plan view of Junction 2 or 4).

| | | | Path Ff | Path Fd | Path Df | |
|---|---|---|---|---|---|---|
| **Junction** | | Mass ratio for Ff | Kij (in dB) = | | | Reference |
| **1** | Rigid-T/soft | 0.29 | -0.2 | 7.3 | 7.3 | ISO 15712-1, Eq. E.4 |
| **2** | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |
| **3** | Rigid-T/soft | 0.29 | -0.2 | SOFT | SOFT | ISO 15712-1, Eq. E.4 |
| **4** | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|---|
| **Separating Partition (190 mm concrete block)** | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-334, Base BLK140(LW) | | 38 | | |
| Leakage if no lining | | N/A | | 0 | | |
| ΔSTC change by Lining on D | ΔR_D,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| ΔSTC change by Lining on d | ΔR_d,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 38 + MAX(15,15) + MIN(15,15)/2 = | | **61** | |
| | | | | | | |
| **Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor)** | | | | | | |
| Flanking Element F1: | | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-333, TLF-12-013 | | 58 | | |
| ΔSTC change by Lining | ΔR_F1,w | No Lining , | | 0 | | |
| Flanking Element f1: | | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-333, TLF-12-013 | | 58 | | |
| ΔSTC change by Lining | ΔR_f1,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 58/2 + 58/2 + MAX(0,0) + MIN(0,0)/2 + -0.2 + 4 = | | **62** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 58/2 + 38/2 + MAX(0,15) + MIN(0,15)/2 + 7.3 + 4 = | | **74** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 58/2 + MAX(15,0) + MIN(15,0)/2 + 7.3 + 4 = | | **74** | |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.2 + 10^- 7.4 + 10^- 7.4 ) = | | **61** | |
| | | | | | | |
| **Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F2: | | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_F2,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| Flanking Element f2: | | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_f2,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(15,15) + MIN(15,15)/2 + 5.7 + 7 = | | **73** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(15,15) + MIN(15,15)/2 + 5.7 + 7 = | | **73** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(15,15) + MIN(15,15)/2 + 5.7 + 7 = | | **73** | |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-7.3 + 10^- 7.3 + 10^- 7.3 ) = | | **68** | |
| | | | | | | |
| **Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab)** | | | | | | |
| Flanking Element F3: | | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-333, TLF-12-013 | | 58 | | |
| ΔSTC change by Lining | ΔR_F3,w | No Lining , | | 0 | | |
| Flanking Element f3: | | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-333, TLF-12-013 | | 58 | | |
| ΔSTC change by Lining | ΔR_f3,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 58/2 + 58/2 + MAX(0,0) + MIN(0,0)/2 + -0.2 + 4 = | | **62** | |
| **Flanking STC for path Fd** | R_ Fd,w | | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.2 + 10^- 9 + 10^- 9 ) = | | **62** | |
| | | | | | | |
| **Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F4: | | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_F4,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| Flanking Element f4: | | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_f4,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(15,15) + MIN(15,15)/2 + 5.7 + 7 = | | **73** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(15,15) + MIN(15,15)/2 + 5.7 + 7 = | | **73** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(15,15) + MIN(15,15)/2 + 5.7 + 7 = | | **73** | |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-7.3 + 10^- 7.3 + 10^- 7.3 ) = | | **68** | |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | **58** | |
| | | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | | **56** | |

**EXAMPLE 4.1.3-H4: (SIMPLIFIED METHOD)**

- **Rooms side-by-side**
- **Concrete floors and lightweight concrete block walls with rigid junctions except at top of non-loadbearing walls (Same structure as 4.1.3-H1, lining of walls & ceiling)**

Separating wall assembly (non-loadbearing) with:
- one wythe of unsealed non-loadbearing concrete blocks with mass 134 kg/m² (e.g. 140 mm hollow blocks of lightweight aggregate[4])
- soft seal at top of wall, rigid junction at bottom
- separating wall lined both sides with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c., with absorptive material[2] filling inter-stud cavities

Junction 1: Bottom Junction (separating wall / floor) with:
- concrete floor with mass 460 kg/m² (e.g. normal weight concrete with thickness of 200 mm) with no topping or flooring
- rigid mortared junction with concrete block wall assembly above

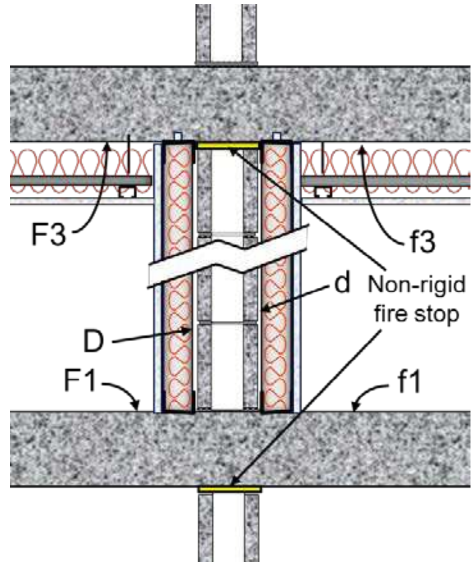
Junction 2 or 4: Each Side (separating wall /abutting side wall) with:
- abutting flanking side wall of unsealed concrete blocks with mass 134 kg/m² (e.g. 140 mm hollow blocks with lightweight aggregate[4])
- soft seal at top of flanking walls, rigid junction at bottom
- rigid mortared T-junctions between separating and flanking walls
- flanking side walls lined with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c., with absorptive material[2] filling inter-stud cavities

Junction 3: Top Junction (separating wall / ceiling) with:
- concrete ceiling slab with mass 460 kg/m2 (e.g. normal weight concrete with thickness of 200 mm)
- soft seal at junction with concrete block wall assembly below
- ceiling lining of 16 mm gypsum board[3] fastened to hat-channels supported on cross-channels hung on wires, 150 mm cavity between concrete and ceiling, with 150 mm absorptive material[2]

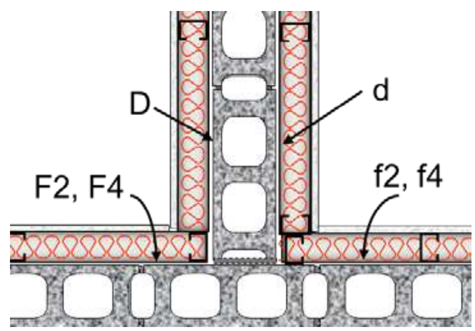
Acoustical Parameters:

| | | |
|---|---|---|
| For 140 mm lightweight concrete block walls: | | |
| Mass/unit area (kg/m²) = | 134 | (Separating wall) |
| | 134 | (Flanking wall) |
| For 200 mm concrete floor: | | |
| Mass/unit area (kg/m²) = | | 460 |
| | | |
| Separating partition area ( m² ) = | | 12.5 |
| Junction length (m ) = | | 5.0 |
| Separating partition height ( m ) = | | 2.5 |
| 10*log(S_Partition/l_junction 1&3) = | | 4.0 |
| 10*log(S_Partition/l_junction 2&4) = | | 7.0 |

**Illustration for this case**




Junction of 140 mm concrete block separating wall (with enhanced gypsum board lining) with 200 mm thick concrete floor and ceiling. (Side view of Junctions 1 and 3)




Junction of separating wall with flanking side wall, both of 140 mm concrete block with enhanced gypsum board linings. (Plan view of Junction 2 or 4).

| Junction | | Mass ratio for Ff | Path Ff | Path Fd | Path Df | Reference |
|---|---|---|---|---|---|---|
| | | | Kij (in dB) = | | | |
| 1 | Rigid-T/soft | 0.29 | -0.2 | 7.3 | 7.3 | ISO 15712-1, Eq. E.4 |
| 2 | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |
| 3 | Rigid-T/soft | 0.29 | -0.2 | SOFT | SOFT | ISO 15712-1, Eq. E.4 |
| 4 | Rigid T-junction | 1.00 | 5.7 | 5.7 | 5.7 | ISO 15712-1, Eq. E.4 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|---|
| **Separating Partition (190 mm concrete block)** | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-334, Base BLK140(LW) | | 38 | | |
| Leakage if no lining | | N/A | | 0 | | |
| ΔSTC change by Lining on D | ΔR_D,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| ΔSTC change by Lining on d | ΔR_d,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 38 + MAX(15,15) + MIN(15,15)/2 = | | **61** | |
| | | | | | | |
| **Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor)** | | | | | | |
| Flanking Element F1: | | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-333, TLF-12-013 | | 58 | | |
| ΔSTC change by Lining | ΔR_F1,w | No Lining , | | 0 | | |
| Flanking Element f1: | | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-333, TLF-12-013 | | 58 | | |
| ΔSTC change by Lining | ΔR_f1,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 58/2 + 58/2 + MAX(0,0) + MIN(0,0)/2 + -0.2 + 4 = | | **62** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 58/2 + 38/2 + MAX(0,15) + MIN(0,15)/2 + 7.3 + 4 = | | **74** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 58/2 + MAX(15,0) + MIN(15,0)/2 + 7.3 + 4 = | | **74** | |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.2 + 10^- 7.4 + 10^- 7.4 ) = | | **61** | |
| | | | | | | |
| **Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F2: | | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_F2,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| Flanking Element f2: | | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_f2,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(15,15) + MIN(15,15)/2 + 5.7 + 7 = | | **73** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(15,15) + MIN(15,15)/2 + 5.7 + 7 = | | **73** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(15,15) + MIN(15,15)/2 + 5.7 + 7 = | | **73** | |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-7.3 + 10^- 7.3 + 10^- 7.3 ) = | | **68** | |
| | | | | | | |
| **Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab)** | | | | | | |
| Flanking Element F3: | | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-333, TLF-12-013 | | 58 | | |
| ΔSTC change by Lining | ΔR_F3,w | RR-333, ΔTLF-CON150-01, SUS150_GFB150_G16 | | 19 | | |
| Flanking Element f3: | | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-333, TLF-12-013 | | 58 | | |
| ΔSTC change by Lining | ΔR_f3,w | RR-333, ΔTLF-CON150-01, SUS150_GFB150_G16 | | 19 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 58/2 + 58/2 + MAX(19,19) + MIN(19,19)/2 + -0.2 + 4 = | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Df** | R_ Df,w | | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 9 + 10^- 9 ) = | | **85** | |
| | | | | | | |
| **Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F4: | | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_F4,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| Flanking Element f4: | | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_f4,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(15,15) + MIN(15,15)/2 + 5.7 + 7 = | | **73** | |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(15,15) + MIN(15,15)/2 + 5.7 + 7 = | | **73** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 38/2 + MAX(15,15) + MIN(15,15)/2 + 5.7 + 7 = | | **73** | |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-7.3 + 10^- 7.3 + 10^- 7.3 ) = | | **68** | |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | **60** | |
| | | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | | **57** | |

**EXAMPLE 4.1.3-V1: (SIMPLIFIED METHOD)**

- **Rooms one-above-the-other**
- **Concrete floors and lightweight concrete block walls with rigid junctions except at top of non-loadbearing walls**

Separating floor/ceiling assembly with:
- concrete floor with mass 460 kg/m$^2$ (e.g. normal weight concrete with thickness of 200 mm) with no topping / flooring on top, or ceiling lining below

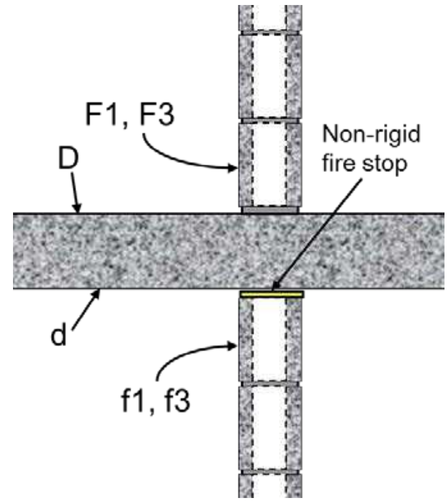
Junction 1, 3, 4: Cross Junction of separating floor / flanking wall with:
- rigid mortared T junction with concrete block wall assemblies above, soft joint with walls below
- wall above and below floor of one wythe of unsealed non-load-bearing concrete blocks with mass 134 kg/m$^2$ (e.g. 140 mm hollow blocks with lightweight aggregate[4]) with no lining of walls. Note that although the wall is bare, the STC value of the base wall (without leakage) is used for the calculation of the Flanking STC values

Junction 2: T-Junction of separating floor / flanking wall with:
- rigid mortared junctions with concrete block wall assembly above, and soft joint (negligible transmission) to wall assembly below
- wall above and below floor of one wythe of unsealed non-load-bearing concrete blocks with mass 134 kg/m$^2$ (e.g. 140 mm hollow blocks with lightweight aggregate[4]) with no lining of walls

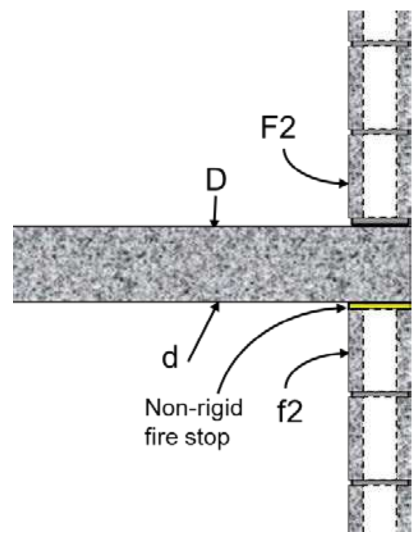
Acoustical Parameters:

| | | |
|---|---|---|
| For 140 mm lightweight concrete block walls: | | |
| Mass/unit area (kg/m$^2$ ) = | 134 | (Wall at junctions 1&3) |
| | 134 | (Wall at junctions 2&4) |
| For 200 mm concrete floor: | | |
| Mass/unit area (kg/m$^2$ ) = | | 460 |
| | | |
| Separating partition area ( m$^2$ ) = | | 20 |
| Junction 1 and 3 length (m ) = | | 5.0 |
| Junction 2 and 4 length (m ) = | | 4.0 |
| 10*log(S_Partition/l_junction 1&3) = | | 6.0 |
| 10*log(S_Partition/l_junction2 &4) = | | 7.0 |

**Illustration for this case**




Cross junction of separating floor of 200 mm thick concrete with 140 mm concrete block wall. (Side view of Junctions 1, 3, 4)




T-Junction of separating floor of 200 mm thick concrete floor with 140 mm concrete block wall. (Side view of Junction 2).

| | | | Path Ff | Path Fd | Path Df | |
|---|---|---|---|---|---|---|
| **Junction** | | Mass ratio for Ff | Kij (in dB) = | | | Reference |
| 1 | Rigid-T/soft | 3.43 | SOFT | 7.3 | SOFT | ISO 15712-1, Eq. E.4 |
| 2 | Rigid-Corner/soft | 3.43 | SOFT | 5.0 | SOFT | ISO 15712-1, Eq. E.9 |
| 3 | Rigid-T/soft | 3.43 | SOFT | 7.3 | SOFT | ISO 15712-1, Eq. E.4 |
| 4 | Rigid-T/soft | 3.43 | SOFT | 7.3 | SOFT | ISO 15712-1, Eq. E.4 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|---|
| **Separating Partition (190 mm concrete block)** | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-333, TLF-12-013 | | 58 | | |
| ΔSTC change by Lining on D | ΔR_D,w | No Lining , | | 0 | | |
| ΔSTC change by Lining on d | ΔR_d,w | No Lining , | | 0 | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 58 + MAX(0,0) + MIN(0,0)/2 = | | **58** | |
| | | | | | | |
| **Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor)** | | | | | | |
| Flanking Element F1: | | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_F1,w | No Lining , | | 0 | | |
| Flanking Element f1: | | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_f1,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 58/2 + MAX(0,0) + MIN(0,0)/2 + 7.3 + 6 = | | **61** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 6.1 + 10^- 9 ) = | | **61** | |
| | | | | | | |
| **Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F2: | | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_F2,w | No Lining , | | 0 | | |
| Flanking Element f2: | | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_f2,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 58/2 + MAX(0,0) + MIN(0,0)/2 + 5 + 7 = | | **60** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 6 + 10^- 9 ) = | | **60** | |
| | | | | | | |
| **Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab)** | | | | | | |
| Flanking Element F3: | | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_F3,w | No Lining , | | 0 | | |
| Flanking Element f3: | | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_f3,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | | 38/2 + 58/2 + MAX(0,0) + MIN(0,0)/2 + 7.3 + 6 = | | **61** | |
| **Flanking STC for path Df** | R_ Df,w | | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 6.1 + 10^- 9 ) = | | **61** | |
| | | | | | | |
| **Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F4: | | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_F4,w | No Lining , | | 0 | | |
| Flanking Element f4: | | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_f4,w | No Lining , | | 0 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 58/2 + MAX(0,0) + MIN(0,0)/2 + 7.3 + 7 = | | **62** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 6.2 + 10^- 9 ) = | | **62** | |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | **55** | |
| | | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | | **53** | |

**EXAMPLE 4.1.3-V2: (SIMPLIFIED METHOD)**

- **Rooms one-above-the-other**
- **Concrete floors and lightweight concrete block walls with rigid junctions except at top of non-loadbearing walls (Same structure as 4.1.3-V1, plus lining of walls)**

Separating floor/ceiling assembly with:
- concrete floor with mass 460 kg/m$^2$ (e.g. normal weight concrete with thickness of 200 mm) with no topping / flooring on top, or ceiling lining below

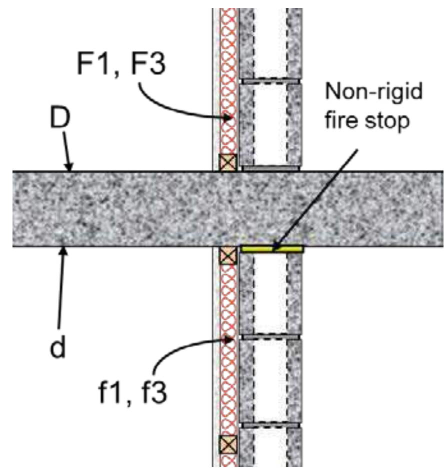
Junction 1, 3, 4: Cross Junction of separating floor / flanking wall with:
- rigid mortared T junction with concrete block wall assemblies above, soft joint with walls below
- wall above and below floor of one wythe of unsealed non-load-bearing concrete blocks with mass 134 kg/m$^2$ (e.g. 140 mm hollow blocks with lightweight aggregate[4])
- flanking walls lined with 13 mm gypsum board[3] supported on 38 mm wood furring spaced 610 mm o.c. with absorptive material[2] filling the intervening cavities

Junction 2: T-Junction of separating floor / flanking wall with:
- rigid mortared junctions with concrete block wall assembly above, and soft joint (negligible transmission) to wall assembly below
- wall above and below floor of one wythe of unsealed non-load-bearing concrete blocks with mass 134 kg/m$^2$ (e.g. 140 mm hollow blocks with lightweight aggregate[4])
- flanking walls lined with 13 mm gypsum board[3] supported on 38 mm wood furring spaced 610 mm o.c. with absorptive material[2] filling the intervening cavities

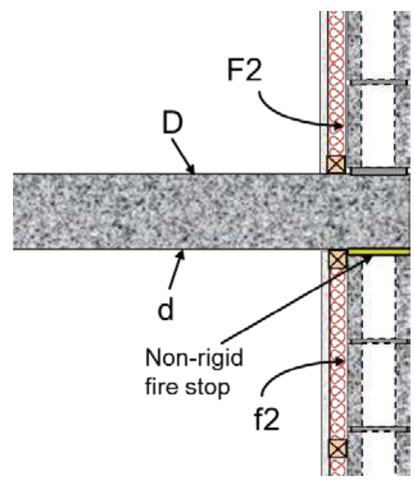
Acoustical Parameters:

| | | |
|---|---|---|
| For 140 mm lightweight concrete block walls: | | |
| Mass/unit area (kg/m$^2$ ) = | 134 | (Wall at junctions 1&3) |
| | 134 | (Wall at junctions 2&4) |
| For 200 mm concrete floor: | | |
| Mass/unit area (kg/m$^2$ ) = | 460 | |
| | | |
| Separating partition area ( m$^2$ ) = | 20 | |
| Junction 1 and 3 length (m ) = | 5.0 | |
| Junction 2 and 4 length (m ) = | 4.0 | |
| 10*log(S_Partition/l_junction 1&3) = | 6.0 | |
| 10*log(S_Partition/l_junction2 &4) = | 7.0 | |

**Illustration for this case**




Cross junction of separating floor of 200 mm thick concrete with 140 mm concrete block wall. (Side view of Junction 1 or 3)




T-Junction of separating floor of 200 mm thick concrete with 140 mm concrete block wall. (Side view of Junction 2. Junction 4 has same lining details, but cross junction)

| Junction | | Mass ratio for Ff | Path Ff<br>Kij (in dB) = | Path Fd | Path Df | Reference |
|---|---|---|---|---|---|---|
| 1 | Rigid-T/soft | 3.43 | SOFT | 7.3 | SOFT | ISO 15712-1, Eq. E.4 |
| 2 | Rigid-Corner/soft | 3.43 | SOFT | 5.0 | SOFT | ISO 15712-1, Eq. E.9 |
| 3 | Rigid-T/soft | 3.43 | SOFT | 7.3 | SOFT | ISO 15712-1, Eq. E.4 |
| 4 | Rigid-T/soft | 3.43 | SOFT | 7.3 | SOFT | ISO 15712-1, Eq. E.4 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|---|
| **Separating Partition (190 mm concrete block)** | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-333, TLF-12-013 | | 58 | | |
| ΔSTC change by Lining on D | ΔR_D,w | No Lining , | | 0 | | |
| ΔSTC change by Lining on d | ΔR_d,w | No Lining , | | 0 | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 58 + MAX(0,0) + MIN(0,0)/2 = | | **58** | |
| | | | | | | |
| **Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor)** | | | | | | |
| Flanking Element F1: | | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_F1,w | RR-334, ΔTL-BLK( LW)-33, WFUR38_GFB38_G13 | | 7 | | |
| Flanking Element f1: | | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_f1,w | RR-334, ΔTL-BLK( LW)-33, WFUR38_GFB38_G13 | | 7 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 58/2 + MAX(7,0) + MIN(7,0)/2 + 7.3 + 6 = | | **68** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 6.8 + 10^- 9 ) = | | **68** | |
| | | | | | | |
| **Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F2: | | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_F2,w | RR-334, ΔTL-BLK( LW)-33, WFUR38_GFB38_G13 | | 7 | | |
| Flanking Element f2: | | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_f2,w | RR-334, ΔTL-BLK( LW)-33, WFUR38_GFB38_G13 | | 7 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 58/2 + MAX(7,0) + MIN(7,0)/2 + 5 + 7 = | | **67** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 6.7 + 10^- 9 ) = | | **67** | |
| | | | | | | |
| **Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab)** | | | | | | |
| Flanking Element F3: | | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_F3,w | RR-334, ΔTL-BLK( LW)-33, WFUR38_GFB38_G13 | | 7 | | |
| Flanking Element f3: | | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_f3,w | RR-334, ΔTL-BLK( LW)-33, WFUR38_GFB38_G13 | | 7 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | | 38/2 + 58/2 + MAX(7,0) + MIN(7,0)/2 + 7.3 + 6 = | | **68** | |
| **Flanking STC for path Df** | R_ Df,w | | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 6.8 + 10^- 9 ) = | | **68** | |
| | | | | | | |
| **Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F4: | | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_F4,w | RR-334, ΔTL-BLK( LW)-33, WFUR38_GFB38_G13 | | 7 | | |
| Flanking Element f4: | | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_f4,w | RR-334, ΔTL-BLK( LW)-33, WFUR38_GFB38_G13 | | 7 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 58/2 + MAX(7,0) + MIN(7,0)/2 + 7.3 + 7 = | | **69** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 6.9 + 10^- 9 ) = | | **69** | |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | **62** | |
| | | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | | **57** | |

**EXAMPLE 4.1.3-V3: (SIMPLIFIED METHOD)**

- **Rooms one-above-the-other**
- **Concrete floors and lightweight concrete block walls with rigid junctions except at top of non-loadbearing walls (Same structure as 4.1.3-V1, plus enhanced lining of walls)**

Separating floor/ceiling assembly with:
- concrete floor with mass 460 kg/m$^2$ (e.g. normal weight concrete with thickness of 200 mm) with no topping / flooring on top, or ceiling lining below.

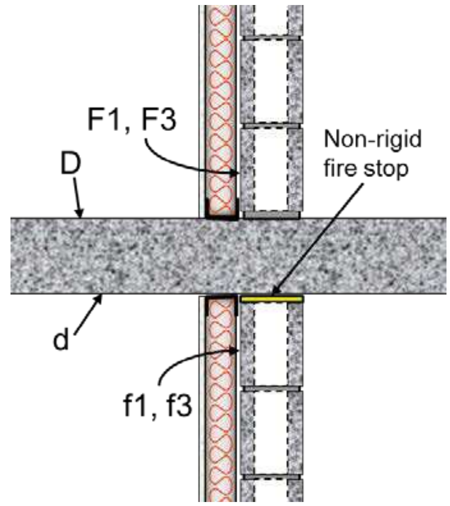
Junction 1, 3, 4: Cross Junction of separating floor / flanking wall with:
- rigid mortared T junction with concrete block wall assemblies above, soft joint with walls below
- wall above and below floor of one wythe of unsealed non-load-bearing concrete blocks with mass 134 kg/m$^2$ (e.g. 140 mm hollow blocks with lightweight aggregate[4])
- flanking walls lined with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c. with absorptive material[2] filling inter-stud cavities

Junction 2: T-Junction of separating floor / flanking wall with:
- rigid mortared junctions with concrete block wall assembly above, and soft joint (negligible transmission) to wall assembly below
- wall above and below floor of one wythe of unsealed non-load-bearing concrete blocks with mass 134 kg/m$^2$ (e.g. 140 mm hollow blocks with lightweight aggregate[4])
- flanking walls lined with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c. with absorptive material[2] filling inter-stud cavities

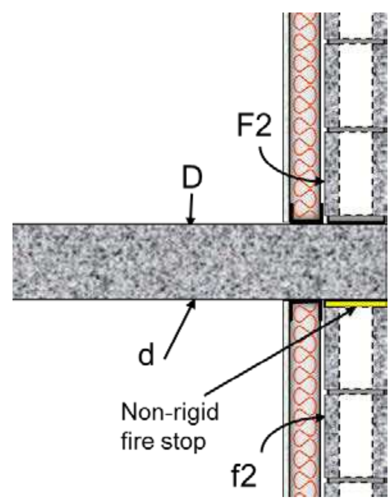
Acoustical Parameters:

| | | |
|---|---|---|
| For 140 mm lightweight concrete block walls: | | |
| Mass/unit area (kg/m$^2$ ) = | 134 | (Wall at junctions 1&3) |
| | 134 | (Wall at junctions 2&4) |
| For 200 mm concrete floor: | | |
| | Mass/unit area (kg/m$^2$ ) = | 460 |
| | | |
| | Separating partition area ( m$^2$ ) = | 20 |
| | Junction 1 and 3 length (m ) = | 5.0 |
| | Junction 2 and 4 length (m ) = | 4.0 |
| | 10*log(S_Partition/l_junction 1&3) = | 6.0 |
| | 10*log(S_Partition/l_junction2 &4) = | 7.0 |

**Illustration for this case**




Cross junction of separating floor of 200 mm thick concrete with 140 mm concrete block wall. (Side view of Junctions 1 or 3)




T-Junction of separating floor of 200 mm thick concrete with 140 mm concrete block wall. (Side view of Junction 2. Junction 4 has same lining details, but cross junction)

| Junction | | Mass ratio for Ff | Path Ff | Path Fd | Path Df | Reference |
|---|---|---|---|---|---|---|
| | | | Kij (in dB) = | | | |
| 1 | Rigid-T/soft | 3.43 | SOFT | 7.3 | SOFT | ISO 15712-1, Eq. E.4 |
| 2 | Rigid-Corner/soft | 3.43 | SOFT | 5.0 | SOFT | ISO 15712-1, Eq. E.9 |
| 3 | Rigid-T/soft | 3.43 | SOFT | 7.3 | SOFT | ISO 15712-1, Eq. E.4 |
| 4 | Rigid-T/soft | 3.43 | SOFT | 7.3 | SOFT | ISO 15712-1, Eq. E.4 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | Calculation | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|---|
| **Separating Partition (190 mm concrete block)** | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-333, TLF-12-013 | | 58 | | |
| ΔSTC change by Lining on D | ΔR_D,w | No Lining , | | 0 | | |
| ΔSTC change by Lining on d | ΔR_d,w | No Lining , | | 0 | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 58 + MAX(0,0) + MIN(0,0)/2 = | | **58** | |
| | | | | | | |
| **Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor)** | | | | | | |
| Flanking Element F1: | | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_F1,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| Flanking Element f1: | | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_f1,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 58/2 + MAX(15,0) + MIN(15,0)/2 + 7.3 + 6 = | | **76** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 7.6 + 10^- 9 ) = | | **76** | |
| | | | | | | |
| **Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F2: | | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_F2,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| Flanking Element f2: | | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_f2,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 58/2 + MAX(15,0) + MIN(15,0)/2 + 5 + 7 = | | **75** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 7.5 + 10^- 9 ) = | | **75** | |
| | | | | | | |
| **Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab)** | | | | | | |
| Flanking Element F3: | | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_F3,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| Flanking Element f3: | | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_f3,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | | 38/2 + 58/2 + MAX(15,0) + MIN(15,0)/2 + 7.3 + 6 = | | **76** | |
| **Flanking STC for path Df** | R_ Df,w | | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 7.6 + 10^- 9 ) = | | **76** | |
| | | | | | | |
| **Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F4: | | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_F4,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| Flanking Element f4: | | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_f4,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 58/2 + MAX(15,0) + MIN(15,0)/2 + 7.3 + 7 = | | **77** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 7.7 + 10^- 9 ) = | | **77** | |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | **70** | |
| | | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | | **58** | |

**EXAMPLE 4.1.3-V4: (SIMPLIFIED METHOD)**

- **Rooms one-above-the-other**
- **Concrete floors and lightweight concrete block walls with rigid junctions except at top of non-loadbearing walls (Same structure as 4.1.3-V1, with lining of walls & ceiling)**

Separating floor/ceiling assembly with:

- concrete floor with mass 460 kg/m$^2$ (e.g. normal weight concrete with thickness of 200 mm) with no topping / flooring on top
- ceiling lining below: 16 mm gypsum board[3] fastened to hat-channels supported on cross-channels hung on wires, cavity of 150 mm between concrete and ceiling, with 150 mm absorptive material[2]

Junction 1, 3, 4: Cross Junction of separating floor / flanking wall with:

- rigid mortared T junction with concrete block wall assemblies above the floor slab, soft joint with walls below
- wall above and below floor of one wythe of unsealed non-load-bearing concrete blocks with mass 134 kg/m$^2$ (e.g. 140 mm hollow blocks with lightweight aggregate[4])
- flanking walls lined with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c. with absorptive material[2] filling inter-stud cavities

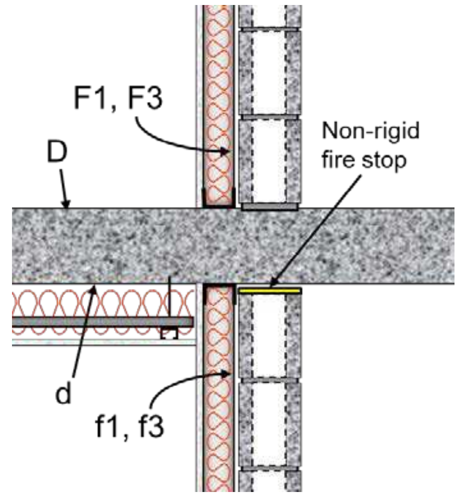
Junction 2: T-Junction of separating floor / flanking wall with:

- rigid mortared junctions with concrete block wall assembly above, and soft joint (negligible transmission) to wall assembly below
- wall above and below floor of one wythe of unsealed non-load-bearing concrete blocks with mass 134 kg/m$^2$ (e.g. 140 mm hollow blocks with lightweight aggregate[4])
- flanking walls lined with 13 mm gypsum board[3] on 65 mm non-loadbearing steel studs spaced 610 mm o.c. with absorptive material[2] filling inter-stud cavities

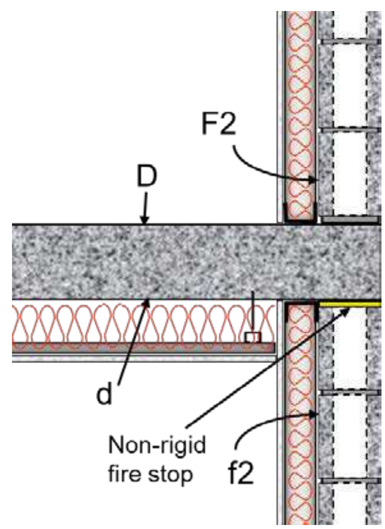
Acoustical Parameters:

| | | |
|---|---|---|
| For 140 mm lightweight concrete block walls: | | |
| Mass/unit area (kg/m$^2$) = | 134 | (Wall at junctions 1&3) |
| | 134 | (Wall at junctions 2&4) |
| For 200 mm concrete floor: | | |
| Mass/unit area (kg/m$^2$) = | | 460 |
| | | |
| Separating partition area (m$^2$) = | | 20 |
| Junction 1 and 3 length (m) = | | 5.0 |
| Junction 2 and 4 length (m) = | | 4.0 |
| 10*log(S_Partition/l_junction 1&3) = | | 6.0 |
| 10*log(S_Partition/l_junction2 &4) = | | 7.0 |

**Illustration for this case**




Cross junction of separating floor of 200 mm thick concrete with 140 mm concrete block wall. (Side view of Junctions 1 & 3)




T-Junction of separating floor of 200 mm thick concrete with 140 mm concrete block wall. (Side view of Junction 2. Junction 4 has same lining details, but cross junction)

| | | | Path Ff | Path Fd | Path Df | |
|---|---|---|---|---|---|---|
| **Junction** | | Mass ratio for Ff | Kij (in dB) = | | | Reference |
| 1 | Rigid-T/soft | 3.43 | SOFT | 7.3 | SOFT | ISO 15712-1, Eq. E.4 |
| 2 | Rigid-Corner/soft | 3.43 | SOFT | 5.0 | SOFT | ISO 15712-1, Eq. E.9 |
| 3 | Rigid-T/soft | 3.43 | SOFT | 7.3 | SOFT | ISO 15712-1, Eq. E.4 |
| 4 | Rigid-T/soft | 3.43 | SOFT | 7.3 | SOFT | ISO 15712-1, Eq. E.4 |

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|---|
| **Separating Partition (190 mm concrete block)** | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-333, TLF-12-013 | | 58 | | |
| ΔSTC change by Lining on D | ΔR_D,w | No Lining , | | 0 | | |
| ΔSTC change by Lining on d | ΔR_d,w | RR-333, ΔTLF-CON150-01, SUS150_GFB150_G16 | | 19 | | |
| **Direct STC in situ** | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 58 + MAX(0,19) + MIN(0,19)/2 = | | **77** | |
| | | | | | | |
| **Junction 1 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete floor)** | | | | | | |
| Flanking Element F1: | | | | | | |
| Laboratory STC for F1 | R_F1,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_F1,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| Flanking Element f1: | | | | | | |
| Laboratory STC for f1 | R_f1,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_f1,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 58/2 + MAX(15,19) + MIN(15,19)/2 + 7.3 + 6 = | | **88** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 8.8 + 10^- 9 ) = | | **84** | |
| | | | | | | |
| **Junction 2 (Rigid T-Junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F2: | | | | | | |
| Laboratory STC for F2 | R_F2,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_F2,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| Flanking Element f2: | | | | | | |
| Laboratory STC for f2 | R_f2,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_f2,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 58/2 + MAX(15,19) + MIN(15,19)/2 + 5 + 7 = | | **87** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 8.7 + 10^- 9 ) = | | **84** | |
| | | | | | | |
| **Junction 3 (Rigid-T/Soft Cross junction, 190 mm block separating wall / 150 mm concrete ceiling slab)** | | | | | | |
| Flanking Element F3: | | | | | | |
| Laboratory STC for F3 | R_F3,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_F3,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| Flanking Element f3: | | | | | | |
| Laboratory STC for f3 | R_f3,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_f3,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | | 38/2 + 58/2 + MAX(15,19) + MIN(15,19)/2 + 7.3 + 6 = | | **88** | |
| **Flanking STC for path Df** | R_ Df,w | | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 8.8 + 10^- 9 ) = | | **84** | |
| | | | | | | |
| **Junction 4 (Rigid T-junction, 190 mm block separating wall / 190 mm block flanking wall)** | | | | | | |
| Flanking Element F4: | | | | | | |
| Laboratory STC for F4 | R_F4,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_F4,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| Flanking Element f4: | | | | | | |
| Laboratory STC for f4 | R_f4,w | RR-334, Base BLK140(LW) | | 38 | | |
| ΔSTC change by Lining | ΔR_f4,w | RR-334, ΔTL-BLK( LW)-62, SS65_GFB65_G13 | | 15 | | |
| **Flanking STC for path Ff** | R_ Ff,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Flanking STC for path Fd** | R_ Fd,w | ISO 15712-1, Eq. 28a and 31 | 38/2 + 58/2 + MAX(15,19) + MIN(15,19)/2 + 7.3 + 7 = | | **89** | |
| **Flanking STC for path Df** | R_ Df,w | ISO 15712-1, Eq. 28a and 31 | Negligible transmission via fire stop | | **90** | (limit) |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-9 + 10^- 8.9 + 10^- 9 ) = | | **85** | |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | **78** | |
| | | | | | | |
| **ASTC due to Direct plus All Flanking Paths** | | Equation 1.1 of this Report | Combining Direct STC with 12 Flanking STC values | | **75** | |

**Summary for Section 4.1.3: Non-loadbearing Lightweight Concrete Block Walls with Concrete Floors**

The worked examples 4.1.3-H1 and 4.1.3-V1 illustrate the basic process for calculating the sound transmission between rooms in a building with bare non-loadbearing lightweight concrete masonry walls and concrete floors (i.e. without added gypsum board finish on the walls or ceiling, or flooring over the concrete slab). These examples differ from those of the preceding section mainly in the weight of the structural surfaces – the floors are heavier and the concrete block masonry walls are much lighter.

The Apparent Sound Transmission Class (ASTC) rating is lower than the STC rating of the separating assembly but the relative contributions of the direct transmission and the flanking transmission are quite different from those for normal weight concrete blocks in the preceding Section 4.1.2. For the side-by-side rooms, the direct transmission through the unsealed lightweight concrete block wall (STC 35) is clearly dominant in example 4.1.3-H1. For vertical transmission, the flanking paths involving the lightweight block walls are marginally dominant in 4.1.3-V1, giving an ASTC rating of 53.

**For the side-by-side pair of rooms**

The effect of added linings is shown in Examples 4.1.3-H2 to H4. It is clear that although the unsealed lightweight block starts from a low rating, good system performance can be achieved with the use of suitable linings. In specific examples:

- Adding a minimal lining (with ΔSTC=7) to all the wall surfaces raises the ASTC rating from 38 to 49.
- In example 4.1.3-H3, adding a better wall lining with ΔSTC=15 raises the ASTC rating to 61. Further improvement is limited by the transmission via the bare concrete surfaces of the floor and ceiling.

Significant further improvement in the ASTC rating requires the treatment of both the floor and ceiling surfaces – treating just the ceiling in example 4.1.3-H4 increases the ASTC rating by only 1 to 57, as the floor-floor and ceiling-ceiling paths have a Flanking STC in the low 60s. Hence, with the non-loadbearing junctions at the top of the concrete block walls, the addition of an effective floor treatment is essential for achieving a very high ASTC rating between side-by-side rooms. [More examples will be added when data from report RR-333 become available.]

**For one room above the other**

The effect of adding linings is shown in Examples 4.1.3-V2 to V4. The use of linings ranging from minimally performing to good changes the dominant transmission path such that:

- The effect of a minimal lining on the flanking walls with ΔSTC=7 raises the ASTC rating from 53 to 57 as shown in Example 4.1.3-V2.
- With a better lining in Example 4.1.3-V3, the direct transmission through the separating floor/ceiling becomes the dominant path, and the ASTC rating reaches its limit of 58 due to the Direct Path.
- This limitation is eased by adding a gypsum board ceiling with sound absorptive material in the cavity under the concrete ceiling slab, which raises the STC rating of the direct path from 58 to 77 and raises the ASTC to 75, as shown in example 4.1.2-V4. A good floor lining could add even more.

With effective ceiling and flanking wall linings in place, as shown in example 4.1.3-V4, a very good system performance of ASTC 75 is possible.

## 4.2 Scenarios for Concrete Block Walls with Wood-Framed Floors and Walls

This section presents the calculation approach for buildings that combine lightweight wood-framed assemblies (walls and floors) with walls of normal weight or lightweight concrete blocks. The transmission of structure-borne vibration in a building with wood-framed assemblies differs markedly from that in heavy homogeneous structures of masonry and concrete.

- For direct transmission through the separating lightweight framed assembly, the high internal loss factors of the wood-framed assembly result in minimal dependence on the connections to the adjoining structures, so laboratory measured sound transmission values are used without adjustment.
- For flanking paths where one or both of the assemblies is wood-framed, a different approach is required than was presented in earlier sections of this Report. The calculation process is very simple, but it requires a “new” type of laboratory test data – the flanking transmission loss measured according to ISO 10848-3.
- Linings on the concrete block surfaces (either for direct or flanking transmission) may be treated using a simple additive correction ΔSTC as in Section 4.1.

An experimental study of such systems was performed at the NRC, as described in Chapter 3 of this Report, and results from this study were used for the examples in this section.

**The Calculation Process** requires specific laboratory test data, but can be performed using single-number ratings following the steps illustrated in Figure 4.2.1, and explained in detail below.

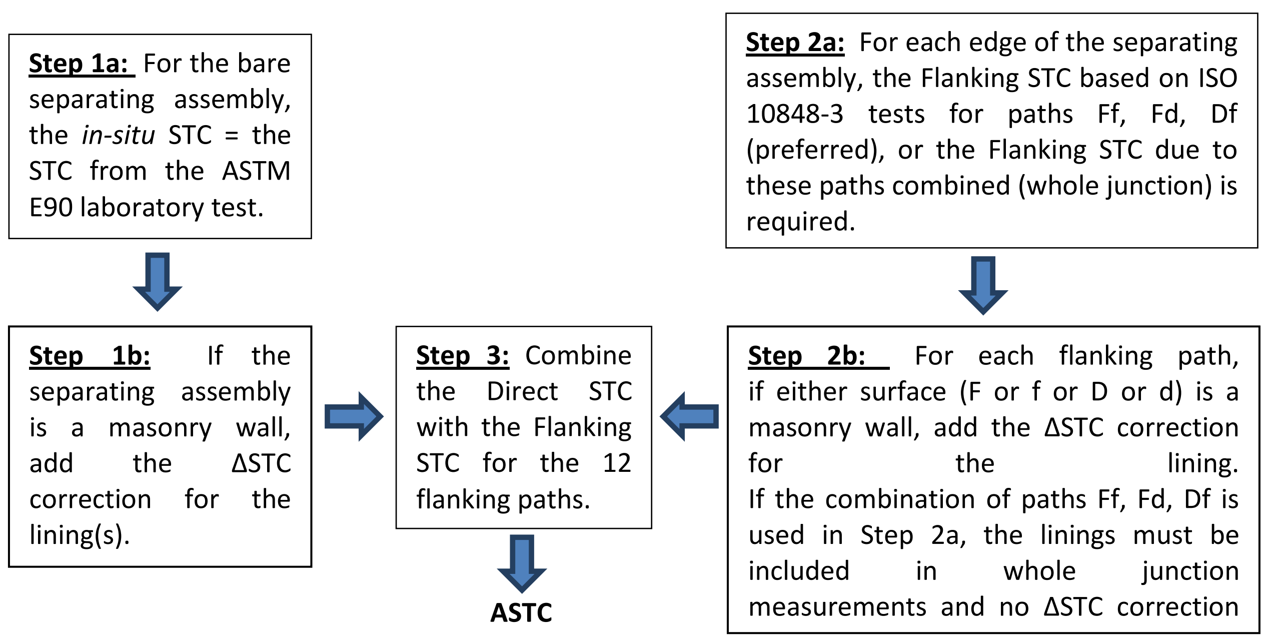



**Figure 4.2.1**: Steps to calculate the ASTC rating for lightweight framed construction (as detailed below)

Step 1: (a) For the bare separating assembly, the in-situ STC rating is equal to the STC rating measured in the laboratory according to ASTM E90.

(b) If the separating assembly is a masonry wall, add the ΔSTC correction for lining(s) on the source room and/or receiving room surfaces (D and d) to obtain the Direct STC rating. This procedure matches that of Section 4.1. (If there are two linings, one on each side, the correction equals the larger of the two lining corrections plus half of the lesser one. See Eq. 4.2.2.)

Step 2: (a) Determine the Flanking STC rating for the 3 flanking paths Ff, Fd and Df at each edge of the separating assembly. Values measured in accordance with ISO 10848-3 should be renormalized by applying Equation 4.2.1. If only the Flanking STC for combined transmission by the set of 3 paths at a junction is available, that data may be used. If both flanking surfaces F and f are concrete masonry walls, the Flanking STC for path Ff may either be taken from measurement according to ISO 10848-3, or calculated using the assembly STC rating and the vibration reduction index (measured or calculated) as in Section 4.1.

(b) If one surface for a flanking path (source room or receiving room) is a masonry wall, add the ΔSTC correction for any lining added to the masonry surface, to obtain the Flanking STC for that path. If both flanking surfaces are masonry walls with linings, the correction equals the larger of the two lining ΔSTC corrections plus half of the lesser one. See Eq. 4.2.3.

Step 3: Combine the transmission via the direct path and 12 flanking paths using Equation 1.2 from Section 1.4 of this Report (equivalent to Eq. 26 in Section 4.4 of ISO 15712-1), as follows:

- If the Flanking STC rating calculated for any flanking path is over 90, set the value to 90.
- Round the final ASTC result to the nearest integer.

**<u>Using measured values of Flanking TL or Normalised Flanking Level Difference</u>** : Where values measured according to ISO 10848-3 are to be converted into Flanking STC for these calculations, they must be re-normalized to reflect the differences between the laboratory test situation and the prediction scenario. This applies to laboratory results expressed as the Flanking TL or to the Normalised Flanking Level Difference ($\mathrm{D}_{n,f}$). The expressions to use in the calculation are:

$$\text{Flanking TL}_{ij} = \mathrm{D}_{n,f}(\text{lab}) + 10\log(S_{situ}/10) + 10\log\left(l_{lab}/l_{ij}\right) \text{ in dB} \qquad \text{Eq. 4.2.1}$$

$$\text{Flanking TL}_{ij} = \text{Flanking TL (lab)} + 10\log(S_{situ}/S_{lab}) + 10\log\left(l_{lab}/l_{ij}\right) \text{ in dB}$$

where:

- The indices *i* and *j* refer to the coupled flanking elements; thus, "*i*" can either be "D" or "F" and "*j*" can be "f" or "d"
- The term, $S_{situ}$ is the area (in $m^2$) of the separating assembly in the prediction scenario
- $l_{ij}$ is the length (in m) of the junction between elements *i* and *j* for the prediction scenario
- $S_{lab}$ and $l_{lab}$ are the corresponding values for the specimen in the ISO 10848 laboratory test
- The corresponding $\text{Flanking STC}_{ij}$ can be determined from the 1/3-octave values of the $\text{Flanking TL}_{ij}$ using the procedure described in ASTM E413

**<u>Expressing the Process using Equations:</u>**

Following from Eq. 1.2 of this Report and Eq. 26 of ISO 15712-1:2005, the ASTC value between two rooms (neglecting sound that is by-passing the building structure, e.g. leaks, ducts,…) is estimated according to the Simplified Method as the logarithmic expression of the Direct STC rating ($\text{STC}_{Dd}$) of the separating wall or floor element and the sum of the Flanking STC ratings of the three flanking paths for every junction at the four edges of the separating element (as shown in Fig. 1.5) such that:

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

Eq. 1.1 is appropriate for all types of building systems with the room geometry of the Standard Scenario, and is applied here using the following expressions to calculate the sound transmission for each path:

(a) In this adaptation of the Simplified Method, the Apparent Sound Transmission Class (ASTC) is substituted for the ATL in Eq. 1.1.

(b) The direct path $STC_{Dd}$ is obtained from the laboratory measured STC rating of the bare element and the ΔSTC changes due to linings on source "D" and/or receiving side "d" of the separating assembly such that:

$$STC_{Dd} = STC_{lab} + max(\Delta STC_D, \Delta STC_d) + \frac{min(\Delta STC_D, \Delta STC_d)}{2}$$

(c) The calculation of the $\mathrm{Flanking\,STC}_{ij}$ for each flanking path depends on the constructions involved. Here, indices *i* and *j* refer to the coupled flanking elements, where "*i*" can either be "D" or "F" and "*j*" can be "f" or "d". The options include:

- In all cases, values of $\mathrm{D}_{n,f}$ or $\mathrm{Flanking\,TL}$ measured according to ISO 10848-3 may be used after normalization to determine the Flanking STC. Alternatively, if both flanking elements F and f are concrete masonry wall assemblies, then Eq. 4.1.3 of Section 4.1 could be used to determine the $\mathrm{Flanking\,STC}_{Ff}$,
- If one or both of the flanking elements is a concrete masonry wall, then Eq. 4.2.2 should be used to add the correction due to any linings, using ΔSTC = 0 for a lightweight framed assembly because lining corrections are not appropriate for framed assemblies.

$$STC_{Dd} = STC_{lab} + max(\Delta STC_D, \Delta STC_d) + \frac{min(\Delta STC_D, \Delta STC_d)}{2} \qquad \text{Eq. 4.2.2}$$

**The worked examples** present all of the pertinent physical characteristics of the assemblies and junctions, including references for the sources of the laboratory test data. All of the examples conform to the Standard Scenario presented in Section 1.2 of this Report. The calculations were performed following the steps presented near the beginning of Section 4.2 (See Figure 4.2.1).

Under the heading "STC, ΔSTC", the examples present input data values which were determined by applying the calculation process of ASTM E413 to laboratory test data of several types:

- STC values measured in the laboratory according to ASTM E90 for the sound transmission loss of wall or floor assemblies
- ΔSTC values calculated from ASTM E90 measurements of the change in sound transmission due to adding a given lining to the specified wall or floor assembly. (See pages 14-16.)
- Flanking STC values measured according to ISO 10848 for a specific set of flanking surfaces.

Under the heading "ASTC", the examples present the values calculated for transmission via specific paths (the Direct STC value for in-situ transmission loss of the separating wall or floor assembly and the Flanking STC for the set of paths at each junction) plus the overall Apparent STC (ASTC) value for the combination of direct and flanking transmission via all paths. Each is rounded to the nearest integer, for consistency with the normal presentation of STC ratings.

**EXAMPLE 4.2-H1: (SIMPLIFIED METHOD)**

- **Rooms side-by-side**
- **Separating wall of normal weight concrete block with wood-framed flanking floors and walls**

Separating wall assembly with:
- one wythe of reinforced concrete blocks with mass 238 kg/m$^2$ (e.g. 190 mm hollow blocks with normal weight aggregate[1], with reinforcing steel and grout-filled cells at 1220 mm o.c.)
- no lining of separating concrete block walls

Bottom Junction 1 (separating wall and floor) with:
- 2 x10 (38 mm x 235 mm) wood ledger plate on each side, fastened through with 16 mm diameter bolts spaced 406 mm o.c.
- cells in concrete blocks between ledger plates are filled with grout
- floor framed with 38 mm x 235 mm wood joists spaced 406 mm o.c., with joists oriented perpendicular to separating (loadbearing) wall and supported from ledger plates on joist hangers, with 150 mm thick absorptive material[2] in the inter-joist cavities
- floor deck of 16 mm oriented strand board (OSB) fastened to joists on floor surfaces F1 and f1
- no floor finish or floor topping

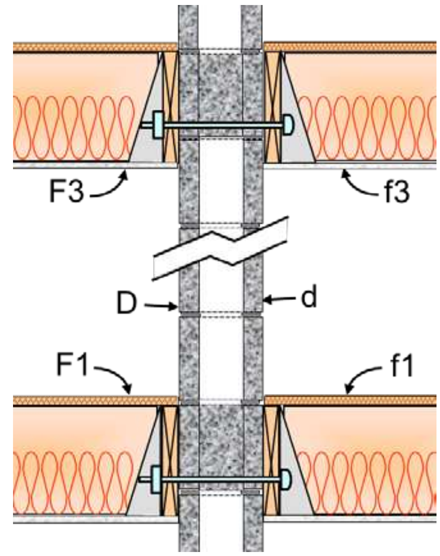
Top Junction 3 (separating wall and ceiling) with:
- ceiling framed with wood joists (same details as bottom junction)
- ceiling with 1 layer of 13 mm gypsum board[3] fastened directly to bottom of floor framing on each side

Side Junctions 2 or 4 (separating wall and abutting side walls) with:
- flanking side walls framed with 38 mm x 89 mm wood studs spaced 406 mm o.c., with 89 mm sound-absorptive material[2] in inter-stud cavities
- side wall framing is not continuous across the junction, and is connected with approved fasteners to the separating concrete block wall which has grout-filled cells at the junction
- 13 mm gypsum board[3] on the side walls ends at separating wall assembly and is attached directly to wall framing

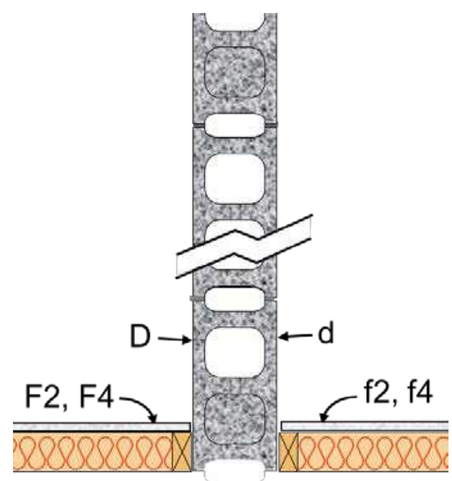
Note: For path/surface designations in the procedure below, treat the room on the left as the source room (surfaces D and F)

| | In Scenario | In Laboratory |
|---|---|---|
| Separating partition area ( m$^2$ ) = | 12.5 | 10.4 |
| Floor/separating wall junction length (m ) = | 5.0 | 4.6 |
| Wall/separating wall junction length (m ) = | 2.5 | 2.26 |
| | | |
| **Normalization For Junctions 1 and 3:** | | |
| 10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) = | 0.44 | RR-334, Eq. 4.2.1 |
| | | |
| **Normalization For Junctions 2 & 4:** | | |
| 10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) = | 0.36 | RR-334, Eq. 4.2.1 |

**Illustration for this case**




Junction 1 & 3 of loadbearing separating concrete block wall with wood-framed flanking floor and ceiling. (Side view)




Junction 2 or 4 of separating concrete block wall with abutting side walls, with side walls' framing and gypsum board terminating at separating wall (Plan view)

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | | STC, Δ_STC | ASTC |
|---|---|---|---|---|---|
| **Separating Partition (190 mm concrete block)** | | | | | |
| Laboratory STC for Dd | R_s,w | RR-334, NRC-Mean BLK190(NW) | | 49 | |
| ΔSTC change by Lining on D | ΔR_D,w | No Lining , | | 0 | |
| ΔSTC change by Lining on d | ΔR_d,w | No Lining , | | 0 | |
| Direct STC in situ | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 49 + MAX(0,0) + MIN(0,0)/2 = | | 49 |
| | | | | | |
| **Junction 1 (Cross junction, 190 mm block separating wall / Wood joist floor)** | | | | | |
| For Flanking Path Ff_1: | | | | | |
| Laboratory Flanking STC | | R334, BLK190-WF-LB-01 | | 59 | |
| **Flanking STC for path Ff_1** | R_Ff,w | ISO 15712-1, Eq. 28 | | 59 + 0.44 = | **59** |
| For Flanking Path Fd_1: | | | | | |
| Laboratory Flanking STC | R_Fd,w | R334, BLK190-WF-LB-01 | | 59 | |
| ΔSTC change by Lining on d | ΔR_d,w | No Lining , | | 0 | |
| **Flanking STC for path Fd_1** | R_ Fd,w | ISO 15712-1, Eq. 28 | | 59 + 0 + 0.44 = | **59** |
| For Flanking Path Df_1: | | | | | |
| Laboratory Flanking STC | R_Df,w | R334, BLK190-WF-LB-01 | | 59 | |
| ΔSTC change by Lining on D | ΔR_D,w | No Lining , | | 0 | |
| **Flanking STC for path Fd_1** | R_ Df,w | ISO 15712-1, Eq. 28 | | 59 + 0 + 0.44 = | **59** |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-5.9 + 10^- 5.9 + 10^- 5.9 ) = | | **54** |
| | | | | | |
| **Junction 2 (T-Junction, 190 mm block separating wall / wood stud flanking wall)** | | | | | |
| For Flanking Path Ff_2: | | | | | |
| Laboratory Flanking STC | | R334, BLK190-WW-LB-01 | | 81 | |
| **Flanking STC for path Ff_2** | R_Ff,w | ISO 15712-1, Eq. 28 | | 81 + 0.36 = | **81** |
| For Flanking Path Fd_2: | | | | | |
| Laboratory Flanking STC | R_Fd,w | R334, BLK190-WW-LB-01 | | 71 | |
| ΔSTC change by Lining on d | ΔR_d,w | No Lining , | | 0 | |
| **Flanking STC for path Fd_2** | R_ Fd,w | ISO 15712-1, Eq. 28 | | 71 + 0 + 0.36 = | **71** |
| For Flanking Path Df_2: | | | | | |
| Laboratory Flanking STC | R_Df,w | R334, BLK190-WW-LB-01 | | 71 | |
| ΔSTC change by Lining on D | ΔR_D,w | No Lining , | | 0 | |
| **Flanking STC for path Fd_2** | R_ Df,w | ISO 15712-1, Eq. 28 | | 71 + 0 + 0.36 = | **71** |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-8.1 + 10^- 7.1 + 10^- 7.1 ) = | | **68** |
| | | | | | |
| **Junction 3 (Cross junction, 190 mm block separating wall / Wood joist ceiling)** | | | | | |
| For Flanking Path Ff_3: | | | | | |
| Laboratory Flanking STC | | R334, BLK190-WC-LB-01 | | 65 | |
| **Flanking STC for path Ff_3** | R_Ff,w | ISO 15712-1, Eq. 28 | | 65 + 0.44 = | **65** |
| For Flanking Path Fd_3: | | | | | |
| Laboratory Flanking STC | R_Fd,w | R334, BLK190-WC-LB-01 | | 65 | |
| ΔSTC change by Lining on d | ΔR_d,w | No Lining , | | 0 | |
| **Flanking STC for path Fd_3** | R_ Fd,w | ISO 15712-1, Eq. 28 | | 65 + 0 + 0.44 = | **65** |
| For Flanking Path Df_3: | | | | | |
| Laboratory Flanking STC | R_Df,w | R334, BLK190-WC-LB-01 | | 65 | |
| ΔSTC change by Lining on D | ΔR_D,w | No Lining , | | 0 | |
| **Flanking STC for path Fd_3** | R_ Df,w | ISO 15712-1, Eq. 28 | | 65 + 0 + 0.44 = | **65** |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.5 + 10^- 6.5 + 10^- 6.5 ) = | | **60** |
| | | | | | |
| **Junction 4 (T-Junction, 190 mm block separating wall / wood stud flanking wall)** | | | | | |
| All values the same as for Junction_2 | | | | | |
| **Flanking STC for path Ff_4** | R_Ff,w | Same as for Ff_2 | | + 0.36 = | **81** |
| **Flanking STC for path Fd_4** | R_ Fd,w | Same as for Fd_2 | | + 71 + 0.36 = | **71** |
| **Flanking STC for path Fd_4** | R_ Df,w | Same as for Df_2 | | + 71 + 0.36 = | **71** |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-8.1 + 10^- 7.1 + 10^- 7.1 ) = | | **68** |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | **53** |
| | | | | | |
| **ASTC due to Direct plus Total Flanking** | | Equation 1.1 | Combining Direct STC with 12 Flanking STC values | | **48** |

**EXAMPLE 4.2-H2: (SIMPLIFIED METHOD)**

- **Rooms side-by-side**
- **Separating wall of normal weight concrete block with wood-framed flanking floors and walls (Same structure as Example 4.2.1, plus linings)**

Separating wall assembly with:

- one wythe of reinforced concrete blocks with mass 238 kg/m$^2$ (e.g. 190 mm hollow blocks with normal weight aggregate[1], with reinforcing steel and grout-filled cells at 1220 mm o.c.)
- concrete block assembly lined on each side by 1 layer of 13 mm gypsum board[3] supported on 41 mm steel studs that are not in contact with the concrete blocks and are spaced 610 mm o.c., with absorptive material[2] filling the inter-stud cavities

Bottom Junction 1 (separating wall and floor) with:

- 2 x10 (38 x 235 mm) wood ledger plate on each side, fastened through with 16 mm diameter bolts spaced 406 mm o.c.
- cells in concrete blocks between ledger plates are filled with grout
- floor framed with 38 x 235 mm wood joists spaced 406 mm o.c., with joists oriented perpendicular to separating (loadbearing)wall and supported from ledger plates on joist hangers, with 150 mm thick absorptive material[2] in the inter-joist cavities
- floor deck of 16 mm oriented strand board (OSB) fastened to joists on floor surfaces F1 and f1
- no floor finish or floor topping

Top Junction 3 (separating wall and ceiling) with:

- ceiling framed with wood joists (same details as bottom junction)
- ceiling with one layer of 13 mm gypsum board[3] fastened directly to bottom of floor framing on each side

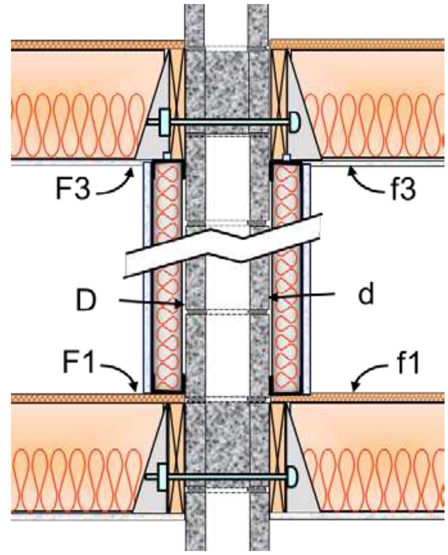
Side Junctions 2 or 4 (separating wall and abutting side walls) with:

- flanking side walls framed with 38 mm x 89 mm wood studs spaced 406 mm o.c., with 89 sound-absorptive material[2] filling the inter-stud cavities
- side wall framing is not continuous across the junction, and is connected with approved fasteners to the separating concrete block wall which has grout-filled cells at the junction
- 13 mm gypsum board[3] on the side walls ends at separating wall assembly and is attached directly to wall framing

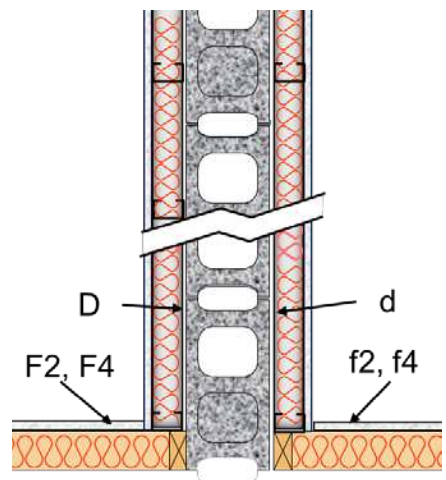
Note: For path/surface designations in the procedure below, treat the room at left as the source room (surfaces D and F)

| | In Scenario | In Laboratory |
|---|---|---|
| Separating partition area ( m$^2$ ) = | 12.5 | 10.4 |
| Floor/separating wall junction length (m ) = | 5.0 | 4.6 |
| Wall/separating wall junction length (m ) = | 2.5 | 2.26 |
| | | |
| **Normalization For Junctions 1 and 3:** | | |
| 10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) = | 0.44 | RR-334, Eq. 4.2.1 |
| | | |
| **Normalization For Junctions 2 & 4:** | | |
| 10*log(S_situ/S_lab) + 10*log(l_lab/l_situ) = | 0.36 | RR-334, Eq. 4.2.1 |

**Illustration for this case**




Junction 1 & 3 of loadbearing separating concrete block wall with wood-framed flanking floor and ceiling. (Side view)




Junction 2 or 4 of separating concrete block wall with abutting side walls, with side walls' framing and gypsum board terminating at separating wall (Plan view)

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | STC, Δ_STC | ASTC |
|---|---|---|---|---|
| **Separating Partition (190 mm concrete block)** | | | | |
| Laboratory STC for Dd | R_s,w | RR-334, NRC-Mean BLK190(NW) | 49 | |
| ΔSTC change by Lining on D | ΔR_D,w | RR-334, ΔTL-BLK(NW)-42 | 9.0 | |
| ΔSTC change by Lining on d | ΔR_d,w | RR-334, ΔTL-BLK(NW)-42 | 9.0 | |
| Direct STC in situ | R_Dd,w | ISO 15712-1, Eq. 24 and 30 | 49 + MAX(9,9) + MIN(9,9)/2 = | 63 |
| | | | | |
| **Junction 1 (Cross junction, 190 mm block separating wall / Wood joist floor)** | | | | |
| For Flanking Path Ff_1: | | | | |
| Laboratory Flanking STC | | R334, BLK190-WF-LB-01 | 59 | |
| **Flanking STC for path Ff_1** | R_Ff,w | ISO 15712-1, Eq. 28 | 59 + 0.44 = | **59** |
| For Flanking Path Fd_1: | | | | |
| Laboratory Flanking STC | R_Fd,w | R334, BLK190-WF-LB-01 | 59 | |
| ΔSTC change by Lining on d | ΔR_d,w | RR-334, ΔTL-BLK(NW)-42 | 9 | |
| **Flanking STC for path Fd_1** | R_ Fd,w | ISO 15712-1, Eq. 28 | 59 + 9 + 0.44 = | **68** |
| For Flanking Path Df_1: | | | | |
| Laboratory Flanking STC | R_Df,w | R334, BLK190-WF-LB-01 | 59 | |
| ΔSTC change by Lining on D | ΔR_D,w | RR-334, ΔTL-BLK(NW)-42 | 9 | |
| **Flanking STC for path Fd_1** | R_ Df,w | ISO 15712-1, Eq. 28 | 59 + 9 + 0.44 = | **68** |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-5.9 + 10^- 6.8 + 10^- 6.8 ) = | **58** |
| | | | | |
| **Junction 2 (T-Junction, 190 mm block separating wall / wood stud flanking wall)** | | | | |
| For Flanking Path Ff_2: | | | | |
| Laboratory Flanking STC | | R334, BLK190-WW-LB-01 | 81 | |
| **Flanking STC for path Ff_2** | R_Ff,w | ISO 15712-1, Eq. 28 | 81 + 0.36 = | **81** |
| For Flanking Path Fd_2: | | | | |
| Laboratory Flanking STC | R_Fd,w | R334, BLK190-WW-LB-01 | 71 | |
| ΔSTC change by Lining on d | ΔR_d,w | RR-334, ΔTL-BLK(NW)-42 | 9 | |
| **Flanking STC for path Fd_2** | R_ Fd,w | ISO 15712-1, Eq. 28 | 71 + 9 + 0.36 = | **80** |
| For Flanking Path Df_2: | | | | |
| Laboratory Flanking STC | R_Df,w | R334, BLK190-WW-LB-01 | 71 | |
| ΔSTC change by Lining on D | ΔR_D,w | RR-334, ΔTL-BLK(NW)-42 | 9 | |
| **Flanking STC for path Fd_2** | R_ Df,w | ISO 15712-1, Eq. 28 | 71 + 9 + 0.36 = | **80** |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-8.1 + 10^- 8 + 10^- 8 ) = | **76** |
| | | | | |
| **Junction 3 (Cross junction, 190 mm block separating wall / Wood joist ceiling)** | | | | |
| For Flanking Path Ff_3: | | | | |
| Laboratory Flanking STC | | R334, BLK190-WC-LB-01 | 65 | |
| **Flanking STC for path Ff_3** | R_Ff,w | ISO 15712-1, Eq. 28 | 65 + 0.44 = | **65** |
| For Flanking Path Fd_3: | | | | |
| Laboratory Flanking STC | R_Fd,w | R334, BLK190-WC-LB-01 | 65 | |
| ΔSTC change by Lining on d | ΔR_d,w | RR-334, ΔTL-BLK(NW)-42 | 9 | |
| **Flanking STC for path Fd_3** | R_ Fd,w | ISO 15712-1, Eq. 28 | 65 + 9 + 0.44 = | **74** |
| For Flanking Path Df_3: | | | | |
| Laboratory Flanking STC | R_Df,w | R334, BLK190-WC-LB-01 | 65 | |
| ΔSTC change by Lining on D | ΔR_D,w | RR-334, ΔTL-BLK(NW)-42 | 9 | |
| **Flanking STC for path Fd_3** | R_ Df,w | ISO 15712-1, Eq. 28 | 65 + 9 + 0.44 = | **74** |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.5 + 10^- 7.4 + 10^- 7.4 ) = | **64** |
| | | | | |
| **Junction 4 (T-Junction, 190 mm block separating wall / wood stud flanking wall)** | | | | |
| All values the same as for Junction_2 | | | | |
| **Flanking STC for path Ff_4** | R_Ff,w | All values the same as for Junction_2 | | **81** |
| **Flanking STC for path Fd_4** | R_ Fd,w | All values the same as for Junction_2 | | **80** |
| **Flanking STC for path Fd_4** | R_ Df,w | All values the same as for Junction_2 | | **80** |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-8.1 + 10^- 8 + 10^- 8 ) = | **76** |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | **57** |
| | | | | |
| **ASTC due to Direct plus Total Flanking** | | Equation 1.1 | Combining Direct STC with 12 Flanking STC values | **56** |

**EXAMPLE 4.2-V1: (SIMPLIFIED METHOD)**

- **Rooms one-above-the-other**
- **Separating wood-framed floor assembly with joists perpendicular to flanking walls of concrete block and parallel to wood-framed flanking walls**

Separating floor/ceiling assembly with:
- floor framed with 38 mm x 235 mm wood joists spaced 406 mm o.c., with joists oriented perpendicular to separating (loadbearing) wall with 150 mm thick absorptive material[2] in the inter-joist cavities
- ceiling of 2 layers of 16 mm fire-rated gypsum board[3], attached to resilient metal channels[3] spaced 406 mm o.c.
- subfloor of oriented strand board (OSB) 16 mm thick
- no floor topping and no floor finish

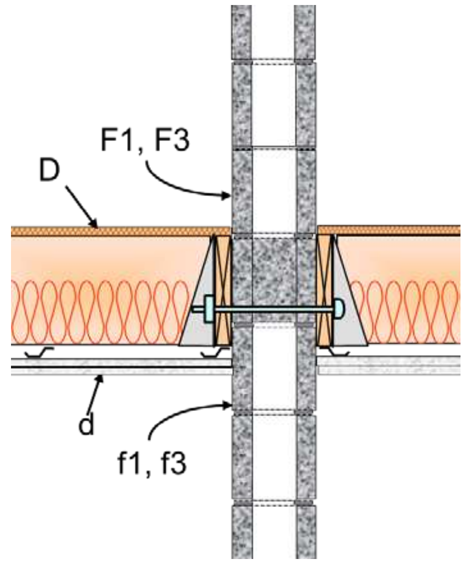
Junction 1 or 3 with loadbearing walls above and below floor with:
- one wythe of reinforced concrete blocks with mass 238 kg/m$^2$ (e.g. 190 mm hollow blocks with normal weight aggregate[1], with reinforcing steel and grout-filled cells at 1220 mm o.c.)
- 2 x 10 (38 x 235 mm) wood ledger plate on each side of concrete blocks, fastened through with 16 mm diameter bolts spaced 406 mm o.c. and floor joists supported on joist hangers attached to ledger plates
- cells in concrete blocks between ledger plates are filled with grout
- no lining on concrete block walls

Junction 2 or 4 with non-loadbearing walls above and below floor with:
- joists of floor assembly parallel to these walls
- 38 mm x 89 mm wood studs spaced 406 mm o.c. with several 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)
- Inter-stud cavities with or without absorptive material[2] (equivalent flanking)
- single layer of 13 mm gypsum board[3] that ends at floor/ceiling assembly; and is attached directly to wall framing

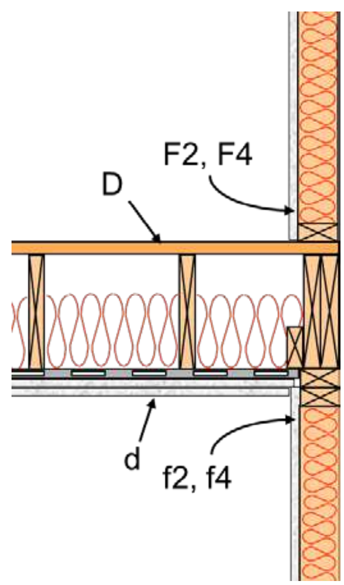
Note: For path/surface designations in the procedure below, treat the upper room as the source room (surfaces D and F)

| | In Scenario | In Laboratory |
|---|---|---|
| Separating partition area ( m$^2$ ) = | 20 | 19.6 |
| Floor/separating wall junction length (m ) = | 5.0 | 4.58 |
| Wall/separating wall junction length (m ) = | 4.0 | 4.58 |
| | | |
| **Normalization For Junctions 1 and 3:** | | |
| $10*\log(S_{situ}/S_{lab}) + 10*\log(l_{lab}/l_{situ})$ = | -0.29 | RR-334, Eq. 4.2.1 |
| | | |
| **Normalization For Junctions 2 & 4:** | | |
| $10*\log(S_{situ}/S_{lab}) + 10*\log(l_{lab}/l_{situ})$ = | 0.68 | RR-334, Eq. 4.2.1 |

**Illustration for this case**




Junction 1 and 3 of separating wood-framed floor / ceiling assembly with loadbearing flanking concrete block wall. (Side view)




Junction 2 or 4 of separating wood-framed floor/ceiling assembly with abutting side walls, with side walls' framing and gypsum board terminating at framing of separating floor. (Side view)

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | | STC, Δ_STC | ASTC | |
|---|---|---|---|---|---|---|
| Separating partition (wood joist floor) | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-336, WJ235-02 | | 53 | | |
| Direct STC in situ | R_Dd,w | No adjustment, ISO 15712-1, 4.2.2 | | | | 53 |
| | | | | | | |
| Junction 1 (Cross junction, Concrete block flanking wall / Wood joist separating floor) | | | | | | |
| For Flanking Path Ff_1: | | | | | | |
| Laboratory Flanking STC | R_s,w | RR-334, WJ235-FW-LB-02 | | 59 | | |
| ΔSTC change by Lining on F | ΔR_F,w | No Lining , | | 0 | | |
| ΔSTC change by Lining on f | ΔR_f,w | No Lining , | | 0 | | |
| Normalization correction | | ISO 15712-1, Eq.28a | | -0.3 | | |
| **Flanking STC for path Ff_1** | R_Ff,w | ISO 15712-1, Eq. 28 | 59 + MAX(0,0) + MIN(0,0)/2 + -0.29 = | | **59** | |
| For Flanking Path Fd_1: | | | | | | |
| Laboratory Flanking STC | R_Fd,w | RR-334, WJ235-FW-LB-02 | | 73 | | |
| ΔSTC change by Lining on F | ΔR_d,w | No Lining , | | 0 | | |
| **Flanking STC for path Fd_1** | R_ Fd,w | ISO 15712-1, Eq. 28 | 73 + 0 + -0.29 = | | **73** | |
| For Flanking Path Df_1: | | | | | | |
| Laboratory Flanking STC | R_Df,w | RR-334, WJ235-FW-LB-02 | | 67 | | |
| ΔSTC change by Lining on f | ΔR_D,w | No Lining , | | 0 | | |
| **Flanking STC for path Fd_1** | R_ Df,w | ISO 15712-1, Eq. 28 | 67 + 0 + -0.29 = | | **67** | |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-5.9 + 10^- 7.3 + 10^- 6.7 ) = | | **58** | |
| | | | | | | |
| Junction 2 (T-Junction, Wood stud flanking wall / Wood joist separating floor) | | | | | | |
| For Flanking Path Ff_2: | | | | | | |
| Laboratory Flanking STC | | R336, WJ235-VF_NLB-02 | | 63 | | |
| **Flanking STC for path Ff_2** | R_Ff,w | ISO 15712-1, Eq. 28 | 63 + 0.68 = | | **64** | |
| For Flanking Path Fd_2: | | | | | | |
| Laboratory Flanking STC | R_Fd,w | R336, WJ235-VF_NLB-02 | | 80 | | |
| **Flanking STC for path Fd_2** | R_ Fd,w | ISO 15712-1, Eq. 28 | 80 + 0.68 = | | **81** | |
| For Flanking Path Df_2: | | | | | | |
| Laboratory Flanking STC | R_Df,w | R336, WJ235-VF_NLB-02 | | 60 | | |
| **Flanking STC for path Fd_2** | R_ Df,w | ISO 15712-1, Eq. 28 | 60 + 0.68 = | | **61** | |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.4 + 10^- 8.1 + 10^- 6.1 ) = | | **59** | |
| | | | | | | |
| Junction 3 (Cross junction, Concrete block flanking wall / Wood joist separating floor) | | | | | | |
| **Flanking STC for path Ff_3** | R_Ff,w | Same as for Ff_1 | 59 + MAX(0,0) + MIN(0,0)/2 + -0.29 = | | **59** | |
| **Flanking STC for path Fd_3** | R_ Fd,w | Same as for Fd_1 | 73 + 0 + -0.29 = | | **73** | |
| **Flanking STC for path Fd_3** | R_ Df,w | Same as for Df_1 | 67 + 0 + -0.29 = | | **67** | |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-5.9 + 10^- 7.3 + 10^- 6.7 ) = | | **58** | |
| | | | | | | |
| Junction 4 (Cross-Junction, Wood stud flanking wall / Wood joist separating floor) | | | | | | |
| All values the same as for Junction 2 | | | | | | |
| **Flanking STC for path Ff_4** | R_Ff,w | Same as for Ff_2 | 63 + 0.68 = | | **64** | |
| **Flanking STC for path Fd_4** | R_ Fd,w | Same as for Fd_2 | 80 + 0.68 = | | **81** | |
| **Flanking STC for path Fd_4** | R_ Df,w | Same as for Df_2 | 60 + 0.68 = | | **61** | |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.4 + 10^- 8.1 + 10^- 6.1 ) = | | **59** | |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | | **53** |
| | | | | | | |
| **ASTC due to Direct plus Total Flanking** | | Subset of Eq. 1.1 | Combining Direct STC with 12 Flanking STC values | | | **50** |

**EXAMPLE 4.2-V2: (SIMPLIFIED METHOD)**

- **Rooms one-above-the-other**
- **Separating wood-framed floor assembly with joists perpendicular to flanking walls of concrete block and parallel to wood-framed flanking walls (Same structure as Example 4.2.V1, plus linings)**

Separating floor/ceiling assembly with:
- floor framed with 38 x 235 mm wood joists spaced 406 mm o.c., with joists oriented perpendicular to separating wall and supported from ledger plates on joist hangers, with 150 mm thick absorptive material[2] in the inter-joist cavities
- ceiling of 2 layers of 16 mm fire-rated gypsum board[3] attached to resilient metal channels[5] spaced 406 mm o.c.
- subfloor of oriented strand board (OSB) 16 mm thick
- no floor topping and no floor finish

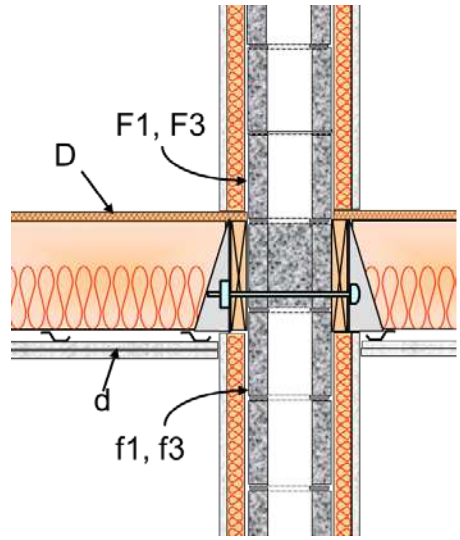
Junction 1 or 3 with loadbearing walls above and below floor with:
- one wythe of reinforced concrete blocks with mass 238 kg/m$^2$ (e.g. 190 mm hollow blocks with normal weight aggregate[1], with reinforcing steel and grout-filled cells at 1220 mm o.c.)
- 2 x 10 (38 x 235 mm) wood ledger plate on each side of concrete blocks, fastened through with 16 mm diameter bolts spaced 406 mm o.c. and floor joists are supported on joist hangers attached to ledger plates
- cells in concrete blocks between ledger plates filled with grout
- lining on each side of the concrete block walls of 1 layer of 13 mm gypsum board[3] supported on 38 mm x 38 mm wood furring spaced 610 mm o.c. and fastened to the concrete blocks, with absorptive material[2] filling the inter-stud cavities

Junction 2 or 4 with 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 406 mm o.c with several 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)
- inter-stud cavities with or without absorptive material[2] ( equivalent flanking)
- single layer of 13 mm gypsum board[3] that ends at floor/ceiling assembly; and is attached directly to wall framing

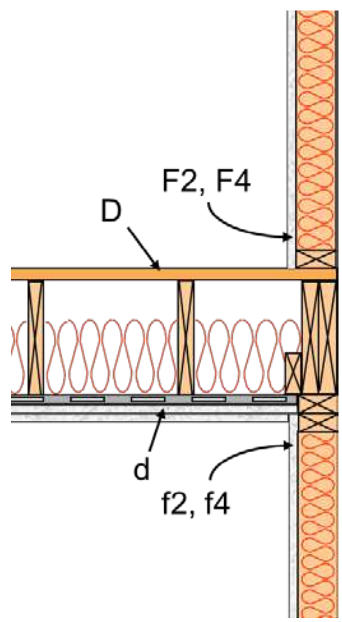
Note: For path/surface designations in the procedure below, treat the upper room as the source room (surfaces D and F)

| | In Scenario | In Laboratory |
|---|---|---|
| Separating partition area ( m$^2$ ) = | 20 | 19.6 |
| Floor/separating wall junction length (m ) = | 5.0 | 4.58 |
| Wall/separating wall junction length (m ) = | 4.0 | 4.58 |
| | | |
| **Normalization For Junctions 1 and 3:** | | |
| $10*\log(S_{situ}/S_{lab}) + 10*\log(l_{lab}/l_{situ})$ = | -0.29 | RR-334, Eq. 4.2.1 |
| | | |
| **Normalization For Junctions 2 & 4:** | | |
| $10*\log(S_{situ}/S_{lab}) + 10*\log(l_{lab}/l_{situ})$ = | 0.68 | RR-334, Eq. 4.2.1 |

**Illustration for this case**




Junction 1 & 3 of separating wood-framed floor / ceiling assembly with loadbearing flanking concrete block wall. (Side view)




Junction 2 or 4 of separating wood-framed floor/ceiling assembly with abutting side walls, with side walls' framing and gypsum board terminating at framing of separating floor. (Side view)

(See the footnotes located at the end of the document)

| | ISO Symbol | Reference | | STC, Δ_STC | | ASTC |
|---|---|---|---|---|---|---|
| **Separating partition (wood joist floor)** | | | | | | |
| Laboratory STC for Dd | R_s,w | RR-336, WJ235-02 | | 53 | | |
| Direct STC in situ | R_Dd,w | No adjustment, ISO 15712-1, 4.2.2 | | | | 53 |
| | | | | | | |
| **Junction 1 (Cross junction, Concrete block flanking wall / Wood joist separating floor)** | | | | | | |
| For Flanking Path Ff_1: | | | | | | |
| Laboratory Flanking STC | R_s,w | RR-334, WJ235-FW-LB-02 | | 59 | | |
| ΔSTC change by Lining on F | ΔR_F,w | RR-334, ΔTL-BLK(NW)-33 | | 4 | | |
| ΔSTC change by Lining on f | ΔR_f,w | RR-334, ΔTL-BLK(NW)-33 | | 4 | | |
| Normalization correction | | ISO 15712-1, Eq.28a | | -0.3 | | |
| **Flanking STC for path Ff_1** | R_Ff,w | ISO 15712-1, Eq. 28 | 59 + MAX(4,4) + MIN(4,4)/2 + -0.29 = | | **65** | |
| For Flanking Path Fd_1: | | | | | | |
| Laboratory Flanking STC | R_Fd,w | RR-334, WJ235-FW-LB-02 | | 73 | | |
| ΔSTC change by Lining on F | ΔR_d,w | RR-334, ΔTL-BLK(NW)-33 | | 4 | | |
| **Flanking STC for path Fd_1** | R_ Fd,w | ISO 15712-1, Eq. 28 | 73 + 4 + -0.29 = | | **77** | |
| For Flanking Path Df_1: | | | | | | |
| Laboratory Flanking STC | R_Df,w | RR-334, WJ235-FW-LB-02 | | 67 | | |
| ΔSTC change by Lining on f | ΔR_D,w | RR-334, ΔTL-BLK(NW)-33 | | 4 | | |
| **Flanking STC for path Fd_1** | R_ Df,w | ISO 15712-1, Eq. 28 | 67 + 4 + -0.29 = | | **71** | |
| **Junction 1: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.5 + 10^- 7.7 + 10^- 7.1 ) = | | **64** | |
| | | | | | | |
| **Junction 2 (T-Junction, Wood stud flanking wall / Wood joist separating floor)** | | | | | | |
| For Flanking Path Ff_2: | | | | | | |
| Laboratory Flanking STC | | R336, WJ235-VF_NLB-02 | | 63 | | |
| **Flanking STC for path Ff_2** | R_Ff,w | ISO 15712-1, Eq. 28 | 63 + 0.68 = | | **64** | |
| For Flanking Path Fd_2: | | | | | | |
| Laboratory Flanking STC | R_Fd,w | R336, WJ235-VF_NLB-02 | | 80 | | |
| **Flanking STC for path Fd_2** | R_ Fd,w | ISO 15712-1, Eq. 28 | 80 + 0.68 = | | **81** | |
| For Flanking Path Df_2: | | | | | | |
| Laboratory Flanking STC | R_Df,w | R336, WJ235-VF_NLB-02 | | 60 | | |
| **Flanking STC for path Fd_2** | R_ Df,w | ISO 15712-1, Eq. 28 | 60 + 0.68 = | | **61** | |
| **Junction 2: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.4 + 10^- 8.1 + 10^- 6.1 ) = | | **59** | |
| | | | | | | |
| **Junction 3 (Cross junction, Concrete block flanking wall / Wood joist separating floor)** | | | | | | |
| **Flanking STC for path Ff_3** | R_Ff,w | Same as for Ff_1 | 59 + MAX(4,4) + MIN(4,4)/2 + -0.29 = | | **65** | |
| **Flanking STC for path Fd_3** | R_ Fd,w | Same as for Fd_1 | 73 + 4 + -0.29 = | | **77** | |
| **Flanking STC for path Fd_3** | R_ Df,w | Same as for Df_1 | 67 + 4 + -0.29 = | | **71** | |
| **Junction 3: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.5 + 10^- 7.7 + 10^- 7.1 ) = | | **64** | |
| | | | | | | |
| **Junction 4 (Cross-Junction, Wood stud flanking wall / Wood joist separating floor)** | | | | | | |
| All values the same as for Junction 2 | | | | | | |
| **Flanking STC for path Ff_4** | R_Ff,w | Same as for Ff_2 | 63 + 0.68 = | | **64** | |
| **Flanking STC for path Fd_4** | R_ Fd,w | Same as for Fd_2 | 80 + 0.68 = | | **81** | |
| **Flanking STC for path Fd_4** | R_ Df,w | Same as for Df_2 | 60 + 0.68 = | | **61** | |
| **Junction 4: Flanking STC for all paths** | | Subset of Eq. 1.1 | - 10*LOG10(10^-6.4 + 10^- 8.1 + 10^- 6.1 ) = | | **59** | |
| **Total Flanking STC (4 Junctions)** | | Subset of Eq. 1.1 | Combining 12 Flanking STC values | | | **55** |
| | | | | | | |
| **ASTC due to Direct plus Total Flanking** | | Subset of Eq. 1.1 | Combining Direct STC with 12 Flanking STC values | | | **51** |

**<u>Summary for Section 4.2: Concrete Block Walls with Lightweight Flanking Walls and Floors</u>**

The worked examples 4.2-H1 and 4.2-V1 illustrate the basic process for calculating the sound transmission between rooms in a building which incorporate bare concrete masonry walls and lightweight framed flanking assemblies. These examples differ from those of the preceding section because lightweight assemblies are treated differently than concrete or concrete block assemblies in the calculation process.

The overall ASTC rating is lower than the STC rating of the separating assembly, and the relative magnitude of the direct and flanking transmissions are quite similar (though the flanking transmission is slightly less important than the direct transmission in cases of side-by-side rooms).

**<u>For the side-by-side pair of rooms</u>**

The effect of added linings is shown in example 4.2.-H2 and the following trends were found:

- Adding a lining with ΔSTC=9 to the concrete block surfaces (both sides of separating wall) raises the ASTC rating from 48 to 56. Even this moderate improvement of the STC rating of the separating wall makes flanking transmission the dominant transmission, especially for the floor-floor and ceiling-ceiling paths.
- If the ceiling in example 4.2-H2 is also improved by mounting the gypsum board ceiling on resilient channels, the Flanking STC for the ceiling paths (Junction 3) would improve to 75. However, this would increase the ASTC rating by only 1 point because the benefit is limited by flanking at the floor junction combined with the appreciable direct transmission.

Significant further improvement in the ASTC rating requires the treatment of <u>both</u> the floor and the ceiling surfaces as well as the use of better linings on the separating wall. With these changes, the ASTC rating could be raised to 65 or higher.

**<u>With one room above the other</u>**

The effect of added linings on the concrete block flanking walls is shown in Example 4.2-V2.

- Example 4.2-V2 shows the effect of adding a minimal wall lining with ΔSTC=4 to all of the concrete block surfaces. Even this small improvement makes the flanking transmission via the concrete block walls nearly insignificant. The use of better linings could raise the Flanking STC for Junctions 1 and 3 (paths involving the concrete block walls) to the point where they are clearly insignificant, but would not improve the ASTC rating appreciably.

Achieving significantly higher ASTC ratings requires the improvement of the floor surface and the wood-framed flanking walls, as well as the use of better linings on the concrete block flanking walls. With such changes, the ASTC rating could be raised to 65 or higher.

## 4.3 Scenarios for Concrete Block Walls with Steel-Framed Floors and Walls

(TO BE ADDED LATER)

## 4.4 Scenarios for Concrete Block Walls with Precast Concrete Floors

(TO BE ADDED LATER)

# 5 Appendices of Sound Transmission Data

This chapter presents full 1/3-octave-band sound transmission data for constructions tested in this project as well as for other constructions included in the Calculation Scenarios of Chapter 4.

# Appendix A1: Concrete Block Walls with and without Linings

This section presents the laboratory measured sound transmission data (measured according to ASTM E90 as described in Chapter 2) for the concrete block wall assemblies tested in this project. It also presents the change in the sound transmission due to the addition of linings and the direct sound transmission data for other wall or floor constructions included in the Calculation Scenarios of Chapter 4.

**Test Procedure and Facility**

Full scale wall assemblies were placed in a testing frame with a test opening which was 3.66 m wide and 2.44 m high. The test opening was located between two decoupled rooms with volumes of approximately 250 $m^3$ and 140 $m^3$ (referred to in this report as the large and the small rooms).

In each room, a calibrated Brüel & Kjær condenser microphone (type 4166 or 4165) with preamp was moved under computer control to nine measurement positions and measurements were made in both rooms using a National Instruments NI4472 data acquisition system installed in a desktop computer. The sound field in each room was created using four bi-amped loudspeakers driven by separate amplifiers and noise sources. To increase the randomness of the sound field, there were fixed diffusing panels located in each room.

Measurements of the airborne sound transmission loss (STL) were conducted in accordance with the requirements of ASTM E90-09, "Standard Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions". Airborne sound transmission loss tests were performed in the forward (the large room is the receiving room) and reverse (the small room is the receiving room) directions. The results presented in this report are the average of the test results for the two transmission directions.

In each case, the sound transmission loss values were calculated from the time and spatially averaged sound pressure levels measured in both the source and the receiving rooms and the average reverberation times of the receiving room. The one-third octave band sound pressure levels were measured for 32 seconds at nine microphone positions in each room and then averaged to calculate the average sound pressure level in each room. Five sound decays were averaged to calculate the reverberation time at each microphone position in the receiving room. These times were then averaged together to calculate the average reverberation times for the room.

**Table A1.1**: STL data for concrete block walls

| Lining Code | Description | STC | 63 Hz | | | 125 Hz | | | 250 Hz | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean TL-BLK190(NW) | 190 mm thick hollow-core concrete blocks, 53% solid, normal weight aggregate[1], faces sealed or unsealed | 49 | 34 | 34 | 33 | 36 | 35 | 36 | 36 | 38 | 41 |
| Bare-BLK140(LW) | 140 mm thick hollow-core concrete blocks, 58% solid, lightweight aggregate[4], faces unsealed | 35 | 24 | 22 | 19 | 19 | 22 | 22 | 23 | 24 | 26 |
| Base-BLK140(LW) | 140 mm thick hollow-core concrete blocks as above, but calculated TL without leakage (See Section 2.1) | 38 | 26 | 23 | 20 | 20 | 21 | 23 | 25 | 26 | 28 |

**Table A1.2**: Change in STL due to linings on BLK190(NW)

| Lining Code | Description | ΔSTC | 63 Hz | | | 125 Hz | | | 250 Hz | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ΔTL-BLK(NW)-01 | Lining PAINT | 0 | 0 | -1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| ΔTL-BLK(NW)-02 | Lining G13 | -3 | 0 | 1 | 0 | 0 | 1 | 1 | -1 | -1 | -2 |
| ΔTL-BLK(NW)-21 | Lining FC25_G13 | -1 | -1 | 0 | -1 | -3 | -4 | -4 | 1 | -1 | -1 |
| ΔTL-BLK(NW)-22 | Lining FC25_GFB38_G13 | 2 | -1 | 0 | -2 | -4 | -4 | -1 | 2 | 4 | 3 |
| ΔTL-BLK(NW)-31 | Lining WFUR38_G13 | -1 | -1 | -2 | -3 | -5 | -6 | -3 | 6 | 6 | -1 |
| ΔTL-BLK(NW)-32 | Lining WFUR38_2G13 | 1 | -2 | -1 | -4 | -8 | -5 | -3 | 10 | 9 | 1 |
| ΔTL-BLK(NW)-33 | Lining WFUR38_GFB38_G13 | 4 | -2 | -1 | -5 | -6 | -1 | 4 | 8 | 8 | 4 |
| ΔTL-BLK(NW)-34 | Lining WFUR38_GFB38_2G13 | 5 | -2 | -1 | -6 | -7 | 1 | 6 | 7 | 9 | 4 |
| ΔTL-BLK(NW)-35 | Lining WFUR38_G16 | -2 | -2 | -1 | -2 | -7 | -7 | -3 | 0 | 5 | 5 |
| ΔTL-BLK(NW)-36 | Lining WFUR38_GFB38_G16 | 2 | -2 | -2 | -4 | -7 | -4 | 6 | 6 | 4 | 7 |
| ΔTL-BLK(NW)-41 | Lining SS41_G13 | 0 | -2 | -3 | -1 | -6 | -5 | -4 | 1 | 3 | 7 |
| ΔTL-BLK(NW)-42 | Lining SS41_GFB38_G13 | 9 | -3 | -4 | -5 | -2 | 2 | 7 | 11 | 11 | 12 |
| ΔTL-BLK(NW)-61 | Lining SS65_G13 | 2 | -3 | -2 | -1 | -7 | -4 | 1 | 6 | 8 | 9 |
| ΔTL-BLK(NW)-62 | Lining SS65_GFB65_G13 | 19 | -6 | -1 | 0 | 7 | 11 | 15 | 18 | 19 | 20 |
| ΔTL-BLK(NW)-63 | Lining SS65_GFB65_2G13 | 22 | -2 | 3 | 7 | 13 | 16 | 21 | 22 | 22 | 23 |
| ΔTL-BLK(NW)-65 | Lining SS65_GFB65_G16 | 21 | -4 | 2 | 5 | 11 | 14 | 19 | 19 | 20 | 23 |
| ΔTL-BLK(NW)-91 | Lining SS92_G13 | 5 | -3 | -2 | -1 | -6 | -2 | 1 | 7 | 9 | 12 |
| ΔTL-BLK(NW)-92 | Lining SS92_GFB38_G13 | 17 | -6 | -3 | -2 | 3 | 7 | 13 | 16 | 17 | 19 |
| ΔTL-BLK(NW)-93 | Lining SS92_GFB65_G13 | 18 | -4 | 1 | -1 | 5 | 10 | 15 | 17 | 18 | 20 |
| ΔTL-BLK(NW)-94 | Lining SS92_GFB92_G13 | 18 | -5 | 0 | 1 | 6 | 10 | 15 | 17 | 19 | 20 |
| ΔTL-BLK(NW)-96 | Lining SS92_GFB92_2G13 | 22 | -1 | 3 | 7 | 12 | 17 | 21 | 21 | 21 | 23 |

(Continuation of Table A1.1 from opposite page):

| 500 Hz | | | 1000 Hz | | | 2000 Hz | | | 4000 Hz | | | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 43 | 44 | 47 | 48 | 50 | 53 | 55 | 58 | 58 | 60 | 62 | 64 | Mean of TLA-12-190, TLA-12-225 averaged with TL-88-356 from IR-586 [Ref 12.1] |
| 29 | 31 | 34 | 36 | 38 | 39 | 40 | 35 | 37 | 40 | 43 | 45 | Mean of TLA-13-028, 029, 044 |
| 32 | 35 | 39 | 41 | 43 | 47 | 50 | 45 | 45 | 49 | 54 | 55 | Calculated from TLA-13-045,046 and TLA-13-031,032 |

(Continuation of Table A1.2 from opposite page)

| 500 Hz | | | 1000 Hz | | | 2000 Hz | | | 4000 Hz | | | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | 0 | 1 | -1 | TLA-12-252, 253, 255 |
| -3 | -2 | -1 | 3 | 4 | 5 | 5 | 4 | 3 | 3 | 3 | 3 | TLA-12-216, 217, 213-212, 215-208 |
| 0 | 1 | 1 | 3 | 5 | 7 | 7 | 5 | 2 | 2 | 4 | 4 | TLA-12-226 |
| 4 | 5 | 3 | 5 | 6 | 9 | 8 | 6 | 4 | 5 | 6 | 5 | TLA-12-227 |
| -1 | -1 | 1 | 2 | 3 | 4 | 4 | 4 | 1 | 1 | 3 | 4 | TLA-12-208, 215-216 |
| 1 | -1 | 2 | 3 | 5 | 6 | 6 | 6 | 4 | 5 | 6 | 7 | TLA-12-212, 213-216 |
| 2 | 2 | 4 | 5 | 6 | 7 | 6 | 5 | 2 | 2 | 4 | 5 | TLA-12-209, 210 |
| 4 | 2 | 4 | 5 | 5 | 7 | 7 | 7 | 5 | 5 | 7 | 8 | TLA-12-211 |
| 0 | 0 | 1 | 2 | 3 | 4 | 4 | 1 | 0 | 3 | 4 | 5 | TLA-12-193-196, 204 |
| 3 | 3 | 3 | 4 | 4 | 5 | 5 | 2 | 1 | 3 | 5 | 5 | TLA-12-191, 192 |
| 10 | 10 | 10 | 12 | 10 | 10 | 10 | 11 | 11 | 13 | 15 | 15 | TLA-12-230, 231 |
| 13 | 10 | 8 | 9 | 7 | 8 | 9 | 9 | 11 | 12 | 13 | 13 | TLA-12-229, 232, 237-236 |
| 13 | 14 | 14 | 16 | 15 | 15 | 15 | 13 | 11 | 13 | 16 | 15 | TLA-12-240, 241, 239 |
| 22 | 21 | 21 | 20 | 18 | 16 | 17 | 17 | 16 | 18 | 21 | 19 | TLA-12-235, 238, 237-236 |
| 25 | 25 | 23 | 22 | 20 | 19 | 20 | 19 | 18 | 21 | 23 | 20 | TLA-12-236, 237-235 |
| 25 | 24 | 23 | 23 | 21 | 20 | 20 | 16 | 16 | 20 | 23 | 21 | TLA-12-234 |
| 14 | 13 | 13 | 15 | 16 | 16 | 16 | 14 | 13 | 16 | 18 | 18 | TLA-12-242 |
| 22 | 21 | 18 | 18 | 18 | 19 | 19 | 18 | 15 | 16 | 19 | 18 | TLA-12-245, 250, 252 |
| 21 | 21 | 20 | 20 | 20 | 20 | 19 | 18 | 16 | 18 | 20 | 19 | TLA-12-244, 248, 245-246 |
| 20 | 21 | 19 | 20 | 19 | 19 | 19 | 18 | 16 | 18 | 20 | 19 | TLA-12-243, 246, 245-244 |
| 24 | 23 | 22 | 21 | 20 | 21 | 21 | 19 | 17 | 21 | 22 | 20 | TLA-12-247 |

**Table A1.3**: Change in STL due to linings on lightweight unsealed BLK140(LW)

| Lining Code | Description | ΔSTC | 63 Hz | | | 125 Hz | | | 250 Hz | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ΔTL-BLK(LW)-01 | Lining PAINT | 0 | 1 | 2 | 3 | 2 | 4 | 3 | 2 | 1 | 1 |
| ΔTL-BLK(LW)-31 | Lining WFUR38_G13 | 3 | -1 | -1 | -2 | -2 | 1 | 1 | 4 | 7 | 4 |
| ΔTL-BLK(LW)-33 | Lining WFUR38_GFB38_G13 | 7 | 0 | 0 | -2 | -2 | 3 | 7 | 8 | 13 | 9 |
| ΔTL-BLK(LW)-35 | Lining WFUR38_G16 | 6 | 1 | 1 | -1 | -1 | 3 | 5 | 6 | 11 | 8 |
| ΔTL-BLK(LW)-62 | Lining SS65_GFB65_G13 | 15 | -5 | -4 | -2 | 4 | 8 | 11 | 13 | 15 | 18 |
| ΔTL-BLK(LW)-65 | Lining SS65_GFB65_G16 | 19 | -3 | 0 | 3 | 5 | 12 | 14 | 17 | 19 | 21 |
| ΔTL-BLK(LW)-66 | Lining SS65_FOAM65_G13 | 0 | 1 | 5 | 6 | 5 | 8 | 5 | 2 | 1 | -1 |
| ΔTL-BLK(LW)-93 | Lining SS92_GFB65+_G13 | 16 | -5 | -3 | 0 | 6 | 9 | 12 | 13 | 15 | 17 |
| ΔTL-BLK(LW)-95 | Lining SS92_GFB65+_G16 | 22 | -2 | 2 | 4 | 8 | 14 | 16 | 19 | 22 | 23 |

(Continuation of Table A1.3 from opposite page):

| 500 Hz | | | 1000 Hz | | | 2000 Hz | | | 4000 Hz | | | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | -1 | -1 | -1 | -2 | -3 | -1 | 0 | 0 | -1 | -1 | TLA-13-045, 046 |
| 1 | 2 | 2 | 3 | 4 | 5 | 6 | 9 | 5 | 4 | 4 | 6 | TLA-13-030 |
| 7 | 5 | 5 | 6 | 7 | 9 | 9 | 11 | 6 | 5 | 4 | 6 | TLA-13-042, 033-031 |
| 4 | 4 | 3 | 4 | 6 | 7 | 7 | 7 | 5 | 6 | 6 | 8 | TLA-13-031, 032, 033-042, 034-035 |
| 19 | 18 | 15 | 16 | 20 | 22 | 23 | 28 | 27 | 25 | 23 | 23 | TLA-13-040, 047 |
| 22 | 23 | 22 | 24 | 27 | 28 | 28 | 28 | 28 | 28 | 29 | 27 | TLA-13-043, 037-035, 038-039 |
| -1 | 1 | 3 | 7 | 9 | 14 | 15 | 14 | 7 | 7 | 11 | 12 | TLA-13-058-045, 057-040 |
| 19 | 19 | 17 | 17 | 20 | 22 | 22 | 27 | 25 | 24 | 24 | 24 | TLA-13-039, 038-043 |
| 24 | 25 | 24 | 26 | 28 | 29 | 28 | 29 | 29 | 29 | 29 | 27 | TLA-13-035, 036, 034-031, 037-043 |

## Appendix A2: Concrete Block Walls with Wood-Framed Floors and Walls

(TO BE ADDED LATER)

## Appendix A3: Concrete Block Walls with Steel-Framed Floors and Walls

(TO BE ADDED LATER)

## Appendix A4: Concrete Block Walls with Precast Concrete Floors

(TO BE ADDED LATER)

# 6 References

1. Cremer L, Heckl M. Structure-borne sound. 2nd ed. Ungar, E. E., editor. Berlin ; New York: Springer-Verlag; 1988. 573 p.

2. Gerretsen E. Calculation of the sound transmission between dwellings by partitions and flanking structures. Applied Acoustics. 1979 Nov;12(6):413–33.

3. Gerretsen E. Calculation of airborne and impact sound insulation between dwellings. Applied Acoustics. 1986;19(4):245–64.

4. Craik RJ. Sound Transmission Through Buildings: Using Statistical Energy Analysis. Aldershot, England ; Brookfield, Vt., USA: Gower Pub Co; 1996. 261 p.

5. ASTM E336 - 14, Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings [Internet]. West Conshohocken, PA: ASTM International; 2014. Available from: http://www.astm.org/Standards/E336.htm

6. ISO 15712-1:2005 -- Building acoustics -- Estimation of acoustic performance of buildings from the performance of elements -- Part 1: Airborne sound insulation between rooms. Geneva, Switzerland: International Standards Organization; 2005.

7. ISO 15712-2:2005 -- Building acoustics -- Estimation of acoustic performance of buildings from the performance of elements -- Part 2: Impact sound insulation between rooms. Geneva, Switzerland: International Standards Organization; 2005.

8. ISO 15712-3:2005 -- Building acoustics -- Estimation of acoustic performance of buildings from the performance of elements -- Part 3: Airborne sound insulation against outdoor sound. Geneva, Switzerland: International Standards Organization; 2005.

9. ISO 15712-4:2005 -- Building acoustics -- Estimation of acoustic performance of buildings from the performance of elements -- Part 4: Transmission of indoor sound to the outside. Geneva, Switzerland: International Standards Organization; 2005.

10. BS EN 12354-1:2000 Building acoustics. Estimation of acoustic performance in buildings from the performance of elements. Airborne sound insulation between rooms. London, UK: BSI; 2000.

11. ISO 10848-1:2006 -- Acoustics -- Laboratory measurement of the flanking transmission of airborne and impact sound between adjoining rooms -- Part 1: Frame document. Geneva, Switzerland: International Standards Organization; 2006. Report No.: ISO 10848-1:2006.

12. ISO 10848-2:2006 -- Acoustics -- Laboratory measurement of the flanking transmission of airborne and impact sound between adjoining rooms -- Part 2: Application to light elements when the junction has a small influence. Geneva, Switzerland: International Standards Organization; 2006. Report No.: ISO 10848-2:2006.

13. ISO 10848-3:2006 -- Acoustics -- Laboratory measurement of the flanking transmission of airborne and impact sound between adjoining rooms -- Part 3: Application to light elements when the

junction has a substantial influence. Geneva, Switzerland: International Standards Organization; 2006. Report No.: ISO 10848-3:2006.

14. ISO 10848-4:2006 -- Acoustics -- Laboratory measurement of the flanking transmission of airborne and impact sound between adjoining rooms -- Part 4: Application to junctions with at least one heavy element. Geneva, Switzerland: International Standards Organization; 2006. Report No.: ISO 10848-4:2006.

15. ISO 10140-1:2010 -- Acoustics -- Laboratory measurement of sound insulation of building elements -- Part 1: Application rules for specific products. Geneva, Switzerland: International Standards Organization; 2010.

16. ISO 10140-2:2010 -- Acoustics -- Laboratory measurement of sound insulation of building elements -- Part 2: Measurement of airborne sound insulation [Internet]. Geneva, Switzerland: International Standards Organization; 2010.

17. ISO 10140-3:2010 -- Acoustics -- Laboratory measurement of sound insulation of building elements -- Part 3: Measurement of impact sound insulation. Geneva, Switzerland: International Standards Organization; 2010.

18. ISO 10140-4:2010 -- Acoustics -- Laboratory measurement of sound insulation of building elements -- Part 4: Measurement procedures and requirements. Geneva, Switzerland: International Standards Organization; 2010.

19. ISO 10140-5:2010 -- Acoustics -- Laboratory measurement of sound insulation of building elements -- Part 5: Requirements for test facilities and equipment. Geneva, Switzerland: International Standards Organization; 2010.

20. ASTM E90-09, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements. West Conshohocken, PA: ASTM International; 2009.

21. ISO 717-1:2013 -- Acoustics -- Rating of sound insulation in buildings and of building elements -- Part 1: Airborne sound insulation. Geneva, Switzerland: International Standards Organization; 2013.

22. ASTM E413 - 10, Classification for Rating Sound Insulation. West Conshohocken, PA: ASTM International; 2010.

23. ISO 16283-1:2014 -- Acoustics -- Field measurement of sound insulation in buildings and of building elements -- Part 1: Airborne sound insulation. Geneva, Switzerland: International Standards Organization; 2014.

24. Quirt D, Zeitler B, Schoenwald S, Sabourin I, Nightingale T. Guide to Calculating Airborne Sound Transmission in Buildings. Ottawa, Canada: National Research Council Canada; 2013. Report No.: RR-331.

25. ISO 140-16:2006 -- Acoustics -- Measurement of sound insulation in buildings and of building elements -- Part 16: Laboratory measurement of the sound reduction index improvement by additional lining. Geneva, Switzerland: International Standards Organization; 2006.

26. Warnock ACC. Sound Transmission Loss Measurements Through 190 mm and 140 mm Blocks With Added Drywall and Through Cavity Block Walls. Ottawa, Canada: National Research Council Canada; 1990 p. 32. Report No.: IR-586.

27. Warnock ACC. Sound transmission through concrete blocks with attached drywall. The Journal of the Acoustical Society of America. 1991 Sep 1;90(3):1454–63.

28. Warnock ACC. Sound transmission through two kinds of porous concrete blocks with attached drywall. The Journal of the Acoustical Society of America. 1992 Sep 1;92(3):1452–60.

29. Warnock ACC. Sound transmission through slotted concrete blocks with attached gypsum board. The Journal of the Acoustical Society of America. 1993 Nov 1;94(5):2713–20.

30. ASTM E1007 - 14 Standard Test Method for Field Measurement of Tapping Machine Impact Sound Transmission Through Floor-Ceiling Assemblies and Associated Support Structures. West Conshohocken, PA: ASTM International; 2014.

## Sources for Sound Transmission Data

Source references for sound transmission data (both collections of conventional laboratory test results for wall and floor assemblies according to ASTM E90, and flanking transmission tests according to ISO 10848) including many NRC Construction reports in the RR- and IR- series are available from the website of the NRC Canada: http://nparc.cisti-icist.nrc-cnrc.gc.ca/npsi/ctrl?lang=en

Collections of conventional laboratory test results for wall or floor assemblies evaluated according to ASTM E90 are presented in a series of NRC publications. Of particular relevance to this report on concrete blocks are the following:

- IR-586, "Sound Transmission Loss Measurements through 190 mm and 140 mm Blocks With Added Drywall and Through Cavity Block Walls", A.C.C. Warnock (1990). This presents results similar to those in Chapter 2 of this report. Changes in the lining materials and test facilities make detailed comparison uncertain, but the results show very similar trends.
- A.C.C. Warnock, "Sound transmission through concrete blocks with attached drywall", J. Acoustical Soc. Am., vol. 90, pp 1454-1463, (1991)
- A.C.C. Warnock, "Sound transmission through two kinds of porous concrete blocks with attached drywall", J. Acoustical Soc. Am., vol. 92, pp 1452-1460, (1992)
- A.C.C. Warnock, "Sound transmission through slotted concrete blocks with attached gypsum board", J. Acoustical Soc. Am., vol. 94, pp 2713-2720, (1993)

The software application soundPATHS is accessible online at the website of the National Research Council Canada. The predictions provided by the application are based on a detailed calculation using 1/3-octave data for the direct and flanking paths as determined by experimental studies in the laboratories of the National Research Council Canada. Technical details concerning the measurement protocol (consistent with ISO 10848) and discussion of the findings of the experimental studies are presented in a series of NRC reports:

- 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),
- 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),
- RR-168, “Flanking Transmission at the Wall/Floor Junction in Multifamily Dwellings - Quantification and Methods of Suppression”, T.R.T. Nightingale, R.E. Halliwell, J.D. Quirt and F. King (2005),
- RR-218, “Flanking Transmission in Multi-Family Dwellings Phase IV”, T.R.T. Nightingale, J.D. Quirt, F. King and R.E. Halliwell, (2006),
- Research Report RR-219, “Guide for Sound Insulation in Wood Frame Construction”, J.D. Quirt, T.R.T. Nightingale, and F. King, (2006). Uses a subset of the database used for SoundPATHS software in a table-based framework to predict the ASTC for a range of wood-framed assemblies. See also NRC Construction Technology Update 66 “Airborne Sound Insulation in Multi-Family Buildings”, J.D. Quirt and T.R.T. Nightingale (2008)
- J. K. Richardson, J. D. Quirt, R. Hlady, “Best Practice Guide on Fire Stops and Fire Blocks and their Impact on Sound Transmission, NRCC #49677 (2007)

The databases of flanking transmission data used in Guide RR-331 and in soundPATHS will be consolidated in a series of NRC publications presenting data from recent studies in collaboration with industry partners:

- RR-333 Apparent Sound Insulation in Concrete Buildings (2016)
- RR-334 Apparent Sound Insulation in Concrete Block Buildings (2015)
- RR-335 Apparent Sound Insulation in Cross Laminated Timber Buildings (2016)
- RR-336 Apparent Sound Insulation in Wood-framed Buildings (2016)
- RR-337 Apparent Sound Insulation in Steel-framed Buildings (2016)

# 7 Explanatory Notes

1 For the 190 mm thick concrete block walls in these examples, the value of 238 kg/m$^2$ is the measured mass per unit area for the tested wall specimen including mortar. Normal weight (NW) concrete block masonry units conform to CSA A165.1 and have a concrete mass density of not less than 2000 kg/m$^3$. 190 mm NW hollow core units are not less than 53% solid, and 140 mm NW hollow core units are not less than 73% solid, each giving a minimum wall mass per area over 200 kg/m$^2$.

2 For the lightweight concrete block walls in these examples, the value of 134 kg/m$^2$ is the measured mass per unit area for the tested wall specimen including mortar. Lightweight concrete block masonry units conform to CSA A165.1 and have a concrete mass density of approximately 1700 kg/m$^3$. Hollow core units are not less than 58% solid, which was the case tested.

3 Resilient metal channels are formed from steel with a maximum thickness of 0.46 mm (25 gauge), with the profile essentially as shown in Figure 6.1 There are slits or holes in the single “leg” between the faces fastened to the framing and to the gypsum board. Installation of the channels must conform to ASTM C754.

**Figure 6.1:**
Drawing to illustrate typical profile of a resilient metal channel. The approximate dimensions in cross-section are 13 mm x 60 mm (Copied from Figure A-9.10.3.1 of National Building Code of Canada with permission; drawing not precisely to scale).