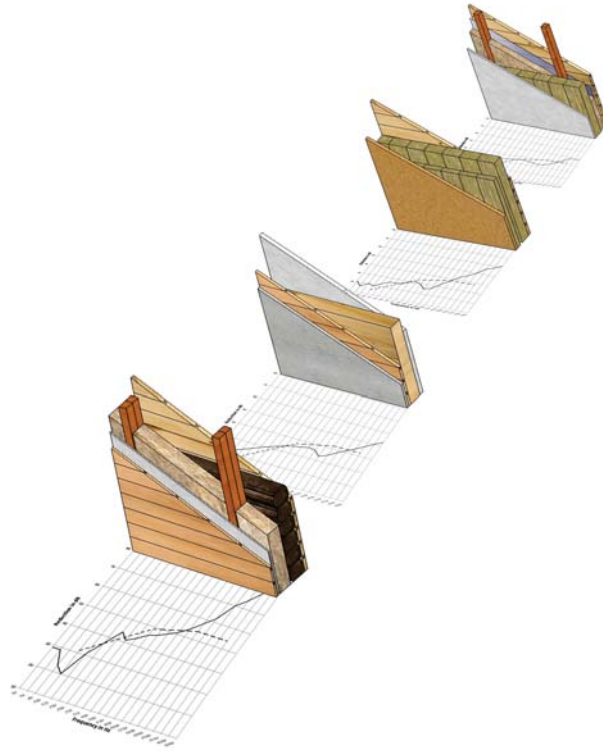# INVESTIGATION OF THE ACOUSTIC PROPERTIES OF FACADE ELEMENTS

Selected Study Cases of Swedish Building Constructions

D. BARD, N.-G. VARDAXIS and J. NEGREIRA

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Contents

Part I

Introduction and overview of the work

1
Introduction

1.1 Background

The presented study is part of the research program S.T.A.R. (Sustainable Thermal Acoustic Retrofit), which is focused on the investigation of thermal and acoustic material properties relevant to retrofitting of buildings. The overall aim is to research and promote sustainable retrofitting solutions in combination with the industrial data and services on the construction sector. The latter objective will be carried out keeping in mind to always comply with the latest regulations and directives regarding energy efficiency in buildings.

The study reported on here took place at Lund University (Sweden), which is one of the partners in the S.T.A.R. program. The Swedish part of the research is focused on acoustic issues; in particular, the main tasks were (i) the investigation of acoustic properties of building materials, (ii) the collection of relevant information for building products and combined solutions used in the market and (iii) the construction sector and the creation of a database for the acquired information to make it available for engineers, researchers and others. The aforementioned work was done in cooperation with the building industry, setting up a fruitful interaction for knowledge exchange and development of new sustainable ideas.

1.2 Scope of the study

The aim of the study presented here is the production of a technical handbook for architects and building construction engineers from which they can acquire fast, understandable and realistic information about facade structures, the combination of building materials involved in every case and their effect on sound insulation properties.

The report deals with the acoustic properties of retrofitted facades and provides a list of typical dwelling construction cases in Sweden. The facade partition cases were collected from the archives of the industrial partners of the S.T.A.R. research program. Measurement data and technical reports from the past that are still used nowadays for commercial work were acquired for the purposes of this research.

1.3 Outline and limitations

In Chapter 2, a short description of acoustics theory, terminology and standardised measurement procedure relevant to the research material is presented. The general purpose is to present all information needed for (either unfamiliar or familiar to acoustics) readers so as to study, understand and use the data provided for their engineering projects. In Chapter 3, in turn, instructions about the implementation and guidelines for the readers to ease their understanding about the catalog with the study cases presented in Part II, are given.

The structural details and the acoustic properties of each facade case included in the report are analysed thorough. Specifically, the building materials are presented in a table-list accompanied by 3d sketches and 2d technical detail in construction section blueprints. The sound reduction index curves are illustrated in a graph for each case for the third-octave spectrum 50-5000 Hz, the single value R_w for acoustic element characterisation being presented as well.

The measured results presented in this report were collected from industrial measurements of sound reduction R according to ISO 140-3 [1] and ISO 140-4 [2], their being evaluated in accordance with ISO 171-1 [3] for acquiring the R_w values. In the Swedish industry, the SS EN 12354-1 standard has been widely used in the last decade, which is a Swedish version of the European standard EN 12354-1 [4]. The latter is based on all the ISO standards relevant to building acoustics mentioned before in this paragraph.

Although there are no statistics to support that, the study cases presented in this report are supposed to comprise a representative sample of the typical Swedish facade structures of the 20th century, as stated by the engineers involved in the data collection, based on their working experience. However, the actual construction or retrofit process concerns the time period between 1880 and 2000, according to the records.

Readers and users of this publication should take into account that deviations from the presented results are probable when compared with other similar applications. The main reason for that is the inability to verify in practice that a combination of similar materials will give exactly the same results. Inherent differences in material properties of the same product due to various manufacturers and production procedures are expected. Therefore, relevant data (R and R_w) from each product manufacturer are usually provided. The way of construction assembly (framing, structural connections) may also change between the presented cases and other cases to be realised and this condition, which in turn will probably affect the sound insulation properties of combined building elements.

2
Theory

2.1 Airborne sound transmission, impact sound and isolation

Building acoustics is the subfield of acoustics dealing with noise insulation between adjacent rooms or transmission from an incident outside sound (environmental noise) into a closed space. The parts of the theory and regulations concerning airborne sound insulation and the relevant rating of the acoustic properties of building partitions are used in this report to present and evaluate the analysed study cases.

Some considerations and terminology have to be clarified first in this section. Firstly, one can usually define noise as unwanted or unpleasant sounds. Disturbing sounds (noise) or vibrations in a building environment can stem from sounds or vibrations travelling from one part of it to another. On the basis of the noise source, one can distinguish between two types of transmission:

- **Airborne sound transmission:** when sound waves travel through the air and reach a building element they cause it to vibrate. The vibrations produced travel throughout the element in question and radiate out to the other side of it through creating pressure differences that propagate and create noise. Typical airborne transmission sources are speech, HiFi systems (such as speakers), and appliances, or noise coming from a vehicle outside a room. The sound transmission path here is one in which the energy is carried for the most part by the air, and only to a minor extent via structural or solid-borne waves; see Figure 2.1(a). Consequently, airborne insulation refers to how isolated is a construction from sounds that propagate in the air.

- **Structure-borne sound transmission:** the direct impact of an object in striking a separating surface of a building, such as a floor, causing both sides of the building element involved to vibrate, and generating sound waves that propagate through it and transmit the sound then to an adjacent room is called structure-borne sound. Typical impact sources are footsteps when people walk, jump or run, and dropped objects, the dropping of which can be heard in a room below; see Figure 2.1(b). Impact sound is usually relevant to floor structures. Therefore, it is not further examined in this publication because only airborne sound insulation is of interest for facade elements.

Both airborne and impact sources generate direct transmission and flanking transmission to adjacent rooms; see Figure 2.1.
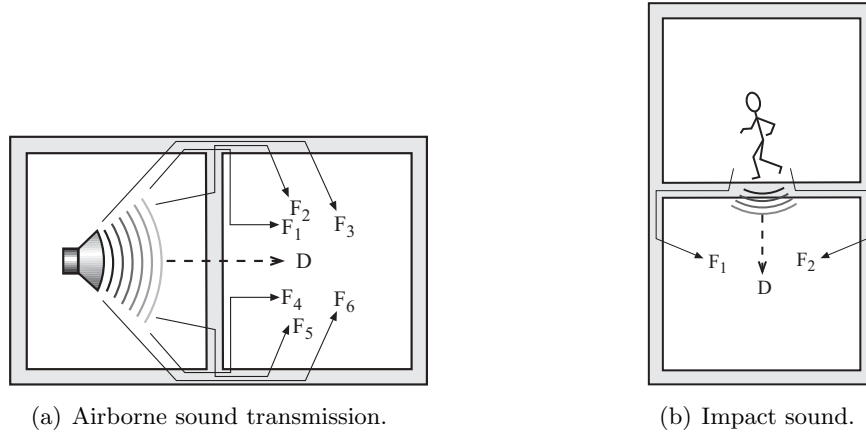
(a) Airborne sound transmission.   (b) Impact sound.

Fig. 2.1: Sound transmission types. "D" denotes direct transmission whereas "F_i" indicates flanking paths.

2.2 Measuring airborne sound

Airborne sound insulation can be measured on a real construction wither in a laboratory or in the field (in-situ). In the first case, the lab where the standardised measurements are performed consists of two adjacent rooms, completely isolated from one another, their being connected only by a common surface, which is the partition to be measured. In this way, it is possible to measure only the direct transmission path (i.e. flanking transmission is not present).

The test rooms are reverberation rooms, so they offer almost perfect diffuse field conditions, which means equally probable distribution of the sound energy in all directions and equal sound pressure levels in the room. The latter statement is a significant assumption during the measurements, because there is an averaging of recordings from several microphone positions taking place. Supposedly, at no point in a test room should the sound pressure levels be affected by sound field non-equality in the recordings. A typical setup of the above mentioned laboratory is illustrated in Figure 2.2.
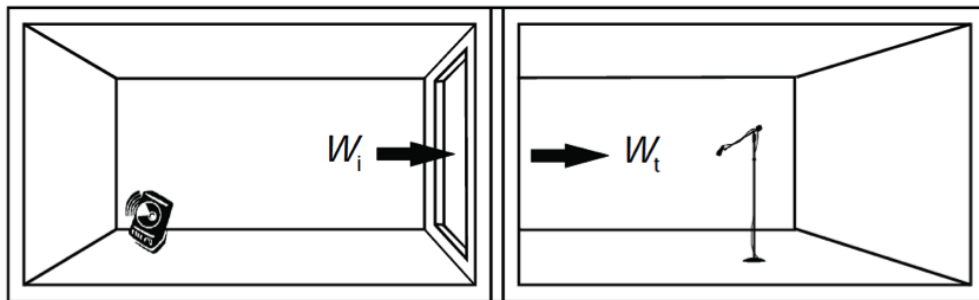
Fig. 2.2: Setup for measurements of sound reduction in a laboratory [5].

However, field measurements offer more realistic results about the general behaviour of the test partition, including any interactions with the rest of the structure. They take place in situ, i.e. having the source and receiver positions in the real rooms with the building parts under investigation, as presented in Figure 2.3. So any influence from indirect transmission paths, also called flanking paths, through other building elements connected to the test sample (lateral walls, floor, ceiling) is recorded in the measurements [5].
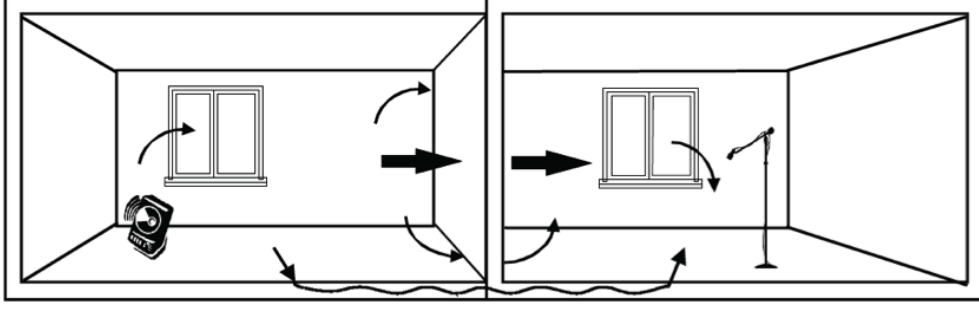
Fig. 2.3: Setup for field measurements of sound reduction in a real structure [5].

Practical instructions on how to perform measurements will be presented eventually in Section 3.1.

2.3 Transmission factor

The transmission factor τ of a surface element refers to the ratio between the transmitted W_{tr} and the incident W_{in} power, and is defined as

$$\tau = \frac{W_{tr}}{W_{in}}. \tag{2.1}$$

2.4 Sound reduction index

The sound reduction index R is a logarithmic quantity (units in dB), used to characterise the acoustic insulation properties of partitions and it is defined as

$$R = 10 \cdot \log\left(\frac{1}{\tau}\right), \tag{2.2}$$

By insertion of Equation (2.1) into Equation (2.2), it then becomes

$$R = 10 \cdot \log\left(\frac{W_{in}}{W_{tr}}\right) \tag{2.3}$$

Please note that in some cases, R can be found also in the literature or research reports as transmission loss, denoted as TL [5].

For laboratory measurements, assuming diffuse field conditions in both sending and receiving rooms, the sound reduction index R is calculated in one-third octave bands according to ISO 140-3 as

$$R = L_s - L_r + 10 \cdot \log\left(\frac{A_r}{S}\right) \tag{2.4}$$

where L_s is the sound pressure level in the sending room in dB, L_r is the sound pressure level in the receiving room in dB, S is the area of the testing partition in m^2, and A_r is the absorption area of the receiving room in m^2 [1]. The latter term is analysed thoroughly in a following subsection.

2.5 Apparent sound reduction index

For the case of field measurements, the apparent sound reduction index R' is used instead of R, since it takes into consideration the additional flanking paths of sound transmission (in the laboratory, no flanking paths are present, cf. Figure 2.2). It is defined as

$$R = 10 \cdot \log \left(\frac{W_{in}}{W_{tr} + W_{fl}} \right), \tag{2.5}$$

W_{fl} being the sound power transmitted through indirect paths by any flanking elements. However, according to ISO 140-4, the conditions of transmission are not so important under the assumption of sufficient diffuse conditions in the sound fields [2]. So, the apparent sound reduction index R' is calculated in 1/3-octave bands again as

$$R' = L_s - L_r + 10 \cdot \log \left(\frac{A_r}{S} \right). \tag{2.6}$$

2.6 Weighted sound reduction index

The sound reduction index values calculated according to the formulae above presented is frequency dependent (due to the frequency dependency of the quantities involved in its calculation, e.g. the sound pressure level). Many times, however, it is easier to have a single value instead of a sound reduction curve for characterising insulation of partitions or other samples. Thus, the weighted sound reduction index R_w or the weighted apparent sound reduction index, R'_w, for laboratory and field measurements respectively, have been adopted for ease of evaluation and comparison.

This weighted sound reduction index is acquired based on standardised calculations using a reference curve predefined in ISO 717-1, which is agreed to be a globally accepted ideal curve. This reference curve has to be shifted in steps of 1 dB to the trend of the measured results, until the sum of the deviations between the two curves (measured and reference) is maximum, but not more than 32 dB, regarding all frequency bands available between 100 and 3150 Hz. Finally, the value of the shifted reference curve at 500 Hz is the one used as the weighted sound reduction index R_w [3].

An example case presenting a sound Reduction Index R measured result, the ISO 717-1 reference curve and a calculation to define R_w is illustrated in Figure 2.4. The sound reduction levels are plotted in one-third octave bands for the range 50-5000 Hz and the presented case is about a limestone wall with asphalt board, mineral wool in studs frame and fibreboard inside panel. The original and shifted standardised ISO reference curves in the graph are the red and dashed black ones respectively. In the first calculation, the sum of unfavourable deviations between the initial reference curve and the measured R in every frequency band is 104 dB. Thus, the reference curve had to be shifted 1 dB downwards (i.e. towards the measured curve) for every band to recalculate the sum of differences, which in the second calculation will be 89 dB (which still does not fulfil the criteria that the sum of the deviations between the two curves should maximum, but not more than 32 dB). After the third shift the sum will be 74 dB, and so on. The same process has to be repeated until the sum of deviations is maximum while not exceeding 32 dB. Consequently, after some more calculations the sum is 26 dB (accepted) and the shifted reference curve is 6 dB below the original one. Finally, the given value at 500 Hz of the shifted reference curve, which is 46 dB corresponds to the weighted sound reduction index R_w [5].
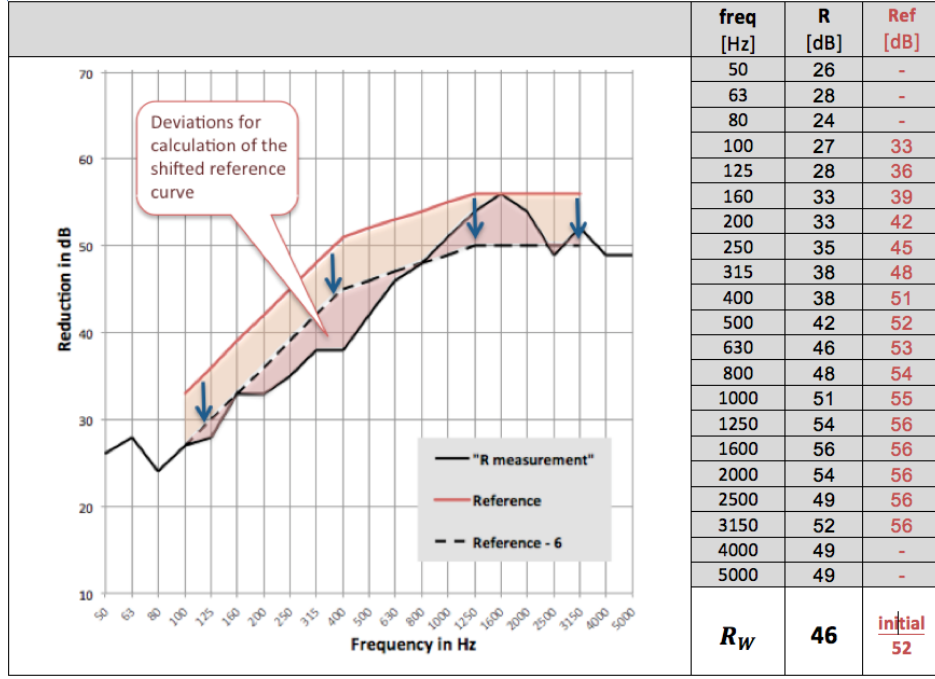
freq [Hz]	R [dB]	Ref [dB]
50	26	-
63	28	-
80	24	-
100	27	33
125	28	36
160	33	39
200	33	42
250	35	45
315	38	48
400	38	51
500	42	52
630	46	53
800	48	54
1000	51	55
1250	54	56
1600	56	56
2000	54	56
2500	49	56
3150	52	56
4000	49	-
5000	49	-
R_W	46	initial 52

Fig. 2.4: Example of Sound Reduction Index R, ISO 717-1 reference curve and R_w value calculation.

2.7 Reverberation time, absorption factor and absorption area

The use of (effective) absorption area, A_r, as mentioned before, is included in the calculations of the sound reduction index. Assessed via measurements, it can be quickly derived by use of Sabine's fundamental equation, defined as

$$A_R = \frac{0.161 \cdot V_R}{T_{60}}. \tag{2.7}$$

The terms V_r and T_{60} denote the volume and reverberation time of the receiving room respectively. Reverberation time (RT or T_{60}) is the amount of time, in seconds, demanded for a signal to decay 60 dB. In room acoustics terms, T_{60} is the time for the reverb, i.e. the contribution of a certain space to the direct signal (reflections, diffusion, absorption), to decrease by 60 dB from the first maximum level after the initial signal is turned off. Therefore, a measurement of T_{60} in the receiving room has to be done as well. The value of 0.5 s is used for receiving rooms in dwellings in case of lack of measurements or data.

The absorption area A_r (or effective surface) is the sum of every individual surface in the room multiplied by the corresponding absorption factor, α, theoretically defined as;

$$A_r = \sum_{i=1}^{n} \alpha_i S_i = \alpha_1 S_1 + \alpha_2 S_2 + ... + \alpha_n S_n. \tag{2.8}$$

The above mentioned absorption coefficient, α, is a value between 0 and 1, used to characterise every material according to the percentage of sound energy absorption achieved by a surface of a partition. Consequently, reflective surfaces like concrete walls have absorption factor values almost 0, whereas the α factor of a thick mineral wool layer is closer to 1 [5].

3

Implementation

3.1 Measurement procedure

The performance of the measurements is standardised, so there can be a global process for the evaluation of building partitions, concerning insulation properties. For detailed evaluation and correct performance or reproduction of the measurement procedures, advanced users should use the standards relevant to building elements evaluation as mentioned before in the report.

According to the data collected from the industry, some of the measurements were rendered in laboratory conditions but most of them were actually performed in the field. Deviations from the standard procedure might have taken place but cannot practically be tracked down. For instance, the most probable condition to be incorrect is the sufficient diffuse sound field conditions inside the rooms where measurements are performed in situ. However, it is an assumption that has often to be made to proceed and measure the acoustic properties of interest.

To summarise them shortly, the measurements for airborne sound insulation consist of some basic steps.

1. Firstly, a background noise measurement shall take place in both sending and receiving rooms so as to investigate if there is any certain sound in the existing environment that might affect distinctively the measurements. This measurement is used also later for comparisons and corrections of the measured sound pressure levels.

2. Secondly, the sound field for the measurements must be set up, meaning the noise generation which represents the sound source, coming out from loudspeakers (one or more) in the sending room. For the standard measurements, a steady signal is used, usually white noise, which contains equal amount of sound power in every frequency band. Instead of white noise, other noise signals (pink, brown) can be generated but with no more than 6 dB slope per one-third-octave. The point is for the test room to be excited independently of the frequency response of the source or the space. In this way, there will be no additional noise effect by any certain eigenmodes[1] excited.

3. After that essential setup, it is time for the sound reduction index measurements. Sound pressure levels must be recorded with microphones in both rooms simultaneously, in order to

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[1]The eigenmodes of a room are the sound pressure level distribution patters assoviated to every natural frequencies of a room, the ones which can resonate easier according to the geometrical characteristics of the closed space combined (or synchronised) with the wavelength dimensions of the excitation noise [5].

evaluate the sound insulation properties of the partition under test. At least five different microphone positions must be used to perform recordings. In each position, a minimum averaging time of 6 seconds must be taken. To ensure correct signal averaging and satisfactory diffuse conditions as mentioned before, a distance of 0.7 m must be kept for the microphone positions between them or any wall, 1 m from the sound source and 0.7 m from the test specimen. Then, the speaker plays the noise signal and the measurement can start using the right equipment, which can be a sound level meters or any digital workstation combined with proper software [1, 2].

4. As a check to the sound pressure levels recorded before, the background noise levels in every frequency band must be at least 6 dB higher than the measured curves, for the measurement to be valid and meaninful. Furthermore, if the measured levels do not exceed the noise levels for more than 15 dB, then some correction calculations have to be made described in ISO 140-3 [1].

5. Additionally, a reverberation time RT measurement shall also take place. The white noise signal is reproduced to feed the room with sound energy and then it is stopped suddenly while a microphone in the room still records. In the recording, one can see the drop from the steady noise level to silence, i.e. the background noise level, and measure the time needed for the reverb to drop 60 dB from its first maximum level. This way T_{60} is acquired or in other cases, when needed, for 30 dB or 15 dB drop, i.e. T_{30} or T_{15} can be acquired likewise.

6. Finally, the sound reduction index curve of $R(f)$ can be calculated according to Equation (2.4) and Equation (2.6), the weighted sound reduction index R_w (for lab measurements) or R'_w (for the in situ case) being afterwards acquired by the ISO 717-1 evaluation process explained in Section 2.6.

3.2 List of study cases – Instructions for the readers

For the purposes or the presentation in this report, a certain template was set up. The list of the study cases includes for every case all the relevant information needed, including materials, dimensions, sketches, graphs and analytical results of the sound reduction measurements and calculations.

In Figure 3.1 there is an explanatory diagram of how the delivered information is organised inside the template of the list. Thus, it can be considered as a set of directions for the users to understand better and make full use of the provided information.

Notes for the readers:
- The material-layers are mentioned from outside to inside.
- The drawings are printed in relative scale.
- The 3d sketches have dimensions of 1×1 m^2 thickness of the specimen.
- The technical drawings have dimensions of 1 m thickness of the specimen.
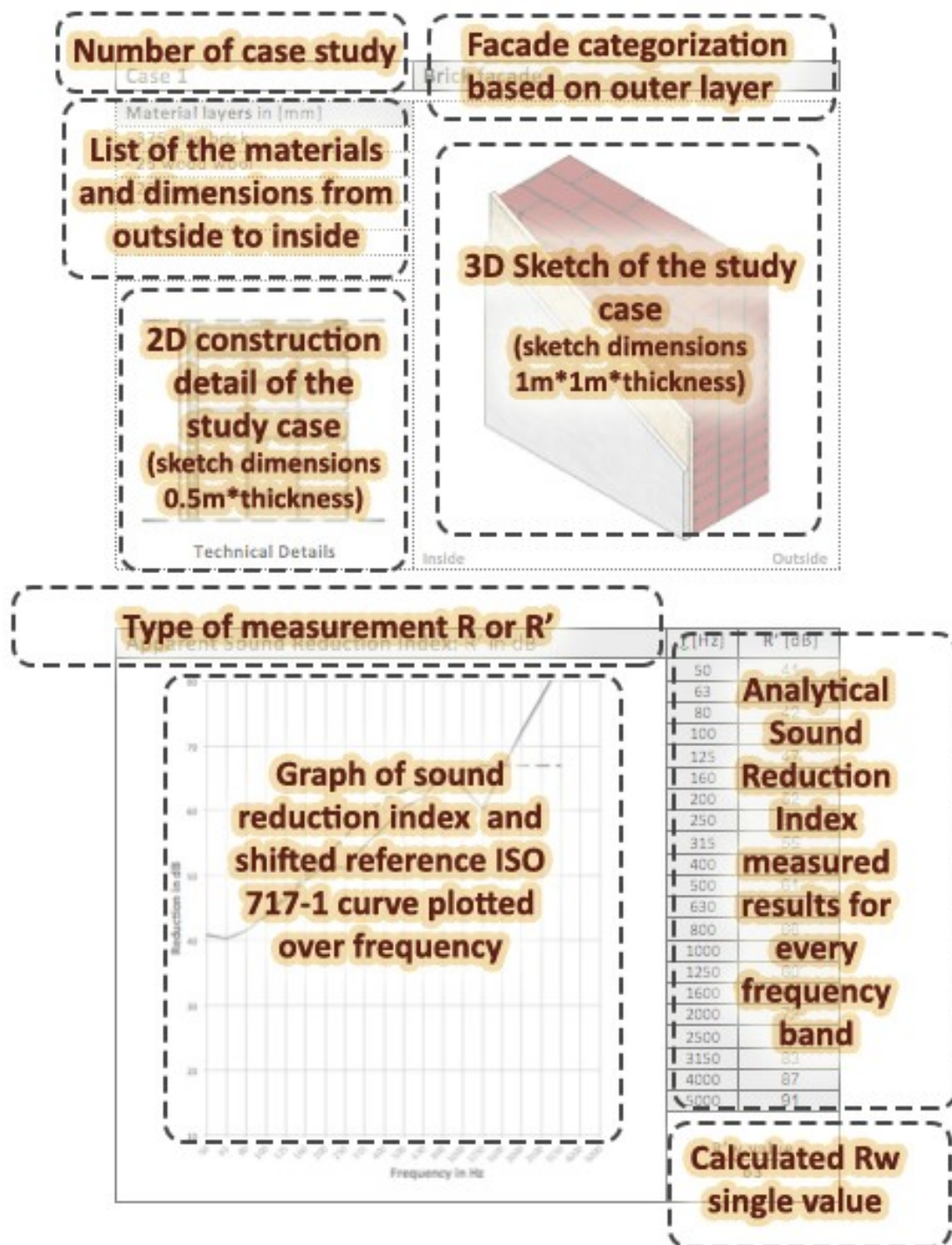
Fig. 3.1: Description of the template used in the study case list.

Bibliography

[1] ISO 140-3: Acoustics – Measurement of sound insulation in buildings and of building elements – Part 3: Laboratory measurements of airborne sound insulation of building elements. Switzerland, 1995.

[2] ISO 140-3: Acoustics – Measurement of sound insulation in buildings and of building elements – Part 4: Field measurements of airborne sound insulation between rooms. International Organization for Standardisation, Geneva, Switzerland, 1998.

[3] ISO 717-1: Acoustics – Rating of sound insulation in buildings and of building elements – Part 1: Airborne sound insulation. International Organization for Standardisation, Geneva, Switzerland, 1996.

[4] EN 12354-1: Building acoustics – Estimation of acoustic performance in buildings from the performance of elements – Part 1: Airborne sound insulation between rooms. European Committee for Standardisation, Brussels, Belgium, 2000.

[5] T. E. Vigran. Building Acoustics. Taylor & Francis Group, 2008.

Part II

List of study cases

Case 1	Brick facade

Material layers in [mm]

- 375 clay brick
- 25 wood wool
- 20 plaster

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB		f [Hz]	R' [dB]
		50	41
		63	40
		80	42
		100	44
		125	47
		160	49
		200	52
		250	51
		315	55
		400	58
		500	61
		630	62
		800	66
		1000	64
		1250	60
		1600	66
		2000	72
		2500	78
		3150	83
		4000	87
		5000	91
		R'w value **63**	
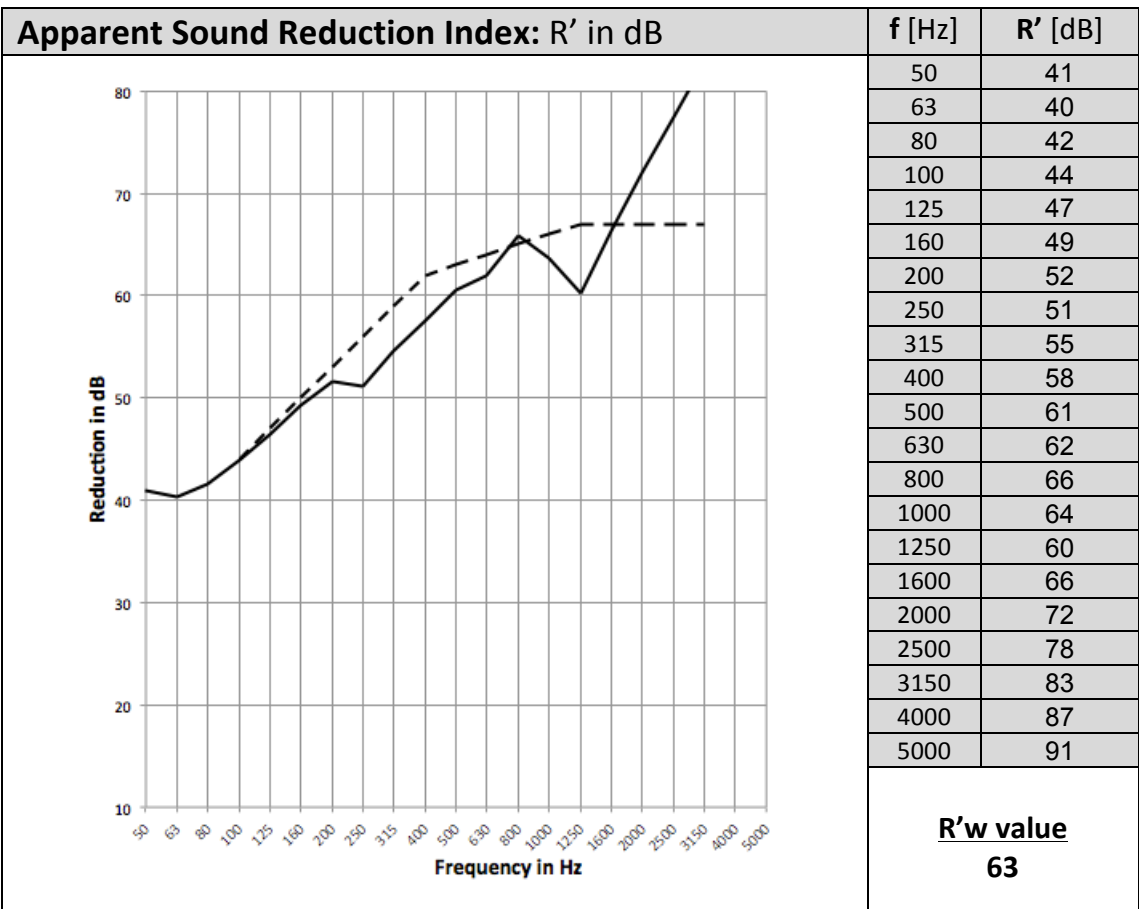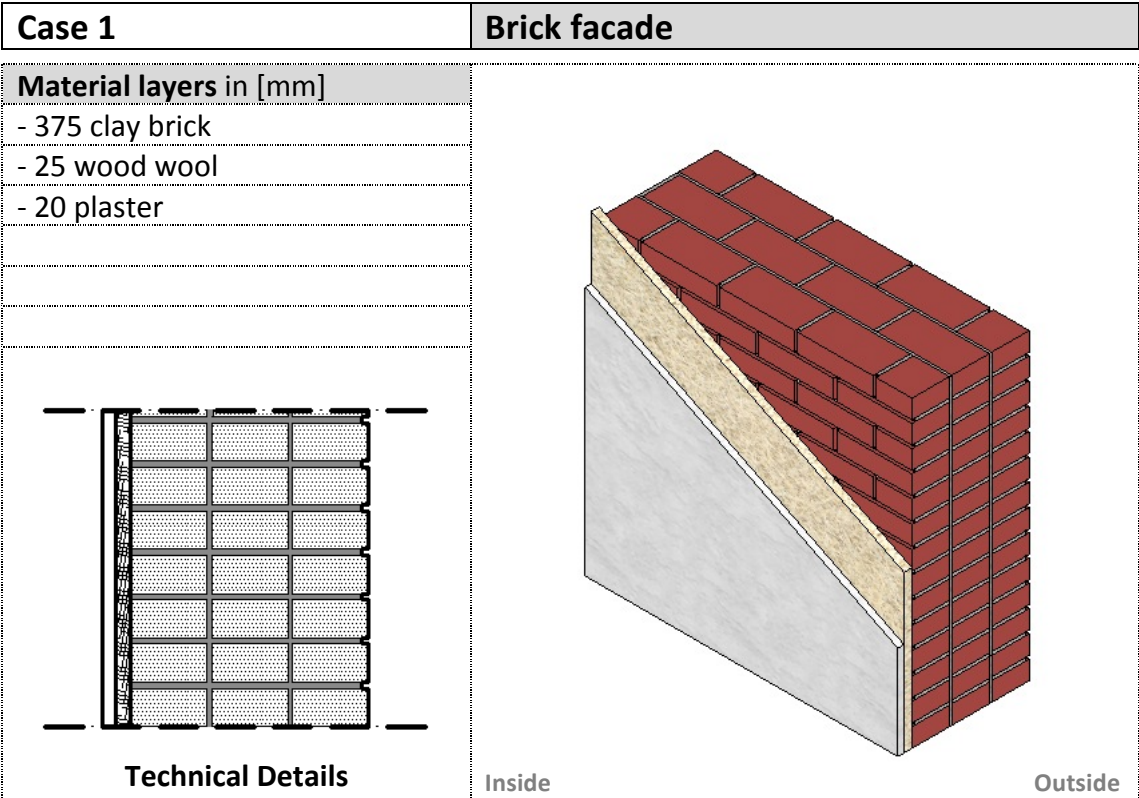
Case 2	Brick facade

Material layers in [mm]
- 20 plaster
- 375 clay brick
- 25 wood wool
- 20 plaster

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	41
	63	39
	80	40
	100	39
	125	40
	160	43
	200	45
	250	47
	315	50
	400	53
	500	55
	630	58
	800	61
	1000	63
	1250	66
	1600	68
	2000	71
	2500	74
	3150	76
	4000	79
	5000	82
	R'w value **58**	

Case 3	Brick facade

Material layers in [mm]
- 120 facade brick
- 25 air gap
- 250 clay brick
- plaster

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	36
	63	38
	80	38
	100	39
	125	40
	160	42
	200	45
	250	48
	315	50
	400	52
	500	54
	630	56
	800	58
	1000	60
	1250	62
	1600	64
	2000	65
	2500	65
	3150	65
	4000	64
	5000	63
	R'w value	
	58	

Reduction in dB

Frequency in Hz

Case 4	Brick facade

Material layers in [mm]
- 100 limestone wall
- 12 asphalt board
- 95 wooden studs frame with mineral wool
- 12 fiber board

Technical Details

Inside   Outside

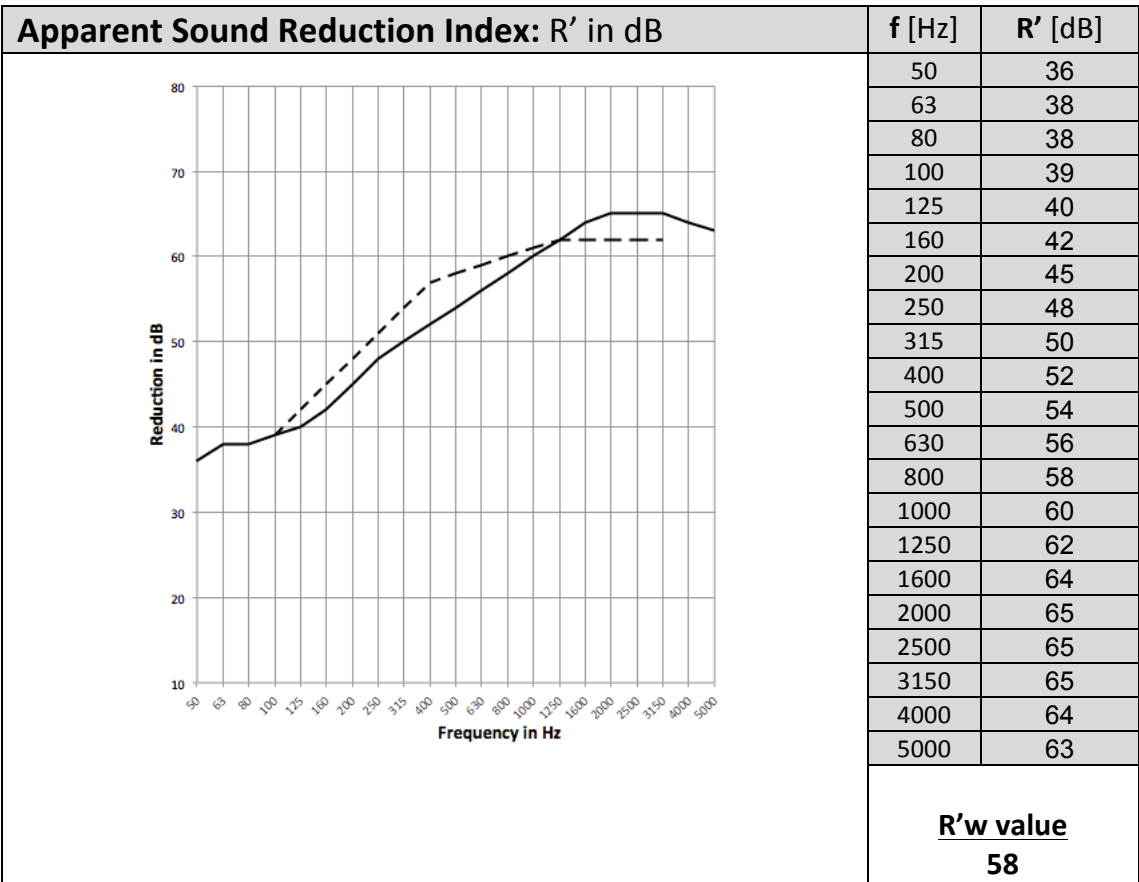| Apparent Sound Reduction Index: R' in dB		f [Hz]	R' [dB]
		50	26
		63	28
		80	24
		100	27
		125	28
		160	33
		200	33
		250	35
		315	38
		400	38
		500	42
		630	46
		800	48
		1000	51
		1250	54
		1600	56
		2000	54
		2500	49
		3150	52
		4000	49
		5000	49
		R'w value **46**	

Case 5	Brick facade

Material layers in [mm]	
- 100 Swedish "mexi" brick	
- 20 air gap	
- 9 reinforced gypsum panel	
- 95 wooden studs frame with glass wool	
- vapor barrier	
- 13 gypsum board	

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	23
	63	28
	80	33
	100	38
	125	42
	160	44
	200	46
	250	48
	315	50
	400	52
	500	54
	630	55
	800	56
	1000	57
	1250	58
	1600	60
	2000	60
	2500	60
	3150	58
	4000	57
	5000	56

R'w value
57

Case 5: Alternative versions	Brick facade

	Material layers in [mm]	
Case 5.1	- 100 Swedish "mexi" brick - 20 air gap - 9 reinforced gypsum panel - 95 wooden studs frame with glass wool - vapor barrier - 3*13 gypsum board	 **Technical Details**

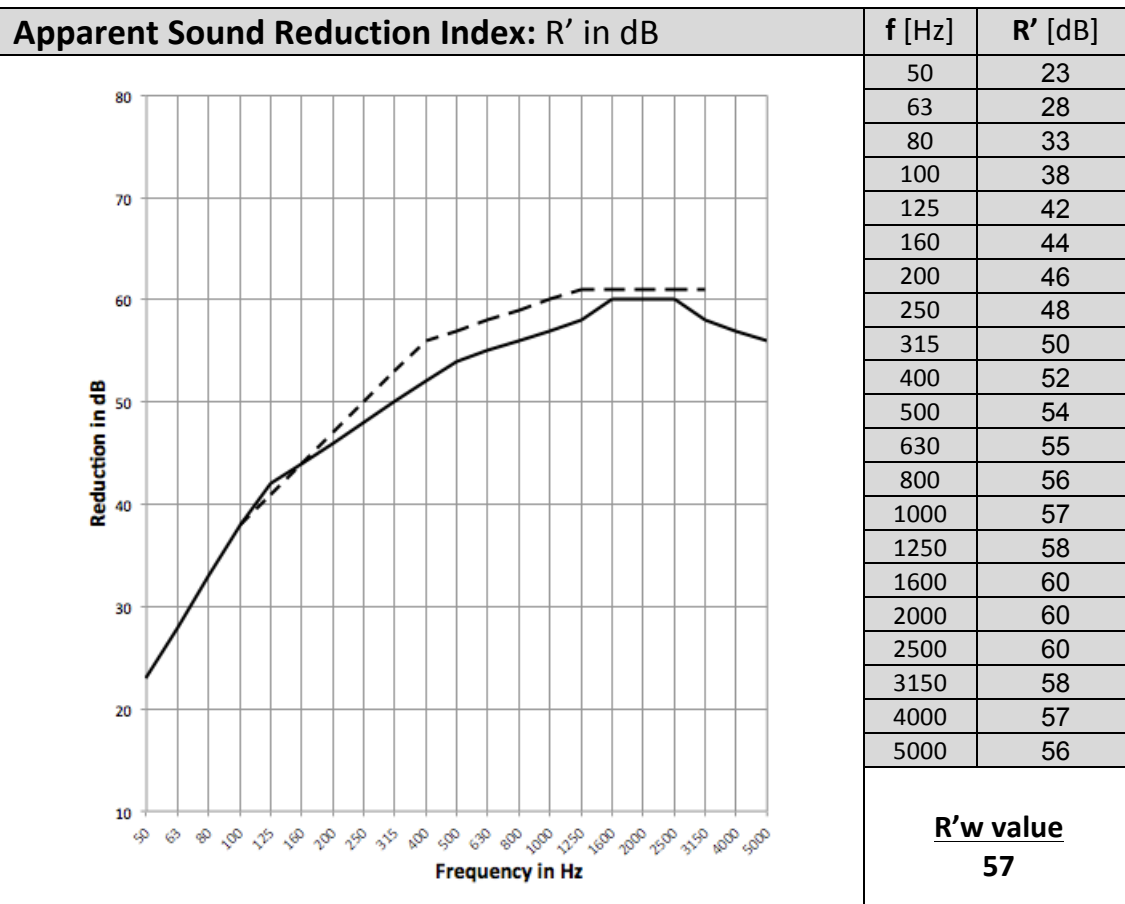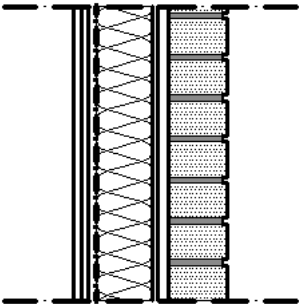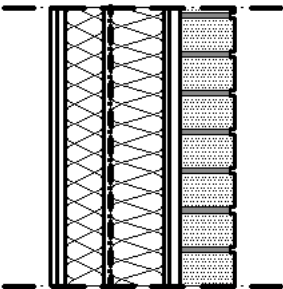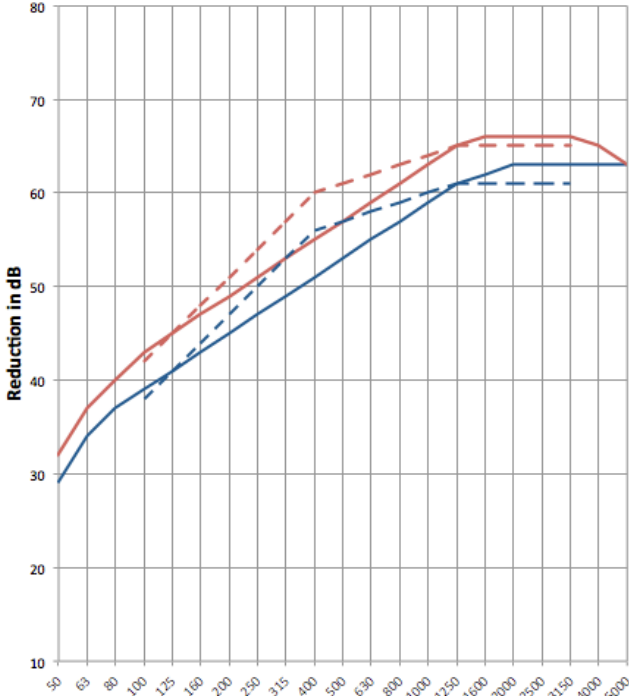|	Material layers in [mm]	
Case 5.2	- 100 Swedish "mexi" brick - 20 air gap - 9 reinforced gypsum panel - 95 wooden studs frame with glass wool - vapor barrier - 13 gypsum board - 70 acoustic profile with wool - 2*13 gypsum board	 **Technical Details**

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]	R' [dB]
	50	29	32
	63	34	37
	80	37	40
	100	39	43
	125	41	45
	160	43	47
	200	45	49
	250	47	51
	315	49	53
	400	51	55
	500	53	57
	630	55	59
	800	57	61
	1000	59	63
	1250	61	65
	1600	62	66
	2000	63	66
	2500	63	66
	3150	63	66
	4000	63	65
	5000	63	63
	R'w values	57	61

Case 6	Brick facade

Material layers in [mm]
- 120 clay brick wall
- 20 air gap
- 13 asphalt board
- 70 wooden studs frame
  with mineral wool
- vapor barrier
- 13 gypsum board

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	23
	63	25
	80	25
	100	30
	125	35
	160	40
	200	44
	250	46
	315	48
	400	50
	500	51
	630	52
	800	53
	1000	54
	1250	55
	1600	56
	2000	56
	2500	55
	3150	54
	4000	53
	5000	52

R'w value
53
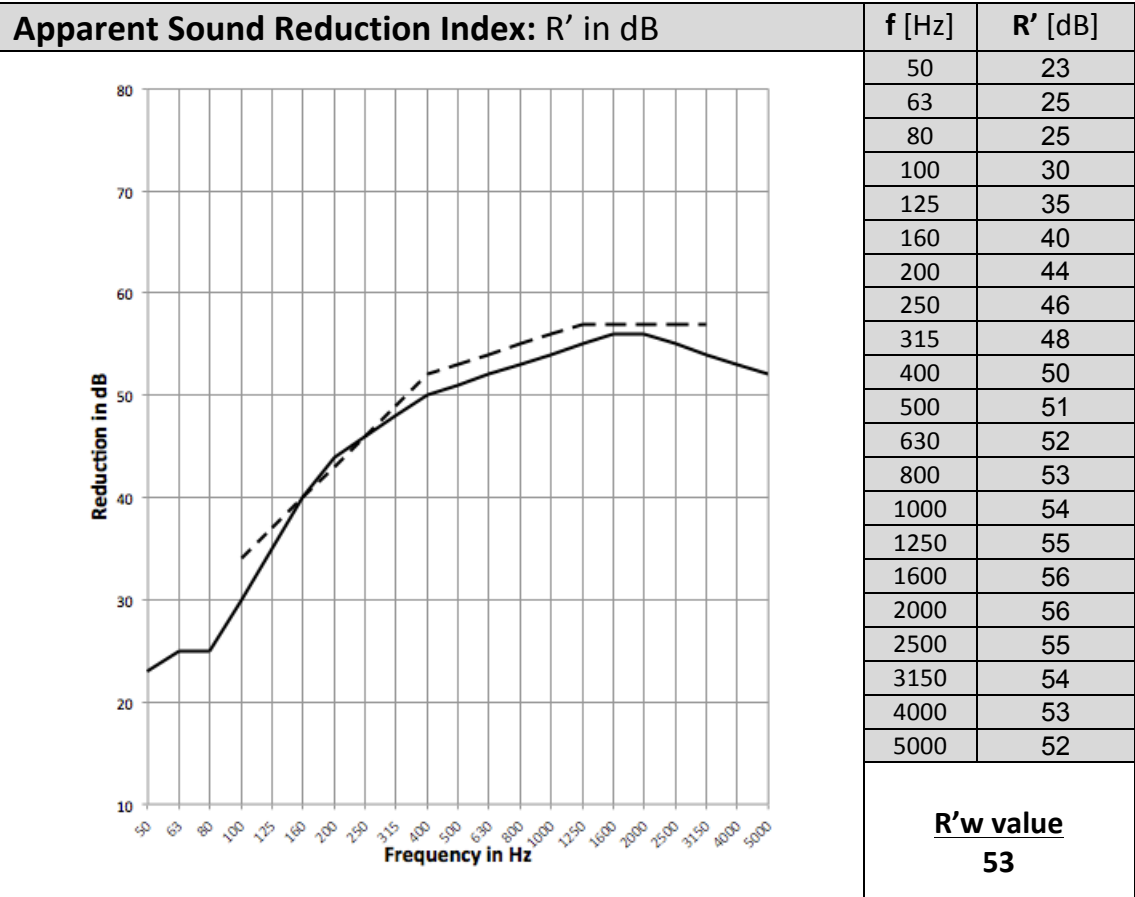
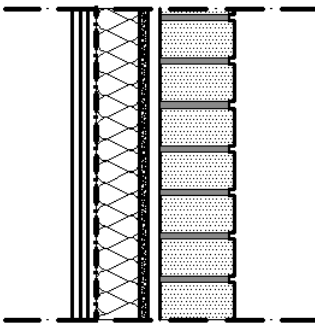| Case 6: Alternative versions	Brick facade

Case 6.1

Material layers in [mm]
- 120 clay brick wall
- 20 air gap
- 13 asphalt board
- 70 wooden studs frame
  with mineral wool
- vapor barrier
- 3*13 gypsum board

Technical Details

Case 6.2

Material layers in [mm]
- 120 clay brick wall
- 20 air gap
- 13 asphalt board
- 70 wooden studs frame
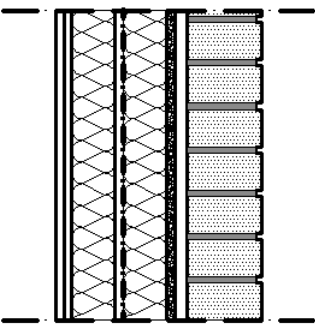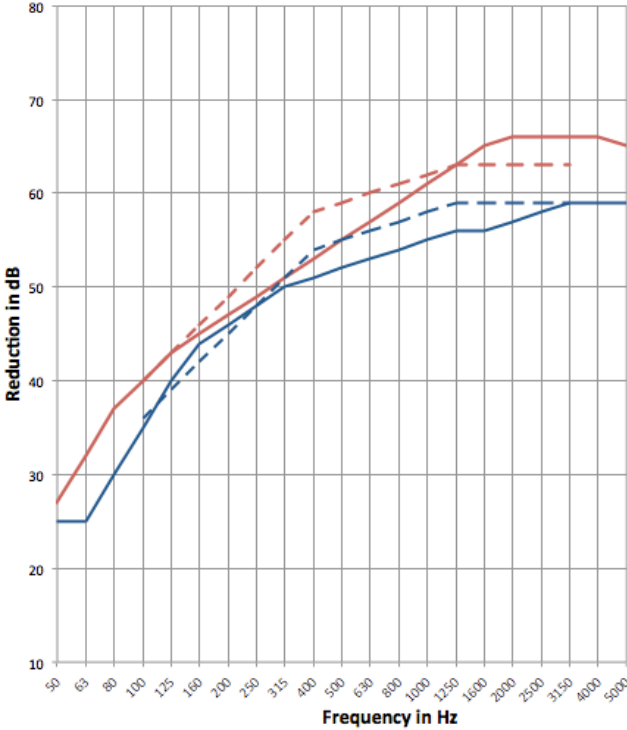 with mineral wool
- vapor barrier
- 13 gypsum board
- acoustic profile with wool
- 2*13 gypsum board

Technical Details

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]	R' [dB]
	50	25	27
	63	25	32
	80	30	37
	100	35	40
	125	40	43
	160	44	45
	200	46	47
	250	48	49
	315	50	51
	400	51	53
	500	52	55
	630	53	57
	800	54	59
	1000	55	61
	1250	56	63
	1600	56	65
	2000	57	66
	2500	58	66
	3150	59	66
	4000	59	66
	5000	59	65
	R'w values	**55**	**59**

Case 7	Stone facade

Material layers in [mm]
- 125 limestone masonry
- 20 air gap
- 170 wooden studs frame
  with mineral wool
- vapor barrier
- 13 gypsum board

Technical Details | Inside   Outside

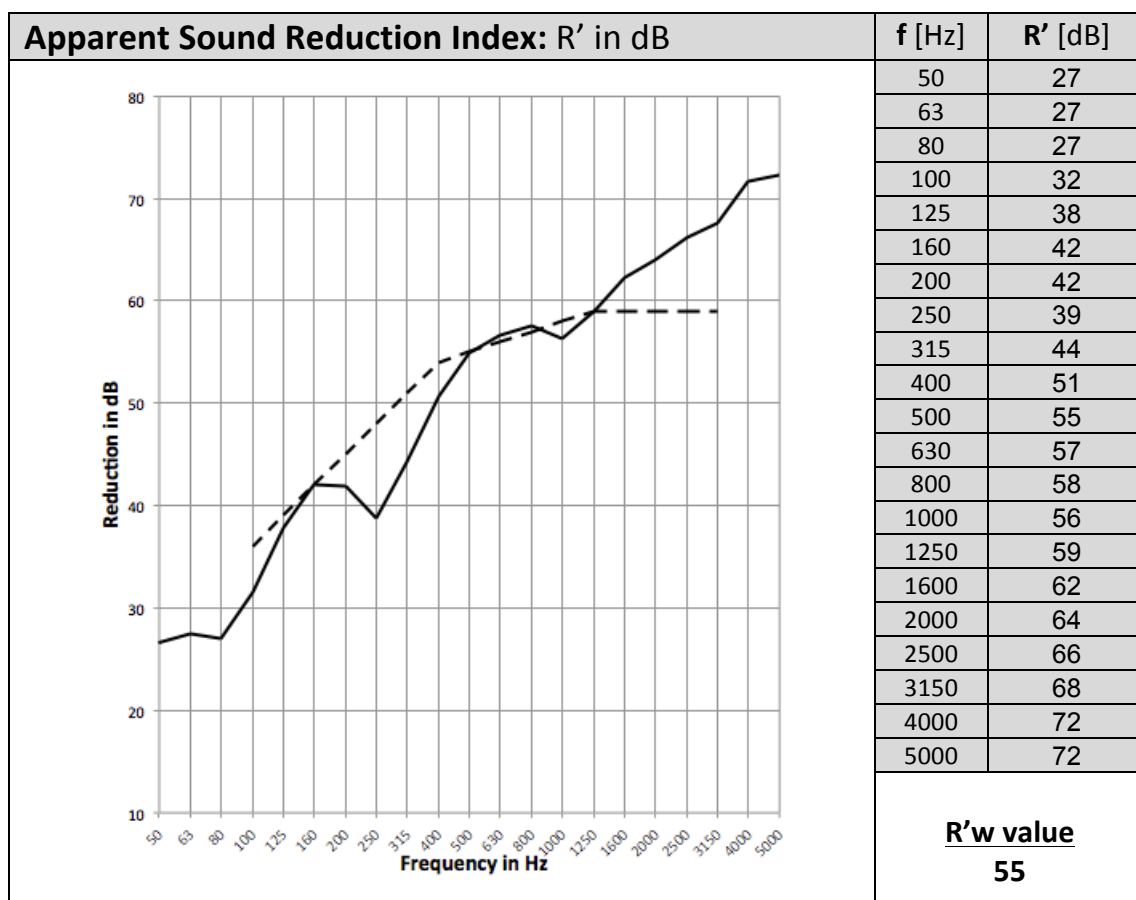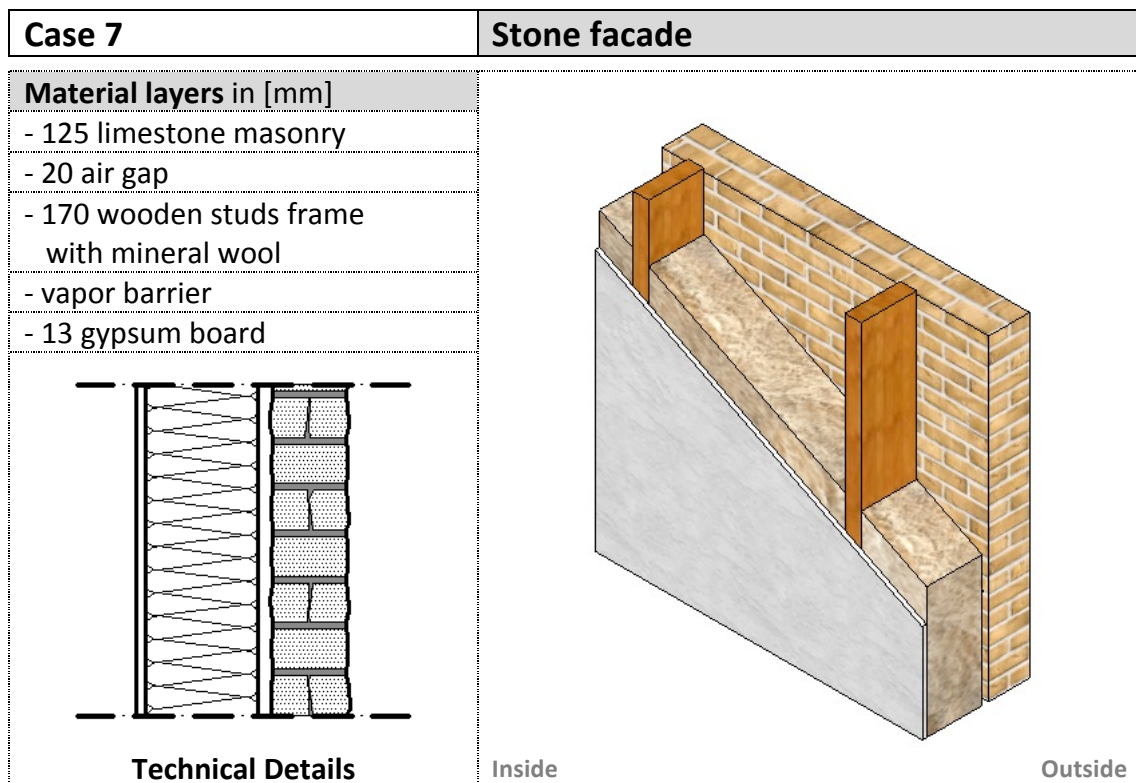| Apparent Sound Reduction Index: R' in dB		f [Hz]	R' [dB]
		50	27
		63	27
		80	27
		100	32
		125	38
		160	42
		200	42
		250	39
		315	44
		400	51
		500	55
		630	57
		800	58
		1000	56
		1250	59
		1600	62
		2000	64
		2500	66
		3150	68
		4000	72
		5000	72
		R'w value **55**	

Case 8	Stone facade

Material layers in [mm]
- 125 limestone masonry
- 20 air gap
- 9 fiber concrete board
- 95 wooden studs frame
  with mineral wool
- 9 fiber concrete board
- 13 gypsum board

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	35
	63	33
	80	39
	100	44
	125	45
	160	47
	200	43
	250	41
	315	45
	400	48
	500	50
	630	53
	800	56
	1000	59
	1250	63
	1600	67
	2000	70
	2500	73
	3150	78
	4000	81
	5000	84

R'w value
55

Case 9	Wood facade

Material layers in [mm]
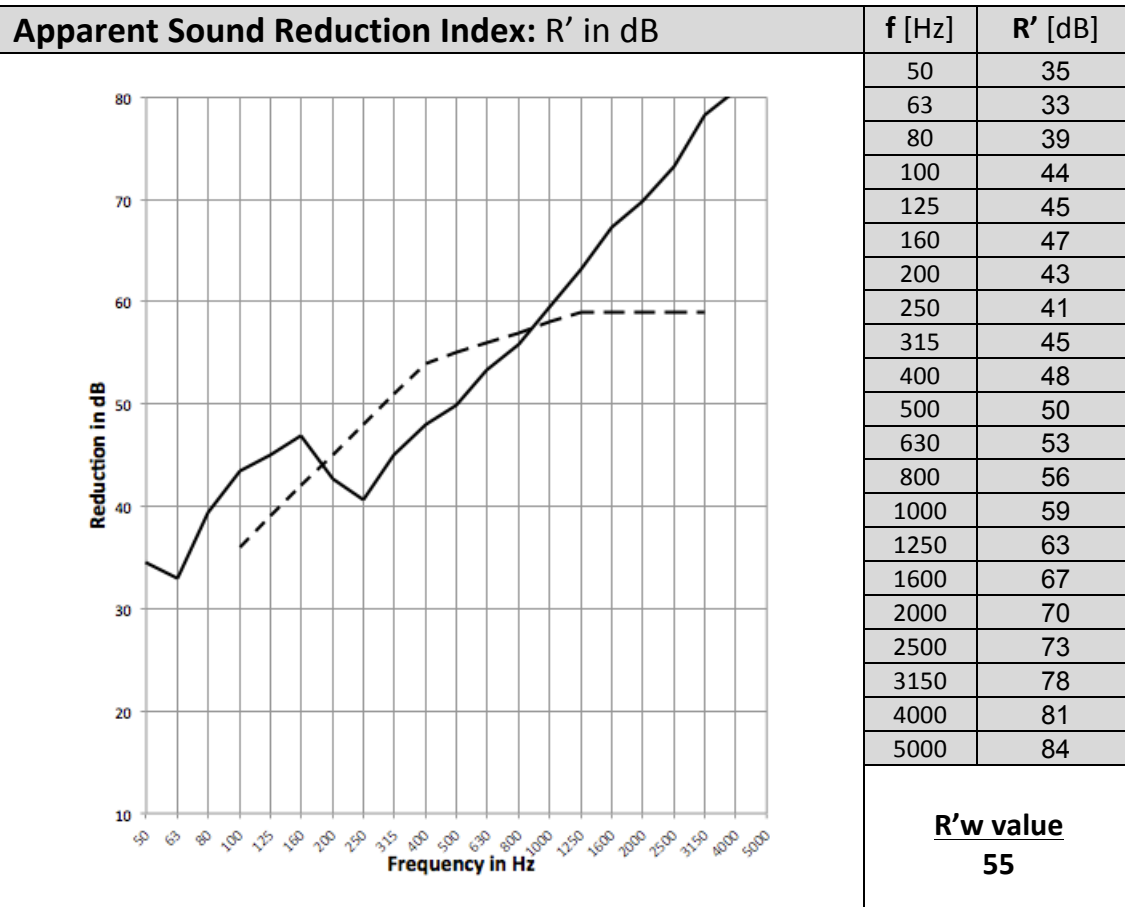
- 19 wood panels
- 150 timber
- 22 wood board

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	17
	63	18
	80	19
	100	14
	125	16
	160	19
	200	20
	250	22
	315	24
	400	25
	500	27
	630	27
	800	24
	1000	24
	1250	27
	1600	30
	2000	33
	2500	36
	3150	39
	4000	42
	5000	45

R'w value
28

| Case 10 | Wood facade |

Material layers in [mm]
- 25 wood panels
- 75 wood plankwall
- 25 wood panel

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	17
	63	13
	80	17
	100	20
	125	15
	160	18
	200	17
	250	17
	315	20
	400	21
	500	22
	630	22
	800	18
	1000	22
	1250	27
	1600	31
	2000	34
	2500	38
	3150	43
	4000	45
	5000	49

R'w value
25
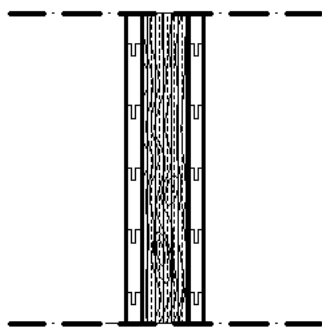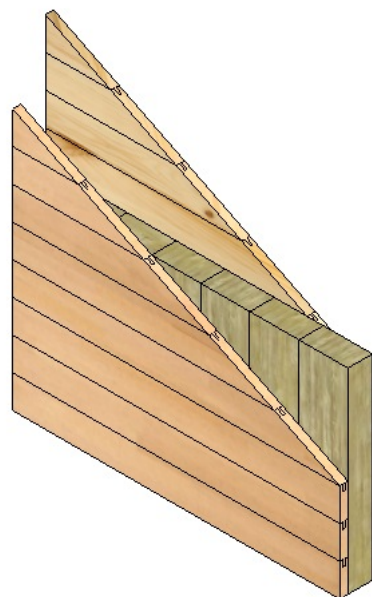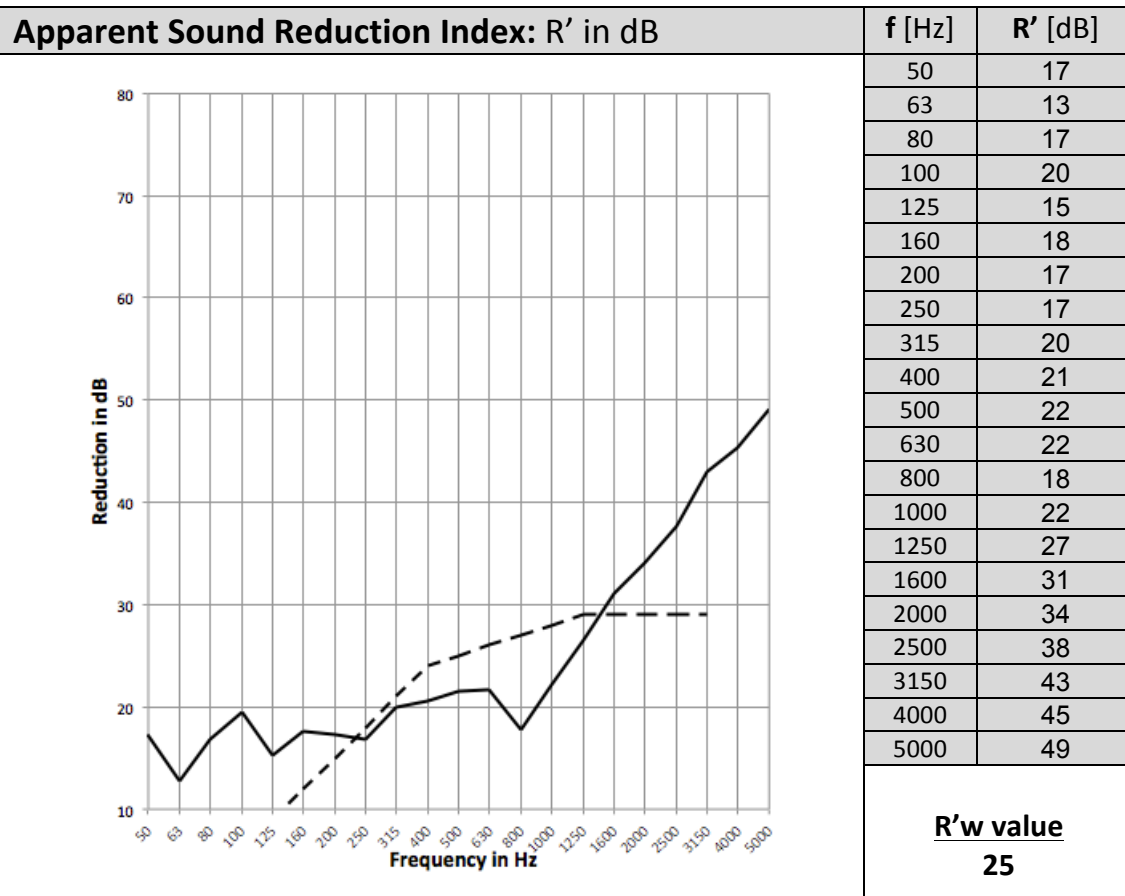
Case 11	Wood facade

Material layers in [mm]
- 25 wood panels
- 125 timber
- 14 wood panels

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	30
	63	25
	80	26
	100	23
	125	24
	160	29
	200	28
	250	27
	315	27
	400	29
	500	27
	630	30
	800	32
	1000	38
	1250	39
	1600	42
	2000	45
	2500	49
	3150	51
	4000	54
	5000	58
	R'w value	
	35	

Case 12	Wood facade

Material layers in [mm]
- 25 wood panels
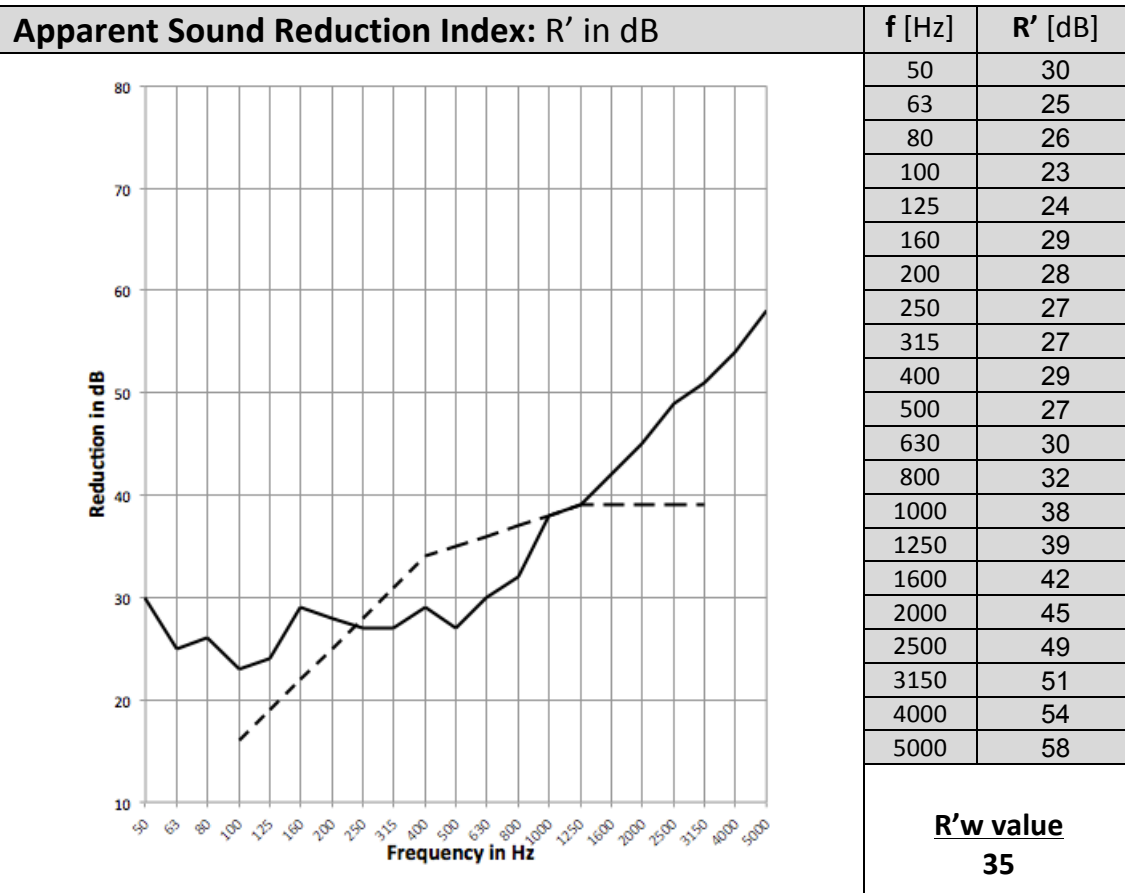- 25 air gap with wooden studs
- 125 timber
- 13 porous board

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	18
	63	22
	80	24
	100	26
	125	27
	160	28
	200	29
	250	31
	315	34
	400	37
	500	39
	630	41
	800	43
	1000	45
	1250	47
	1600	49
	2000	49
	2500	49
	3150	49
	4000	49
	5000	49
	R'w value 43	

Case 12: Alternative versions	Wood facade

	Material layers in [mm]	
Case 12.1	- 25 wood panels - 25 air gap with wooden studs - 125 timber - 13 porous board - 2*13 gypsum board	 **Technical Details**

	Material layers in [mm]	
Case 12.2	- 25 wood panels - 25 air gap with wooden studs - 125 timber - 9 reinforced gypsum panel - 70 wooden studs frame with mineral wool - 13 porous board	 **Technical Details**

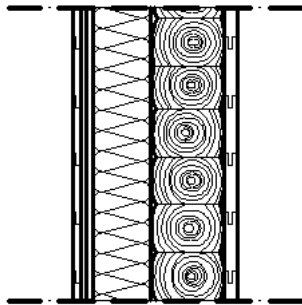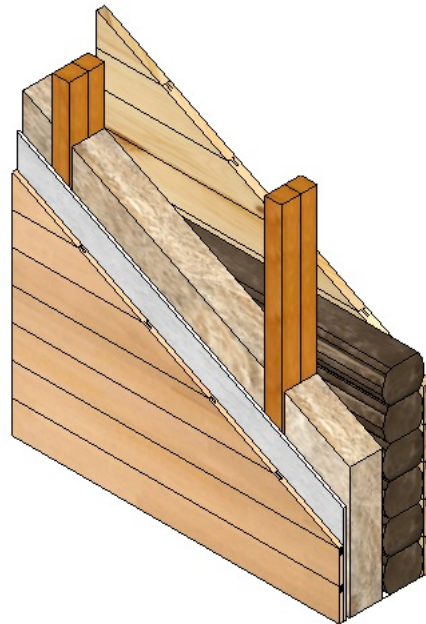| Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]	R' [dB]
	50	22	25
	63	25	28
	80	27	31
	100	28	33
	125	29	35
	160	30	37
	200	31	39
	250	32	40
	315	34	41
	400	36	42
	500	38	43
	630	40	44
	800	42	45
	1000	44	46
	1250	46	48
	1600	48	50
	2000	50	52
	2500	52	54
	3150	53	56
	4000	53	56
	5000	53	56
	R'w values	**43**	**47**
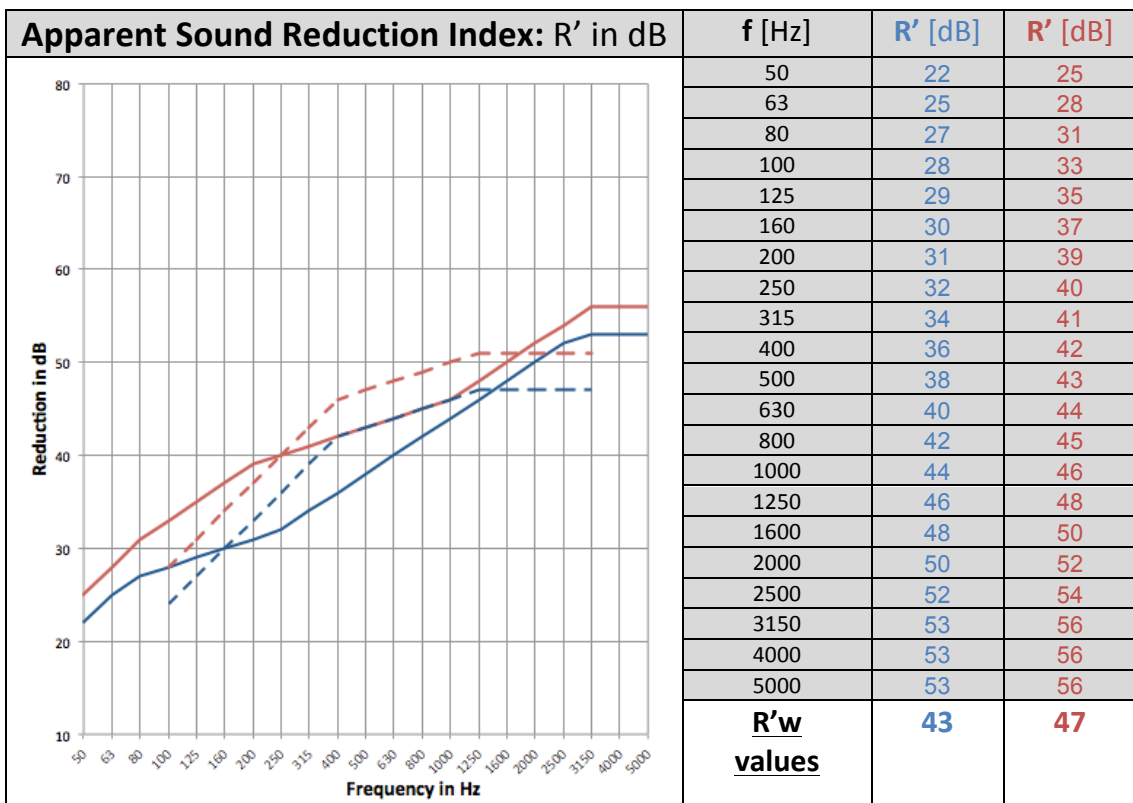
Case 13	Wood facade

Material layers in [mm]
- 25 wood panels
- 125 timber
- 100 wooden studs frame
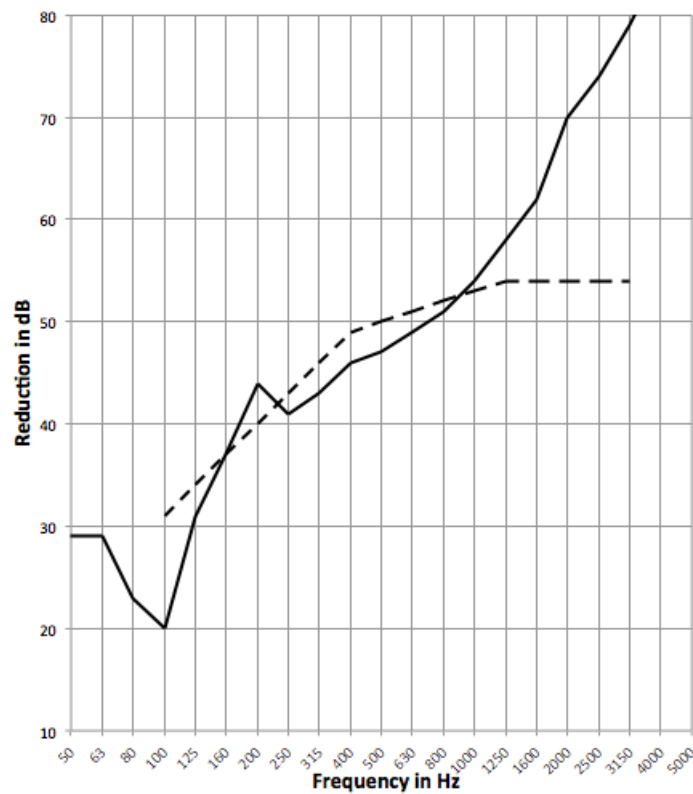 with mineral wool
- 10 air gap
- 9 gypsum board
- 14 wood panels

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	29
	63	29
	80	23
	100	20
	125	31
	160	37
	200	44
	250	41
	315	43
	400	46
	500	47
	630	49
	800	51
	1000	54
	1250	58
	1600	62
	2000	70
	2500	74
	3150	79
	4000	85
	5000	87

R'w value
50

Case 13: Alternative versions	Wood facade

	Material layers in [mm]
Case 13.1	- 25 wood panels
	- 125 timber
	- 100 wooden studs frame with mineral wool
	- 10 air gap
	- 12 asphalt board
	- 14 wood panels

Technical Details

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	30
	63	30
	80	24
	100	18
	125	26
	160	36
	200	42
	250	43
	315	43
	400	46
	500	48
	630	48
	800	50
	1000	52
	1250	55
	1600	61
	2000	67
	2500	71
	3150	78
	4000	79
	5000	76
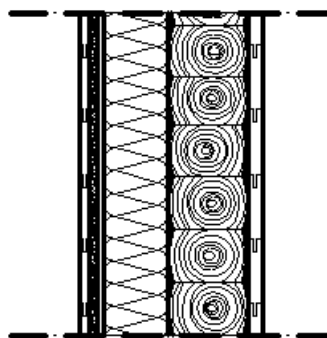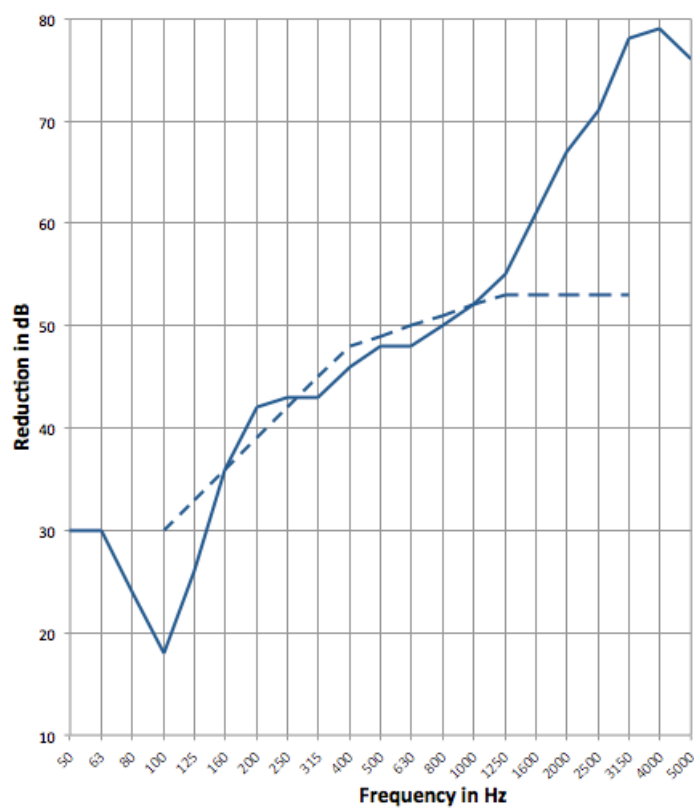
R'w value

49

| Case 14 | Wood facade |

Material layers in [mm]
- 30 plaster
- 100 timber
- 20 wood panels
- 20 clay

Technical Details

Inside   Outside

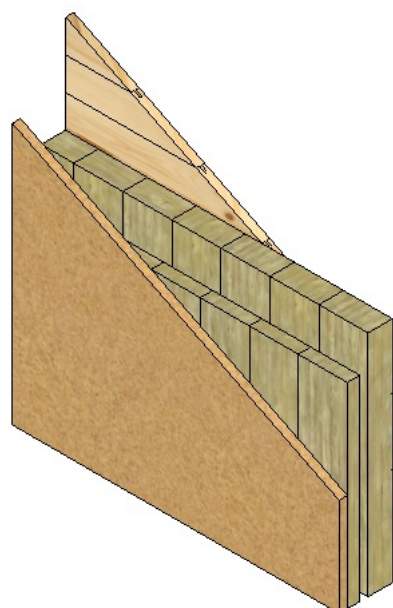| Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	26
	63	20
	80	23
	100	25
	125	27
	160	29
	200	31
	250	32
	315	34
	400	35
	500	36
	630	37
	800	36
	1000	33
	1250	35
	1600	38
	2000	41
	2500	44
	3150	47
	4000	50
	5000	53

R'w value
38
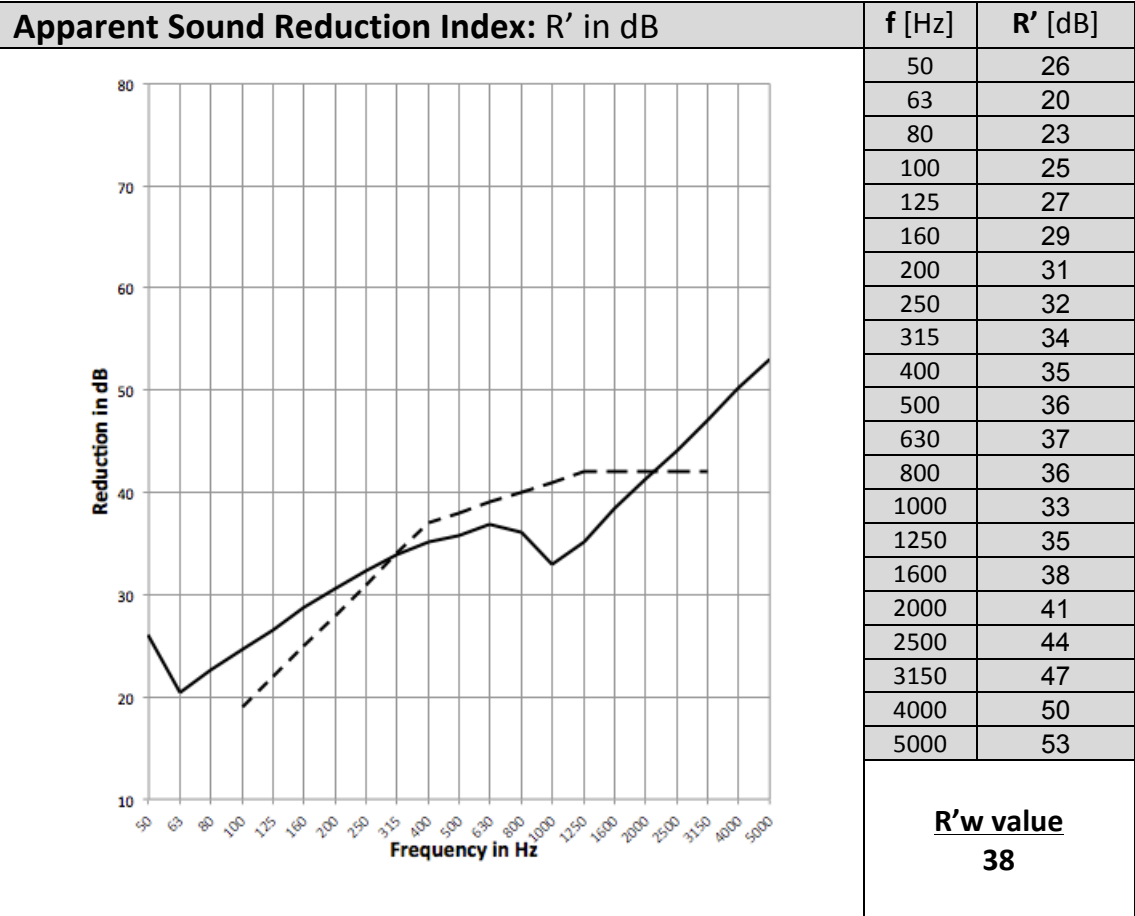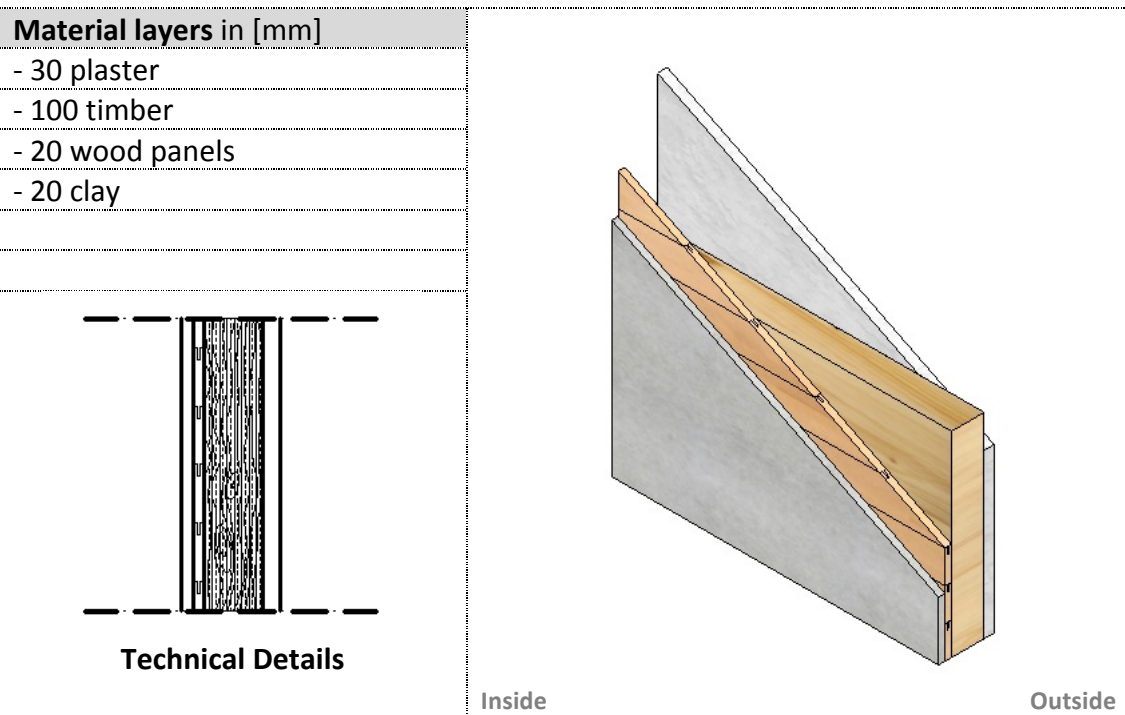
Case 15	Wood facade

Material layers in [mm]
- 25 wood panels
- 75 wood plank wall
- 25 air gap
- 38 wood plank wall
- 25 fiber board

Technical Details
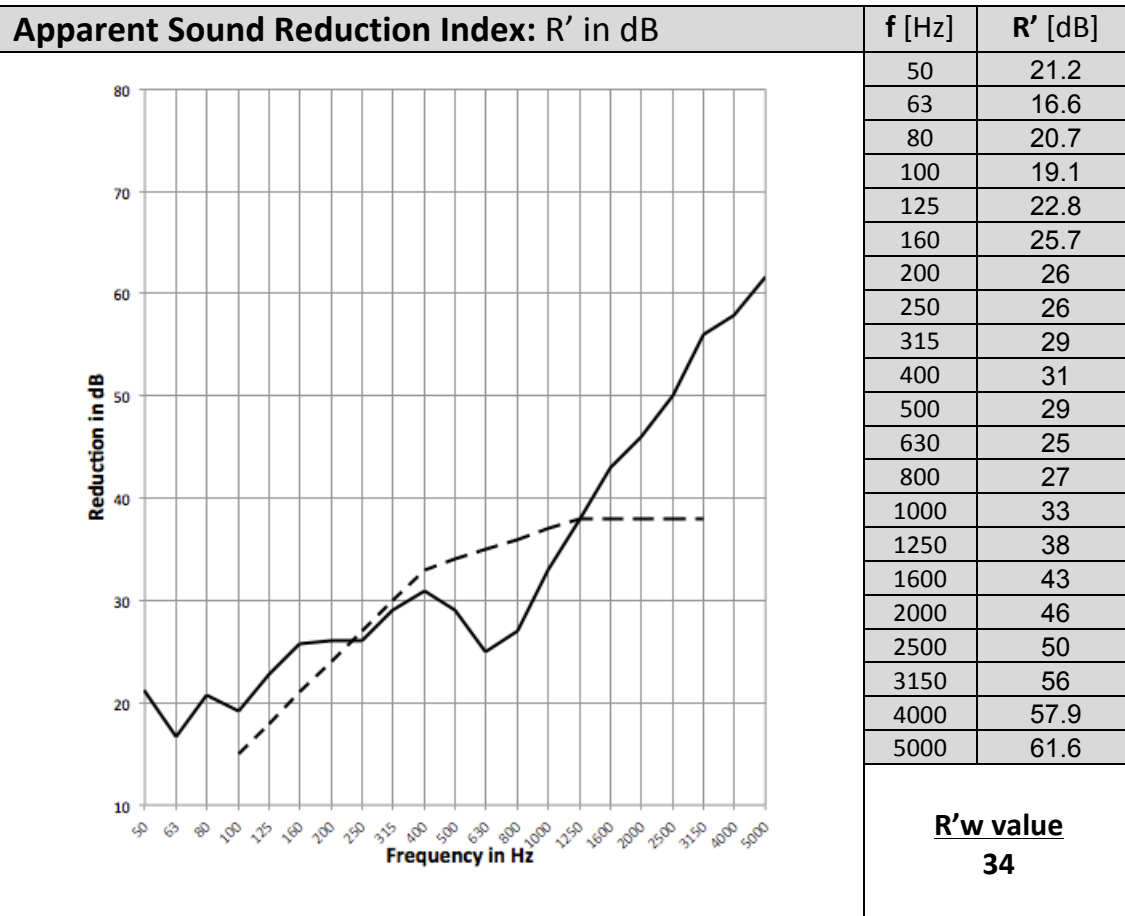
Inside   Outside

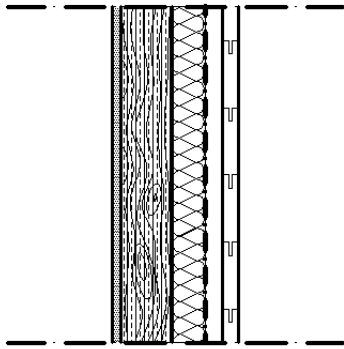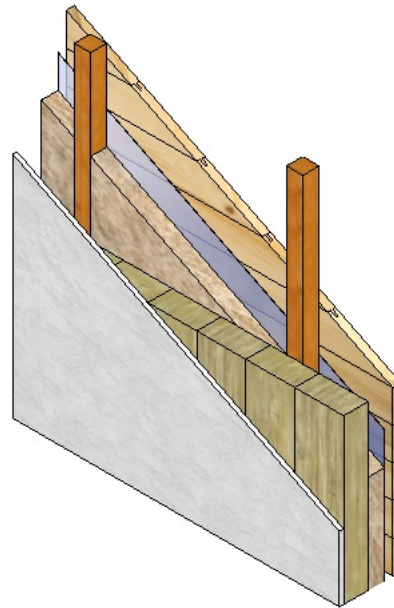| Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	21.2
	63	16.6
	80	20.7
	100	19.1
	125	22.8
	160	25.7
	200	26
	250	26
	315	29
	400	31
	500	29
	630	25
	800	27
	1000	33
	1250	38
	1600	43
	2000	46
	2500	50
	3150	56
	4000	57.9
	5000	61.6
	R'w value	
	34	
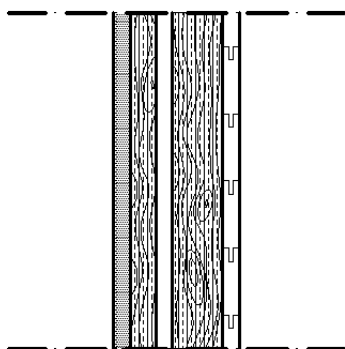
Case 16	Wood facade

Material layers in [mm]
- 25 wood panels
- 25 air gap
- vapor barrier
- 50 wooden studs frame
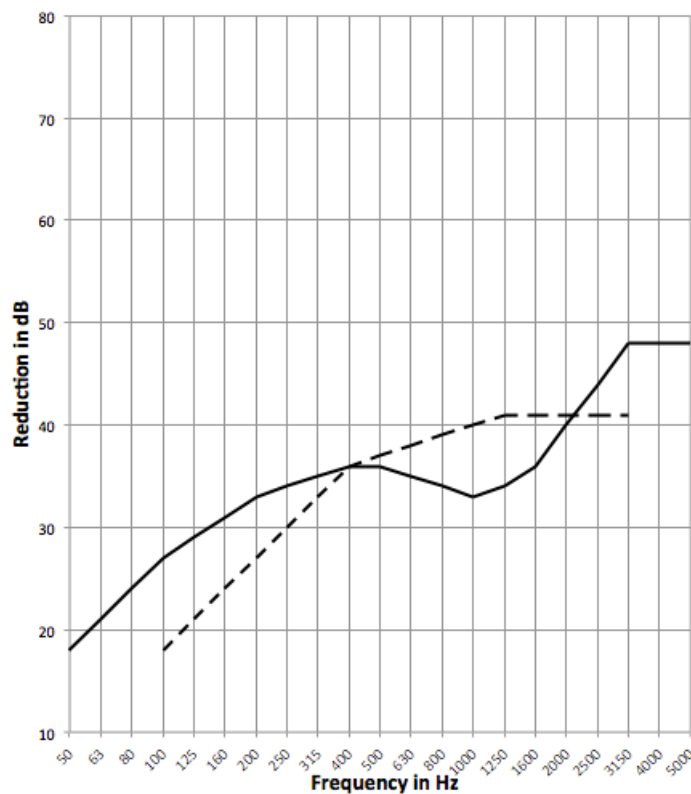 with mineral wool
- 75 wood plank wall
- 13 porous board

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	18
	63	21
	80	24
	100	27
	125	29
	160	31
	200	33
	250	34
	315	35
	400	36
	500	36
	630	35
	800	34
	1000	33
	1250	34
	1600	36
	2000	40
	2500	44
	3150	48
	4000	48
	5000	48

R'w value
37

Case 16: Alternative versions	Wood facade

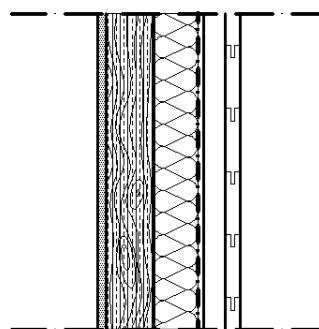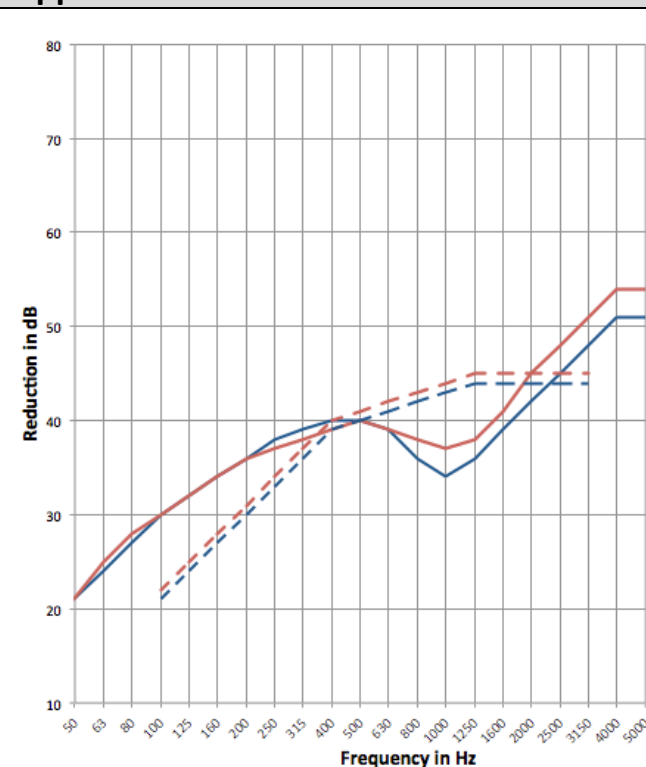|	Material layers in [mm]	
Case 16.1	- 25 wood panels - 25 air gap - vapor barrier - 50 wooden studs frame with mineral wool - 75 wood plank wall - 13 porous board - 2*13 gypsum board	**Technical Details**
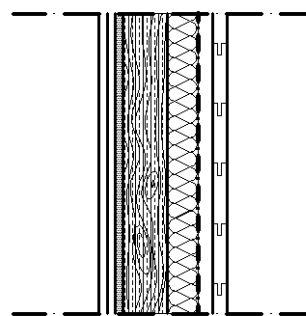
	Material layers in [mm]	
Case 16.2	- 25 wood panels - 25 air gap - vapor barrier - 9 gypsum board - 75 wooden studs frame with mineral wool - 75 wood plank wall - 13 porous board	**Technical Details**
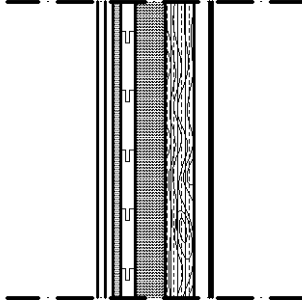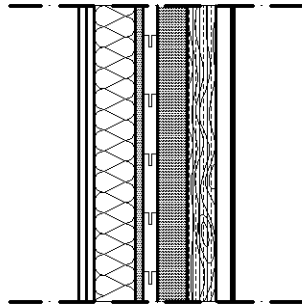
Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]	R' [dB]
	50	21	21
	63	24	25
	80	27	28
	100	30	30
	125	32	32
	160	34	34
	200	36	36
	250	38	37
	315	39	38
	400	40	39
	500	40	40
	630	39	39
	800	36	38
	1000	34	37
	1250	36	38
	1600	39	41
	2000	42	45
	2500	45	48
	3150	48	51
	4000	51	54
	5000	51	54
	R'w values	**40**	**41**

Case 17	Wood facade
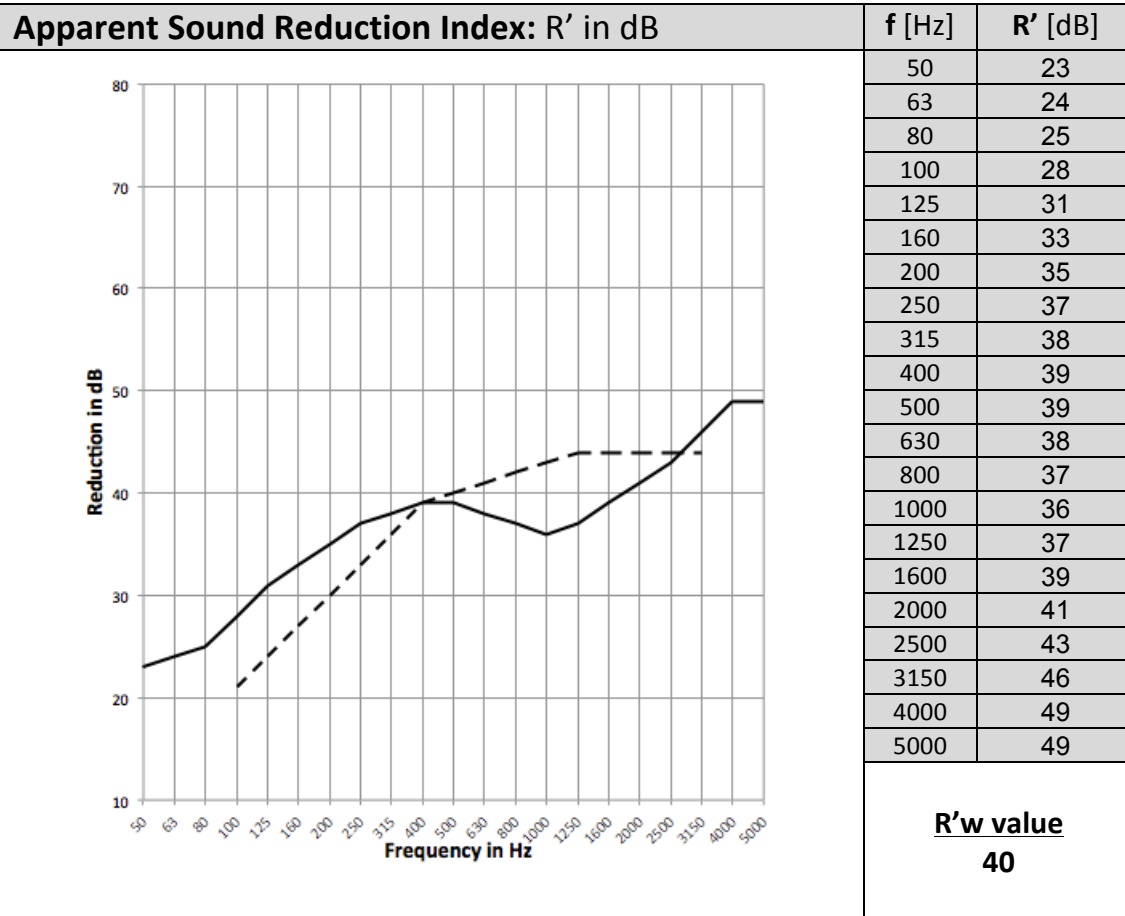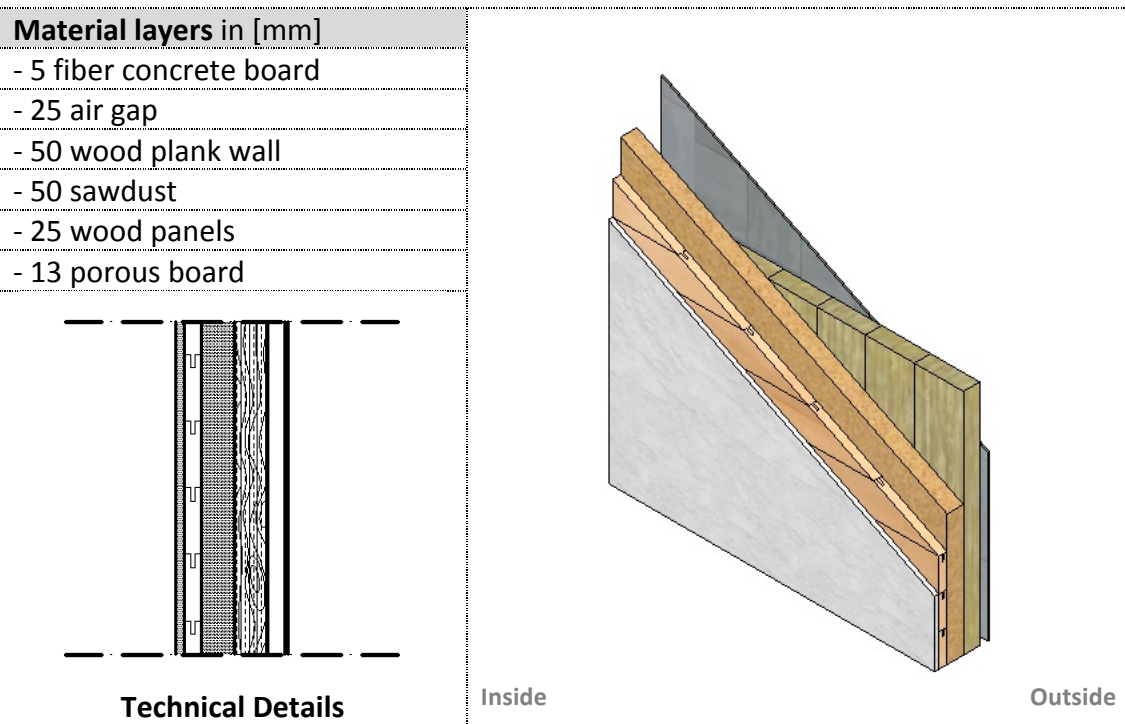
Material layers in [mm]
- 5 fiber concrete board
- 25 air gap
- 50 wood plank wall
- 50 sawdust
- 25 wood panels
- 13 porous board

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	23
	63	24
	80	25
	100	28
	125	31
	160	33
	200	35
	250	37
	315	38
	400	39
	500	39
	630	38
	800	37
	1000	36
	1250	37
	1600	39
	2000	41
	2500	43
	3150	46
	4000	49
	5000	49
	R'w value	
	40	

Case 17: Alternative versions	Wood facade

	Material layers in [mm]	
Case 17.1	- 5 fiber concrete board - 25 air gap - 50 wood plank wall - 50 sawdust - 25 wood panels - 13 porous board - 2*13 gypsum board	 **Technical Details**

	Material layers in [mm]	
Case 17.2	- 5 fiber concrete board - 25 air gap - 50 wood plank wall - 50 sawdust - 25 wood panels - 13 porous board - 70 wooden studs frame with mineral wool - 2*13 gypsum board	 **Technical Details**

Apparent Sound Reduction Index: R' in dB		f [Hz]	R' [dB]	R' [dB]
		50	23	26
		63	27	28
		80	30	30
		100	33	32
		125	36	34
		160	38	36
		200	39	38
		250	40	40
		315	41	42
		400	42	43
		500	42	44
		630	41	45
		800	40	46
		1000	39	47
		1250	40	48
		1600	41	49
		2000	43	50
		2500	46	51
		3150	49	52
		4000	51	53
		5000	53	54
		R'w values	**42**	**47**
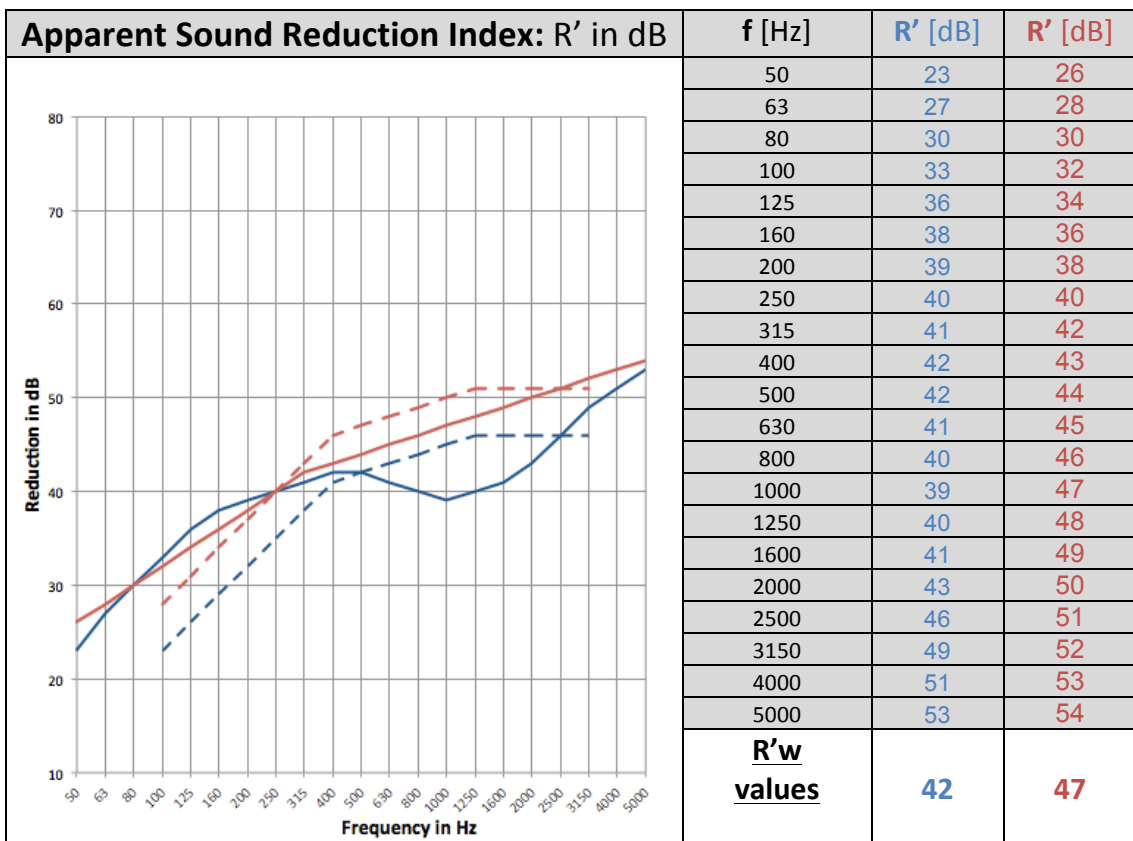
Case 18	Wood facade with plaster

Material layers in [mm]
- 30 plaster
- 22 wood panels
- 75 wood plank wall
- 25 fiber board

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	22
	63	17
	80	21
	100	18
	125	21
	160	23
	200	23
	250	23
	315	26
	400	27
	500	28
	630	29
	800	27
	1000	25
	1250	29
	1600	34
	2000	37
	2500	40
	3150	45
	4000	48
	5000	52

R'w value
30
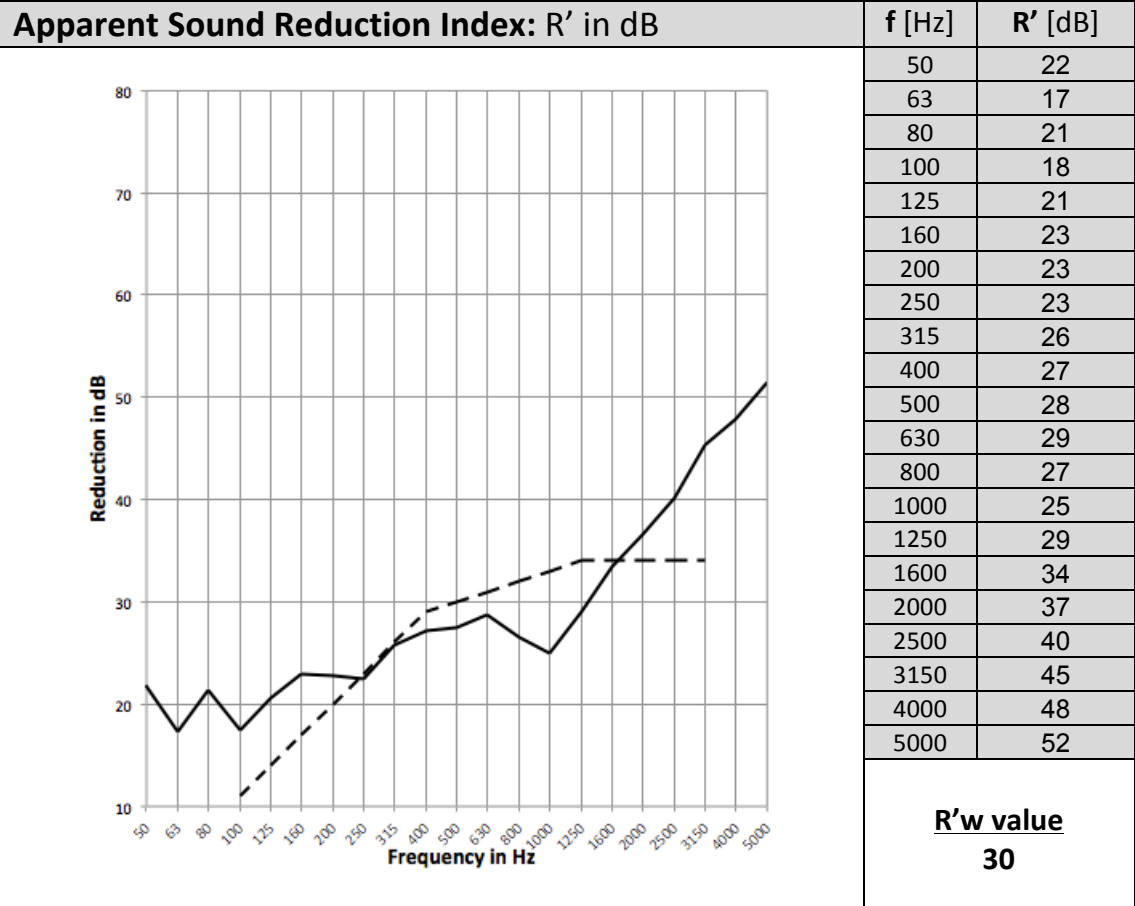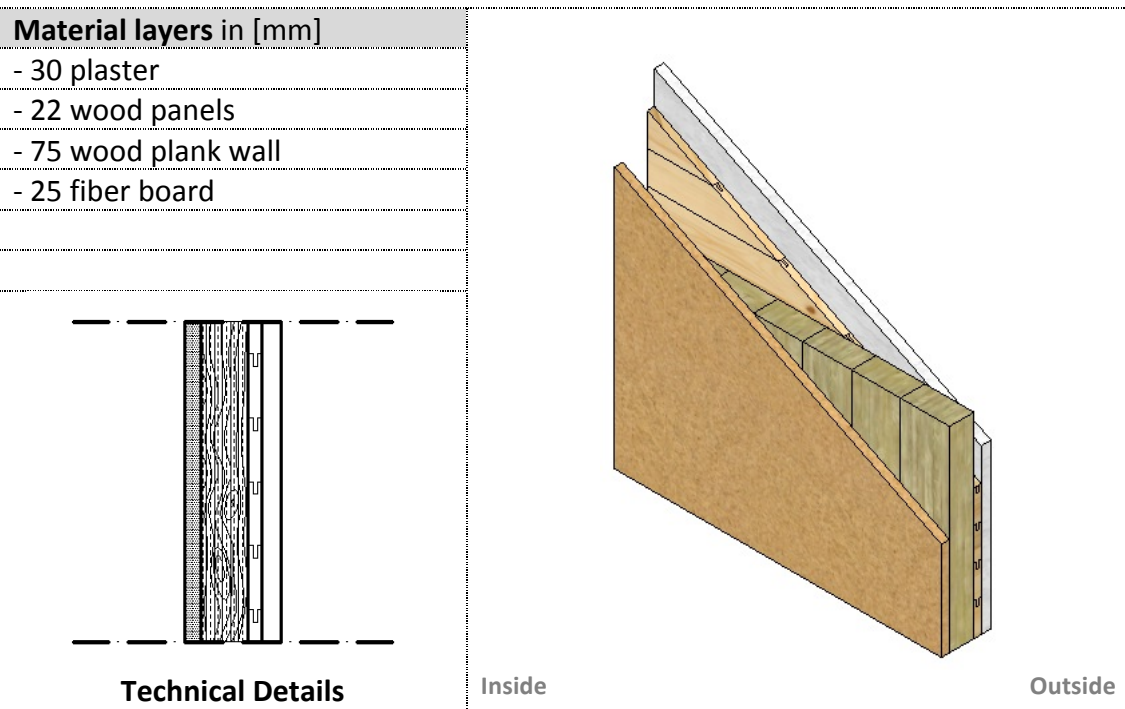
Case 19	Wood facade with plaster

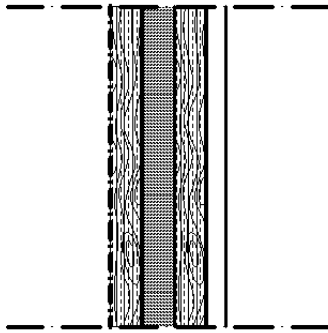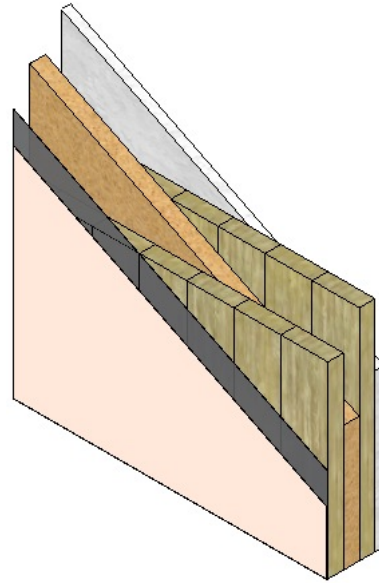**Material layers** in [mm]
- 30 plaster
- 50 wood plank wall
- 50 sawdust
- 50 wood plank wall
- insulation paper
- paper wall

Technical Details

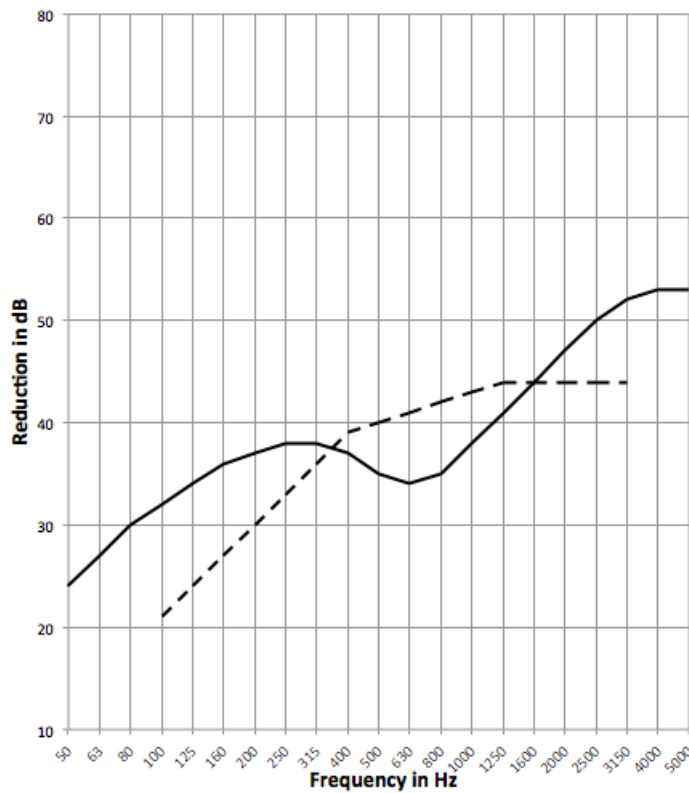Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	24
	63	27
	80	30
	100	32
	125	34
	160	36
	200	37
	250	38
	315	38
	400	37
	500	35
	630	34
	800	35
	1000	38
	1250	41
	1600	44
	2000	47
	2500	50
	3150	52
	4000	53
	5000	53

R'w value
40

Case 19: Alternative versions	Wood facade with plaster

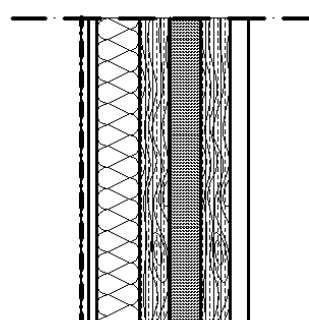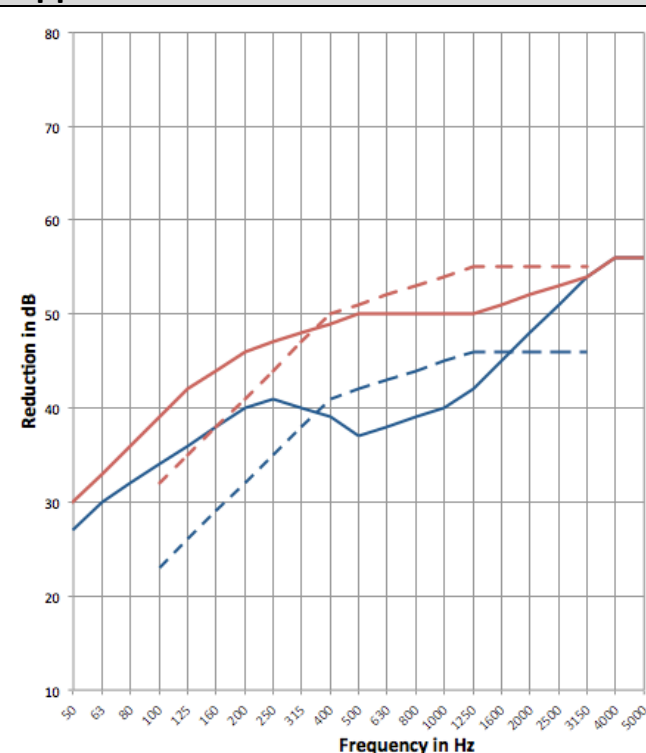|	Material layers in [mm]	
Case 19.1	- 30 plaster - 50 wood plank wall - 50 sawdust - 50 wood plank wall - 2*13 gypsum board - insulation paper - paper wall	 **Technical Details**

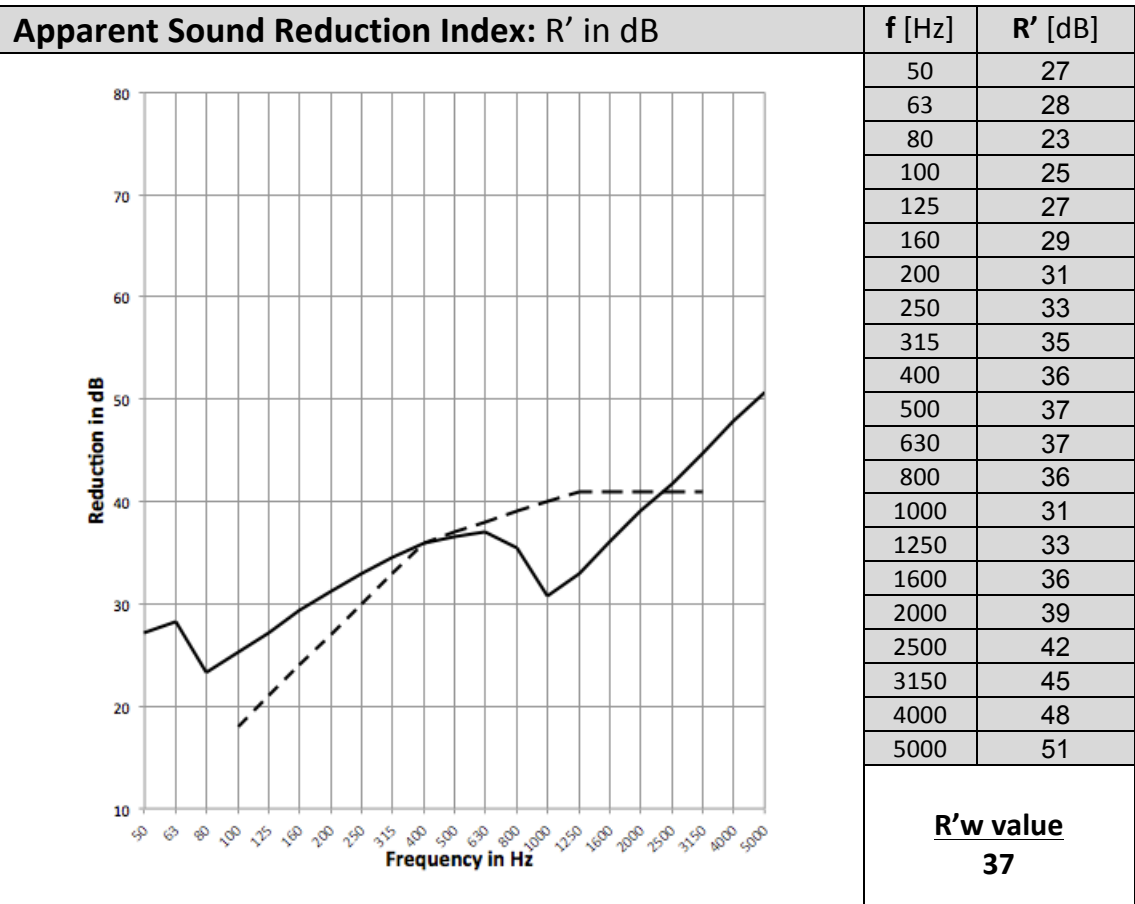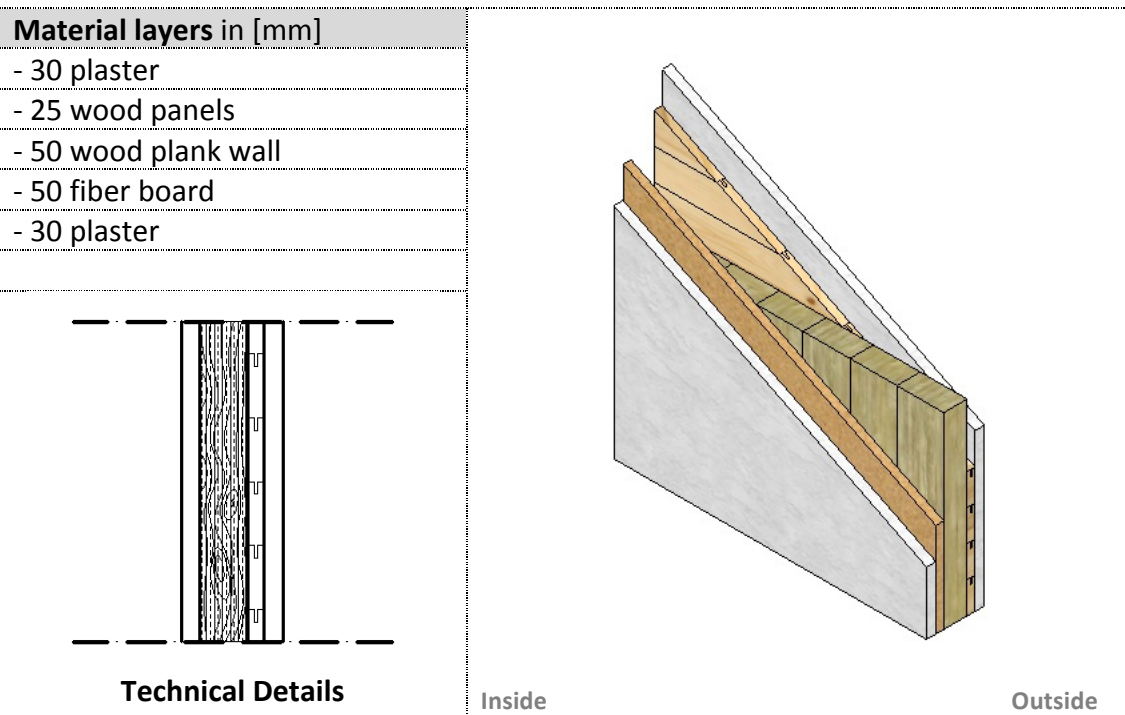|	Material layers in [mm]	
Case 19.2	- 30 plaster - 50 wood plank wall - 50 sawdust - 50 wood plank wall - 70 acoustic profile with wool - 2*13 gypsum board - insulation paper - paper wall	 **Technical Details**

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]	R' [dB]
	50	27	30
	63	30	33
	80	32	36
	100	34	39
	125	36	42
	160	38	44
	200	40	46
	250	41	47
	315	40	48
	400	39	49
	500	37	50
	630	38	50
	800	39	50
	1000	40	50
	1250	42	50
	1600	45	51
	2000	48	52
	2500	51	53
	3150	54	54
	4000	56	56
	5000	56	56
	R'w values	**42**	**51**

Case 20	Wood facade with plaster

Material layers in [mm]
- 30 plaster
- 25 wood panels
- 50 wood plank wall
- 50 fiber board
- 30 plaster

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	27
	63	28
	80	23
	100	25
	125	27
	160	29
	200	31
	250	33
	315	35
	400	36
	500	37
	630	37
	800	36
	1000	31
	1250	33
	1600	36
	2000	39
	2500	42
	3150	45
	4000	48
	5000	51
	R'w value	
	37	

Case 21	Wood panels facade on wooden frame

Material layers in [mm]

- 10-25 outer wood panels
- 25 wood panels
- 25 air gap
- 13 asphalt board
- 70 wooden studs frame
  with mineral wool
- vapor barrier
- 13 gypsum board
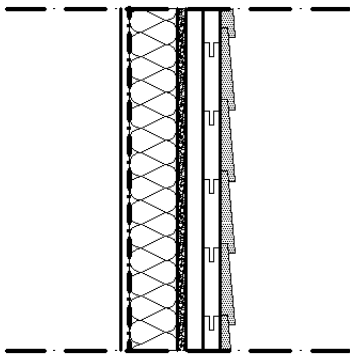
Technical Details
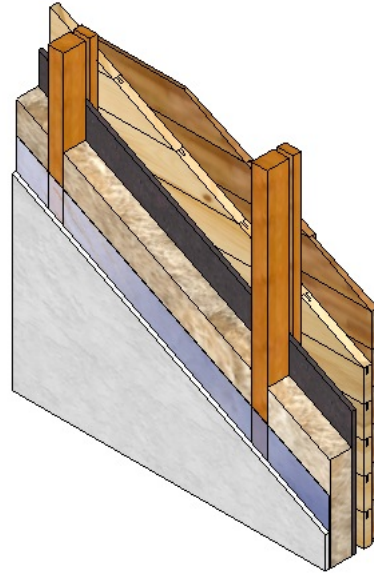
Inside   Outside
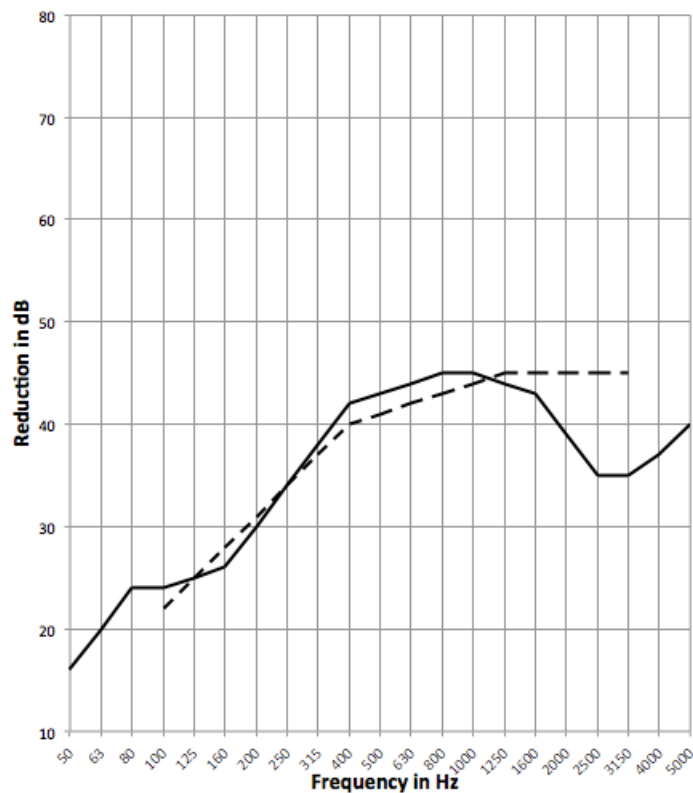
Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	16
	63	20
	80	24
	100	24
	125	25
	160	26
	200	30
	250	34
	315	38
	400	42
	500	43
	630	44
	800	45
	1000	45
	1250	44
	1600	43
	2000	39
	2500	35
	3150	35
	4000	37
	5000	40
	R'w value **41**	

Reduction in dB

Frequency in Hz

Case 21: Alternative versions	Wood panels facade on wooden frame

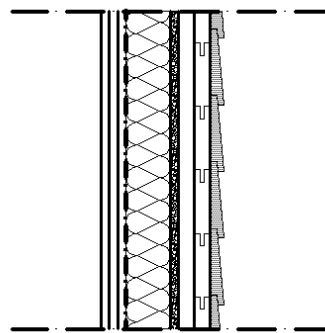**Case 21.1**

Material layers in [mm]
- 10-25 outer wood panels
- 25 wood panels
- 25 air gap
- 13 asphalt board
- 70 wooden studs frame
  with mineral wool
- vapor barrier
- 3* 13 gypsum board

Technical Details

Case 21.2

Material layers in [mm]
- 10-25 outer wood panels
- 25 wood panels
- 25 air gap
- 13 asphalt board
- 70 wooden studs frame
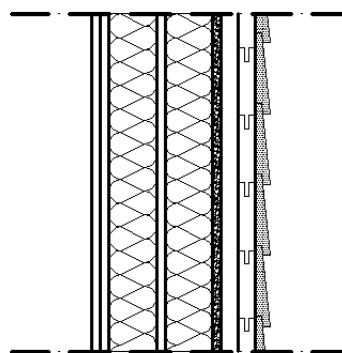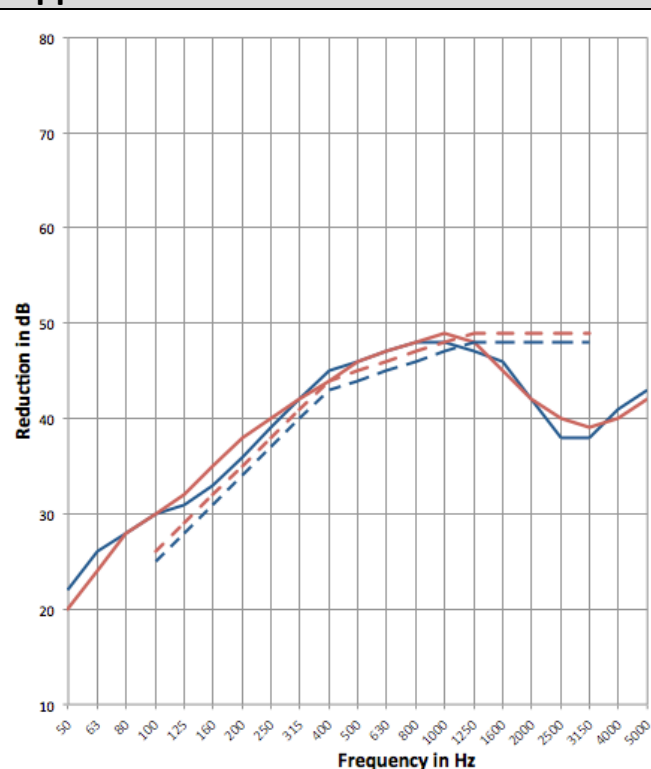 with mineral wool
- vapor barrier
- 13 gypsum board
- 70 acoustic profile with wool
- 2*13 gypsum board

Technical Details

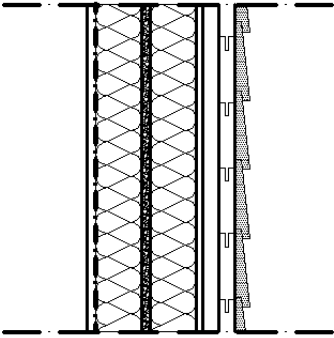**Apparent Sound Reduction Index:** R' in dB
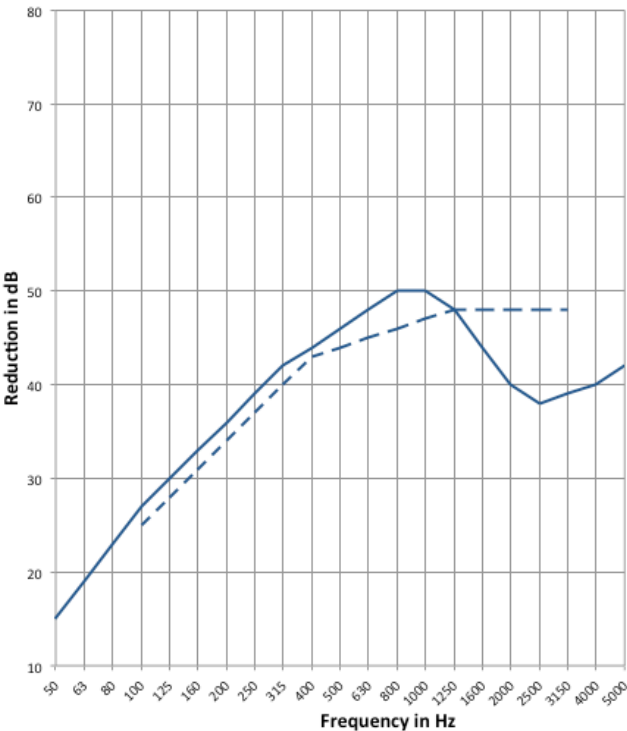
f [Hz]	R' [dB]	R' [dB]
50	22	20
63	26	24
80	28	28
100	30	30
125	31	32
160	33	35
200	36	38
250	39	40
315	42	42
400	45	44
500	46	46
630	47	47
800	48	48
1000	48	49
1250	47	48
1600	46	45
2000	42	42
2500	38	40
3150	38	39
4000	41	40
5000	43	42
R'w values	**44**	**45**

Case 21: Alternative versions	Wood panels facade on wooden frame

Material layers in [mm]

Case 21.3

- 10-25 outer wood panels
- 25 wood panels
- 25 air gap
- 13 gypsum board
- 70 wooden studs frame
  with mineral wool
- 13 asphalt board
- 70 wooden studs frame
  with mineral wool
- vapor barrier
- 13 gypsum board

Technical Details

Apparent Sound Reduction Index: R' in dB

f [Hz]	R' [dB]
50	15
63	19
80	23
100	27
125	30
160	33
200	36
250	39
315	42
400	44
500	46
630	48
800	50
1000	50
1250	48
1600	44
2000	40
2500	38
3150	39
4000	40
5000	42

R'w value

44

Case 22	Wood panels facade on wooden frame

Material layers in [mm]
- 19 wood panels
- insulation paper
- 102 wooden studs frame
  with air gap
- 12 wood panels
- 25 wood panels

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	18
	63	27
	80	19
	100	21
	125	20
	160	16
	200	16
	250	26
	315	29
	400	27
	500	28
	630	32
	800	33
	1000	37
	1250	41
	1600	45
	2000	47
	2500	50
	3150	52
	4000	53
	5000	56

R'w value
33
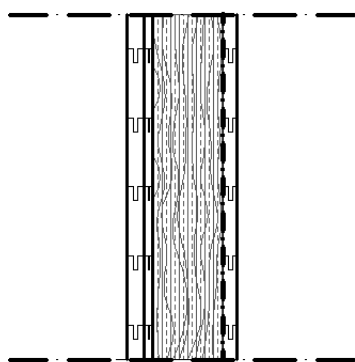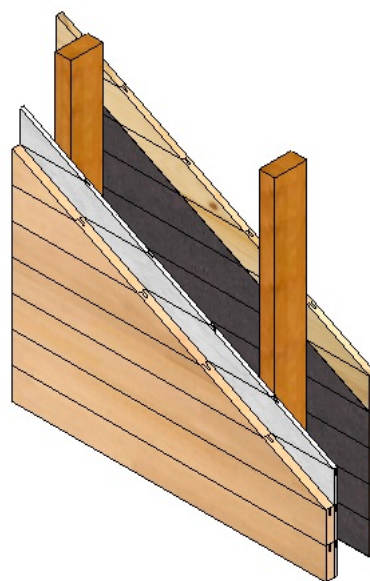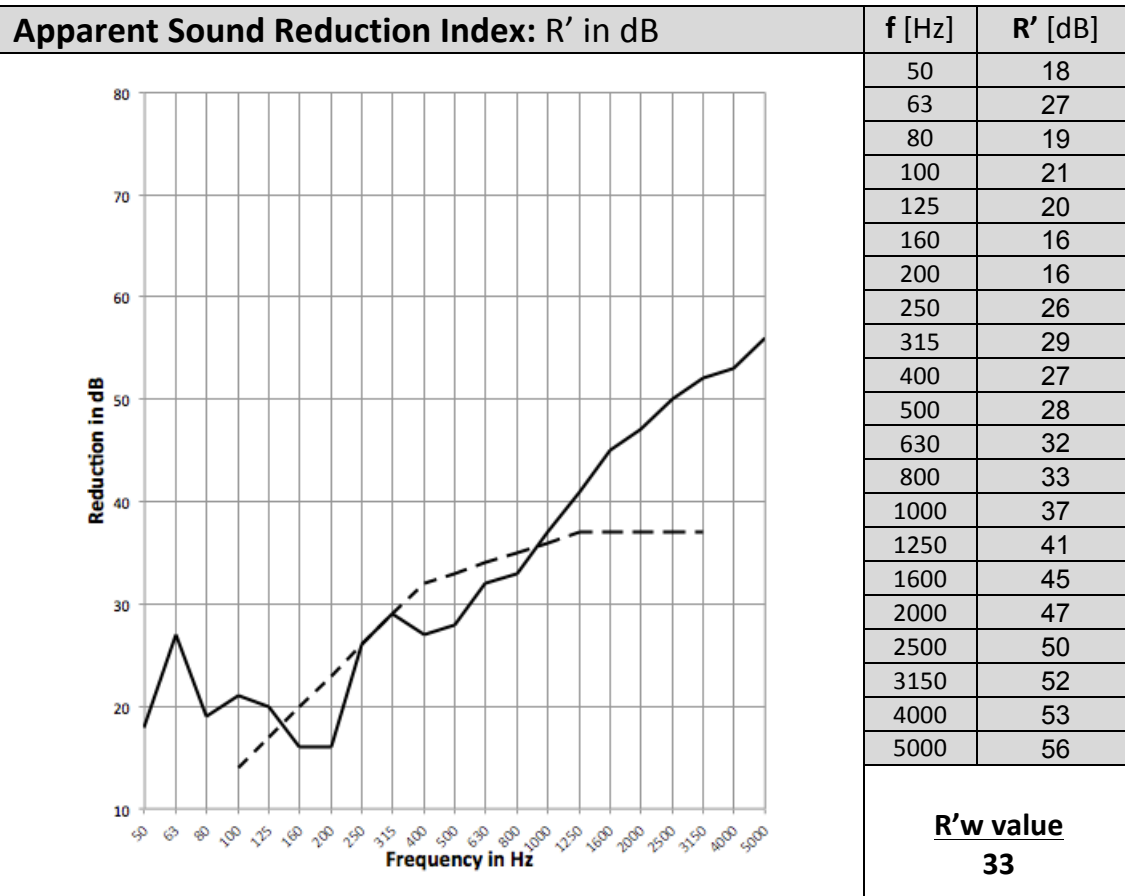
Case 22: Alternative versions	Wood panels facade on wooden frame

	Material layers in [mm]
Case 22.1	- 19 wood panels
	- insulation paper
	- 102 wooden studs frame with mineral wool
	- 12 wood panels
	- 25 wood panels

Technical Details

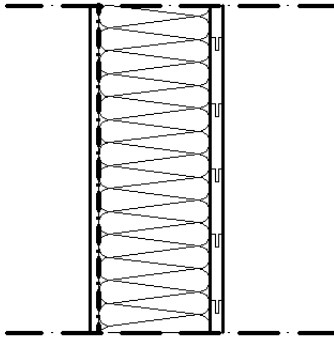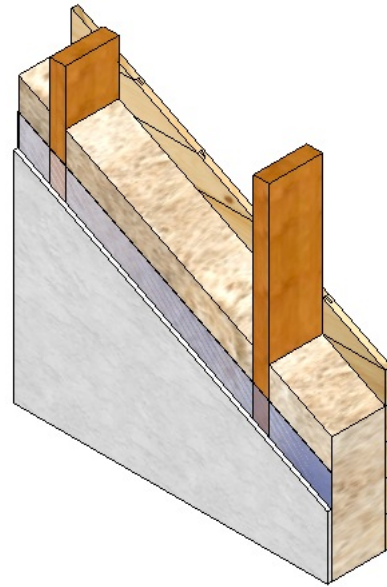| Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	21
	63	30
	80	25
	100	22
	125	19
	160	19
	200	22
	250	31
	315	33
	400	30
	500	29
	630	35
	800	37
	1000	41
	1250	43
	1600	47
	2000	50
	2500	53
	3150	55
	4000	57
	5000	58
	R'w value	
	37	
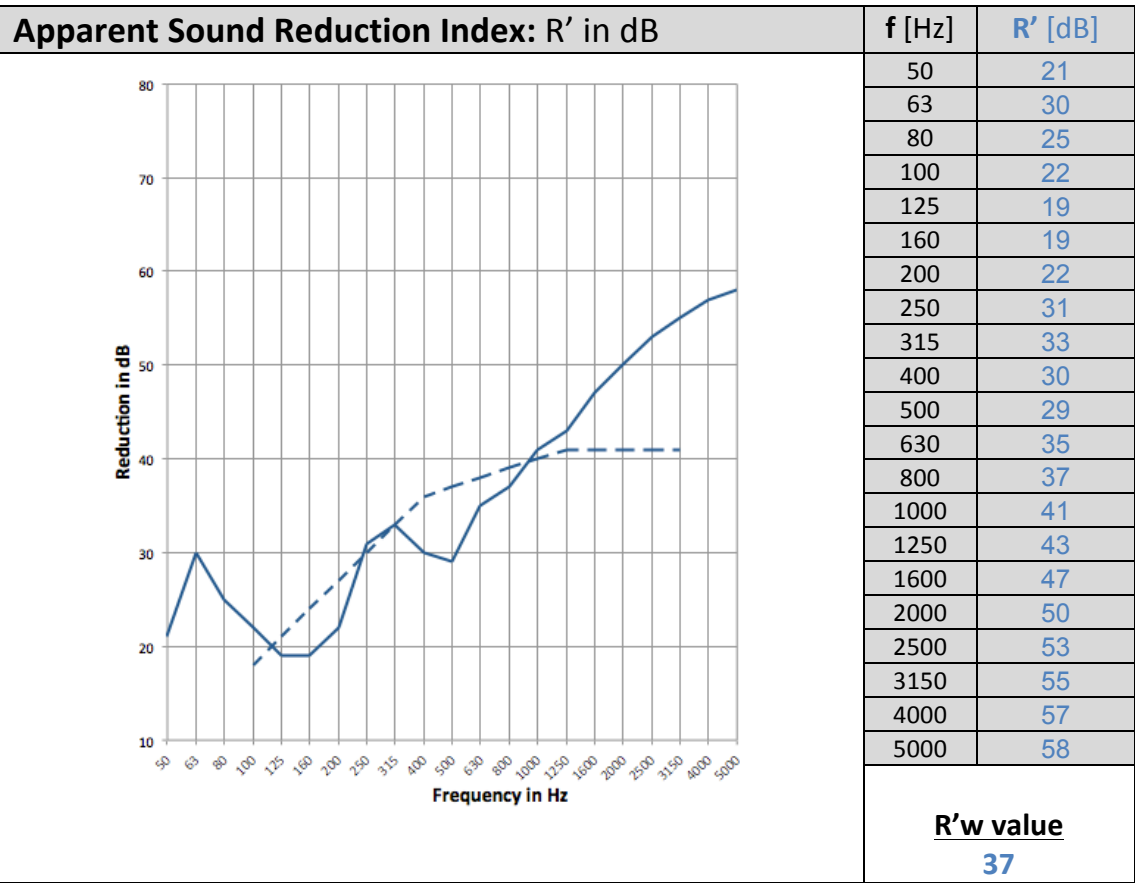
Case 23	Wood panels facade on wooden frame

Material layers in [mm]

- 20 wood panels
- 170 wooden studs frame
  with mineral wool
- vapor barrier
- 13 gypsum board

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	19
	63	17
	80	22
	100	26
	125	26
	160	31
	200	33
	250	34
	315	39
	400	41
	500	41
	630	43
	800	43
	1000	44
	1250	45
	1600	47
	2000	49
	2500	49
	3150	51
	4000	53
	5000	55

R'w value
44

Case 24	Wood panels facade on wooden frame
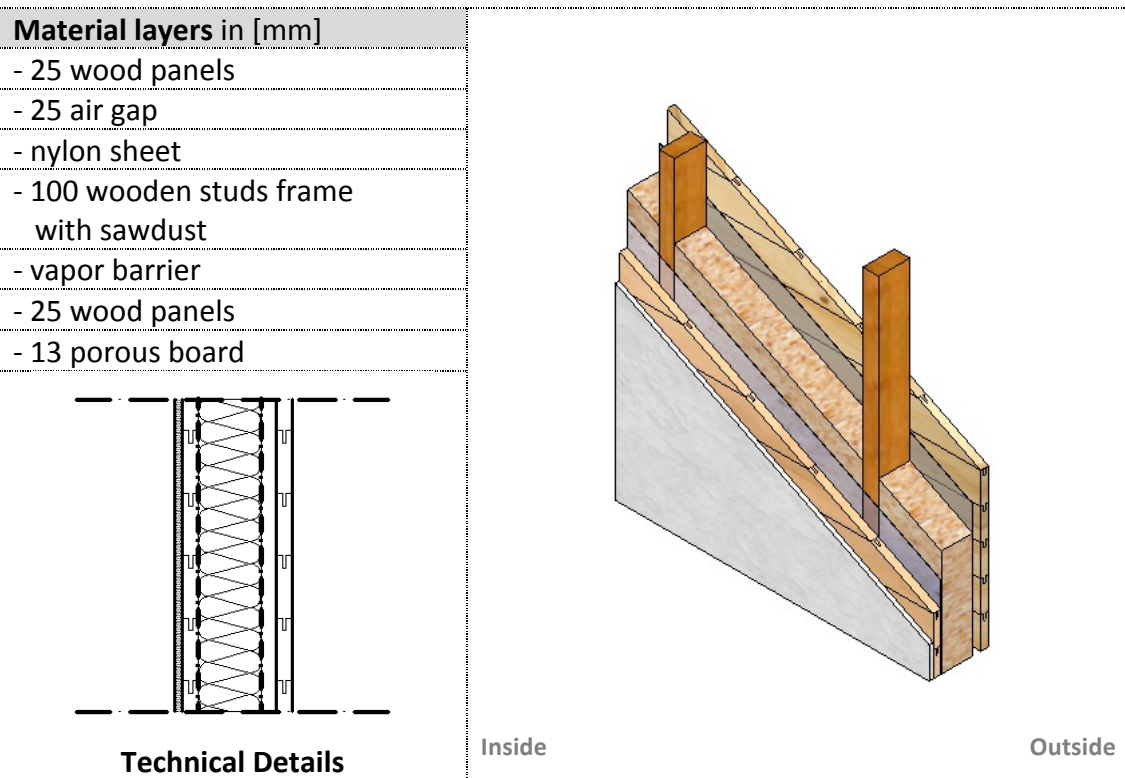
Material layers in [mm]
- 20 wood panels
- 200 wooden studs frame
  with mineral wool
- 13 fiber panel
- 13 gypsum board
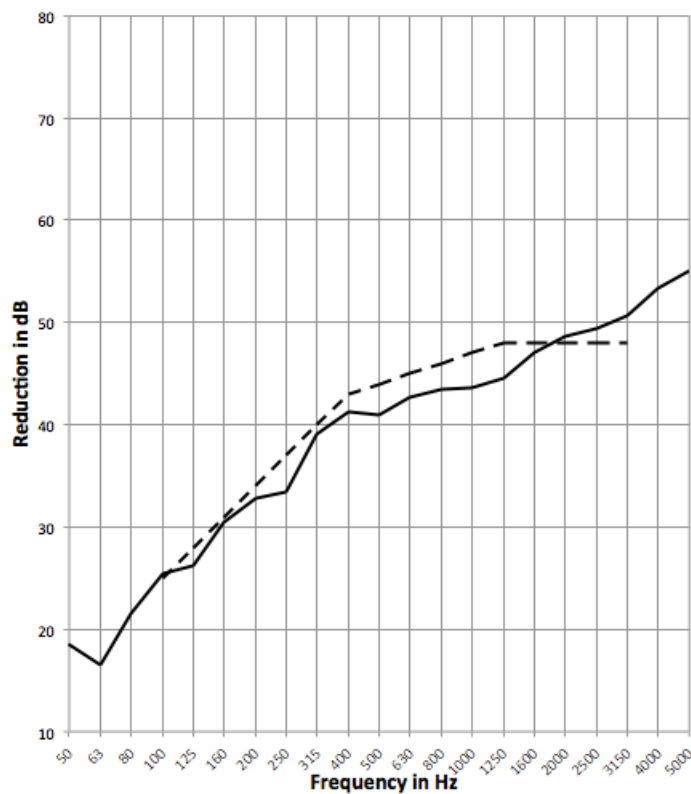

Technical Details
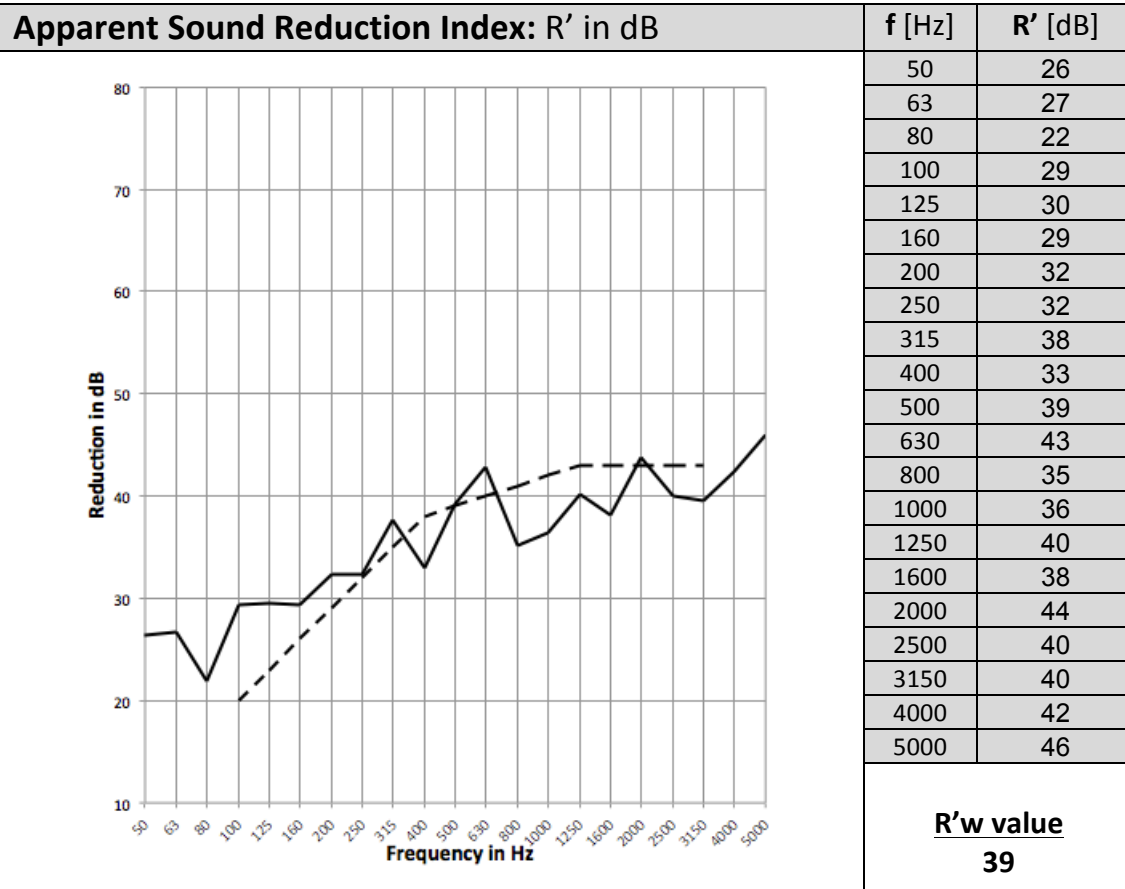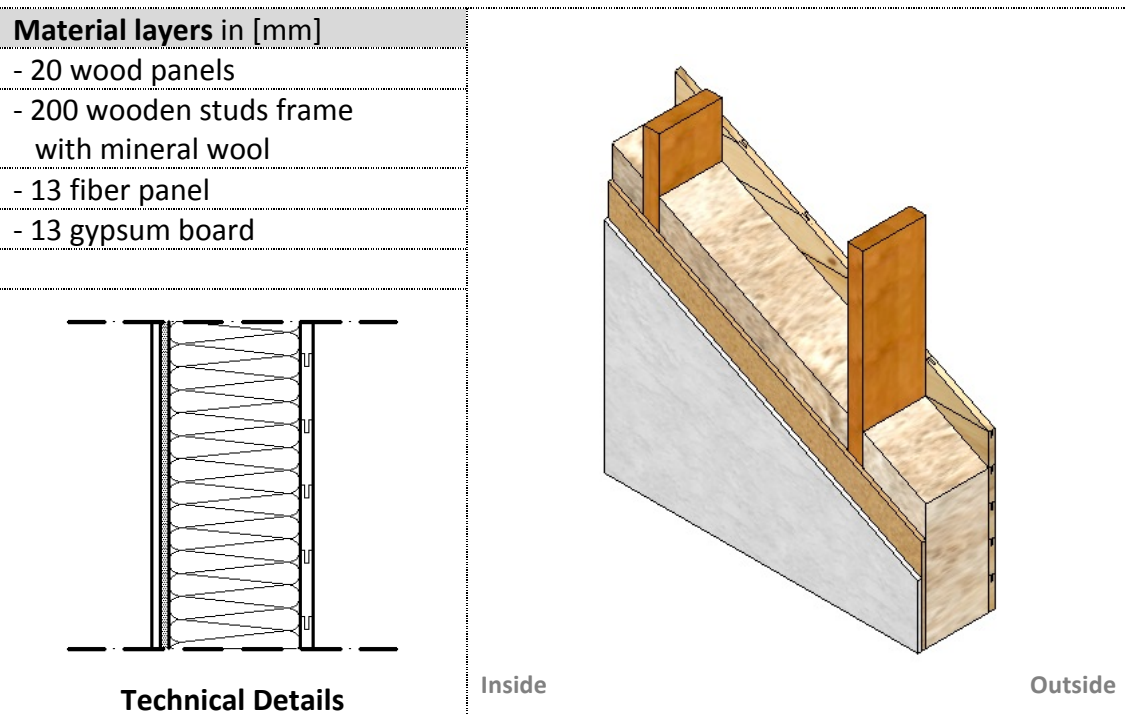
Inside   Outside

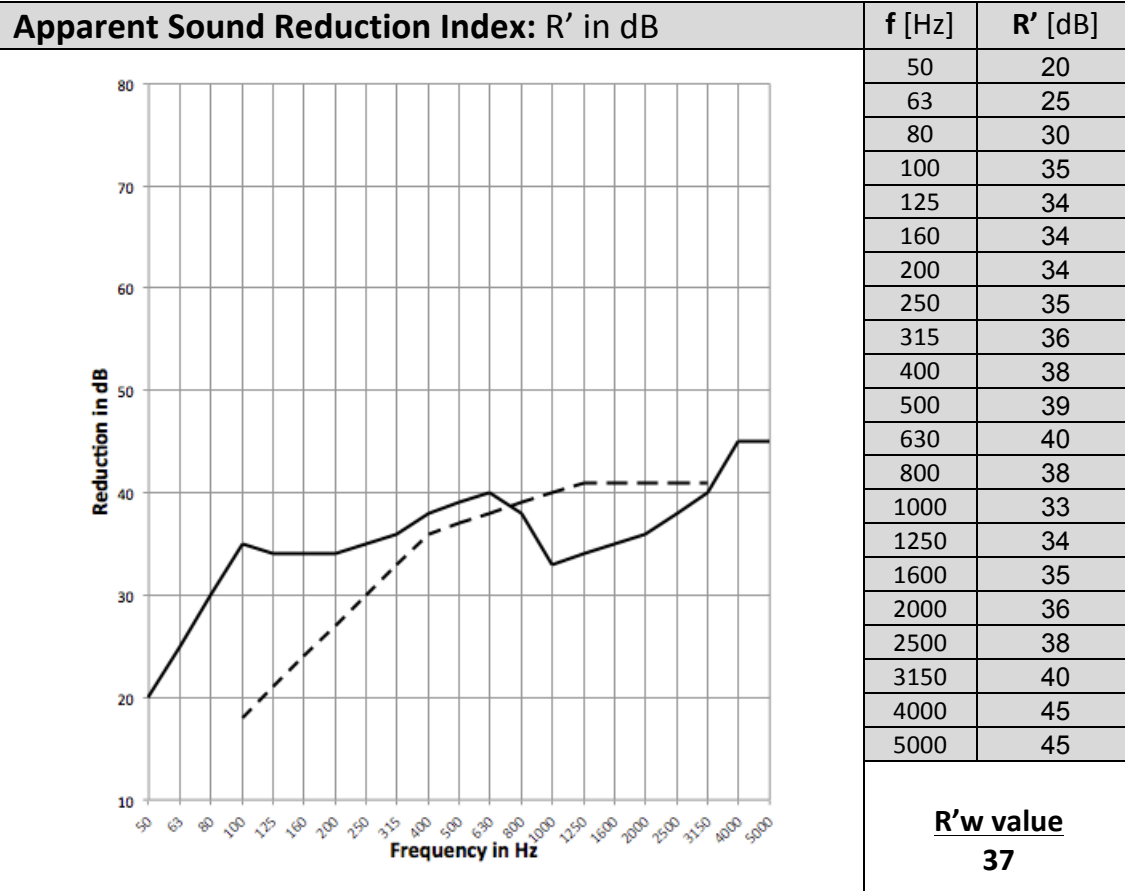| Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	26
	63	27
	80	22
	100	29
	125	30
	160	29
	200	32
	250	32
	315	38
	400	33
	500	39
	630	43
	800	35
	1000	36
	1250	40
	1600	38
	2000	44
	2500	40
	3150	40
	4000	42
	5000	46
	R'w value **39**	

Case 25	Wood panels facade on wooden frame

Material layers in [mm]

- 25 wood panels
- 25 air gap
- nylon sheet
- 100 wooden studs frame
  with sawdust
- vapor barrier
- 25 wood panels
- 13 porous board

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	20
	63	25
	80	30
	100	35
	125	34
	160	34
	200	34
	250	35
	315	36
	400	38
	500	39
	630	40
	800	38
	1000	33
	1250	34
	1600	35
	2000	36
	2500	38
	3150	40
	4000	45
	5000	45

R'w value

37

Case 25: Alternative versions	Wood panels facade on wooden frame

	Material layers in [mm]	
Case 25.1	- 25 wood panels	
	- 25 air gap	
	- nylon sheet	
	- 100 wooden studs frame with sawdust	
	- vapor barrier	
	- 25 wood panels	
	- 13 porous board	
	- 2*13 gypsum board	**Technical Details**

	Material layers in [mm]	
Case 25.2	- 25 wood panels	
	- 25 air gap	
	- nylon sheet	
	- 100 wooden studs frame with sawdust	
	- vapor barrier	
	- 25 wood panels	
	- 13 porous board	
	- 70 acoustic profile with wool	
	- 2*13 gypsum board	**Technical Details**
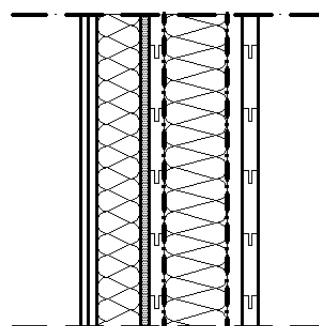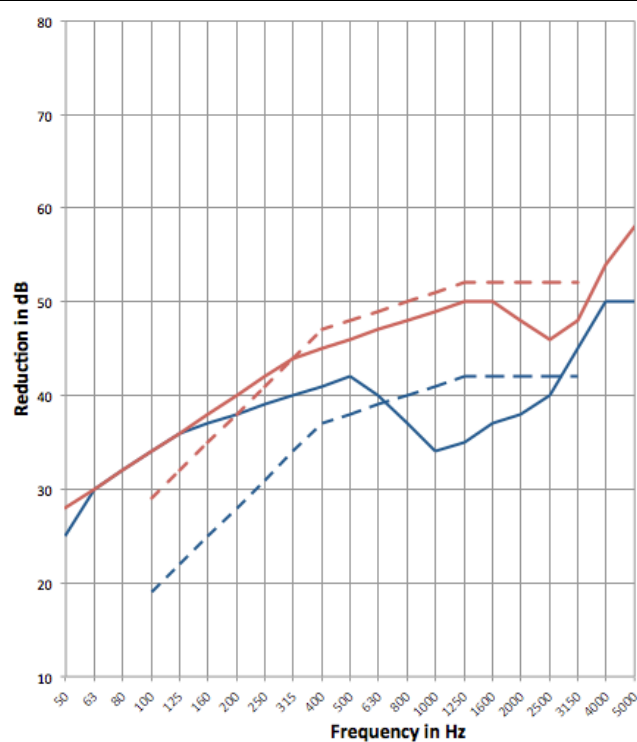
Apparent Sound Reduction Index: R' in dB	**f** [Hz]	**R'** [dB]	**R'** [dB]
	50	25	28
	63	30	30
	80	32	32
	100	34	34
	125	36	36
	160	37	38
	200	38	40
	250	39	42
	315	40	44
	400	41	45
	500	42	46
	630	40	47
	800	37	48
	1000	34	49
	1250	35	50
	1600	37	50
	2000	38	48
	2500	40	46
	3150	45	48
	4000	50	54
	5000	50	58
	R'w values	**38**	**48**

Case 25: Alternative versions	Wood panels facade on wooden frame

	Material layers in [mm]
Case 25.3	- 25 wood panels
	- 25 air gap
	- 9 gypsum board
	- 70 wooden studs frame With mineral wool
	- nylon sheet
	- 100 wooden studs frame with sawdust
	- vapor barrier
	- 25 wood panels
	- 13 porous board
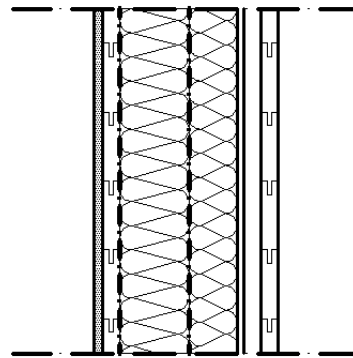
Technical Details
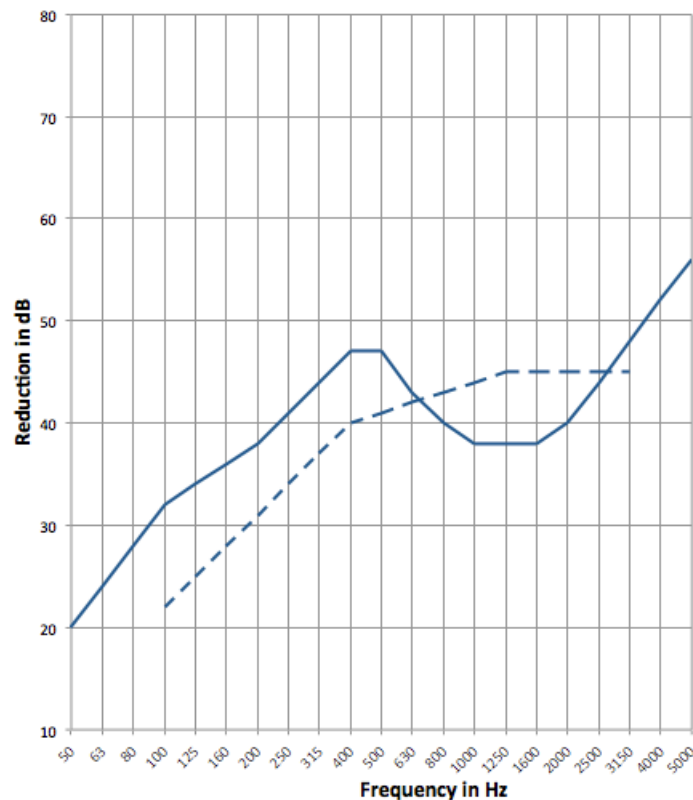
Apparent Sound Reduction Index: R′ in dB	f [Hz]	R′ [dB]
	50	20
	63	24
	80	28
	100	32
	125	34
	160	36
	200	38
	250	41
	315	44
	400	47
	500	47
	630	43
	800	40
	1000	38
	1250	38
	1600	38
	2000	40
	2500	44
	3150	48
	4000	52
	5000	56

R'w value
41

Case 26	Wood panels facade on wooden frame

Material layers in [mm]
- 28 wood panels
- 28 air gap
- nylon sheet
- 145 wooden studs frame
  with rock wool
- plastic sheet
- 13 gypsum board

Technical Details
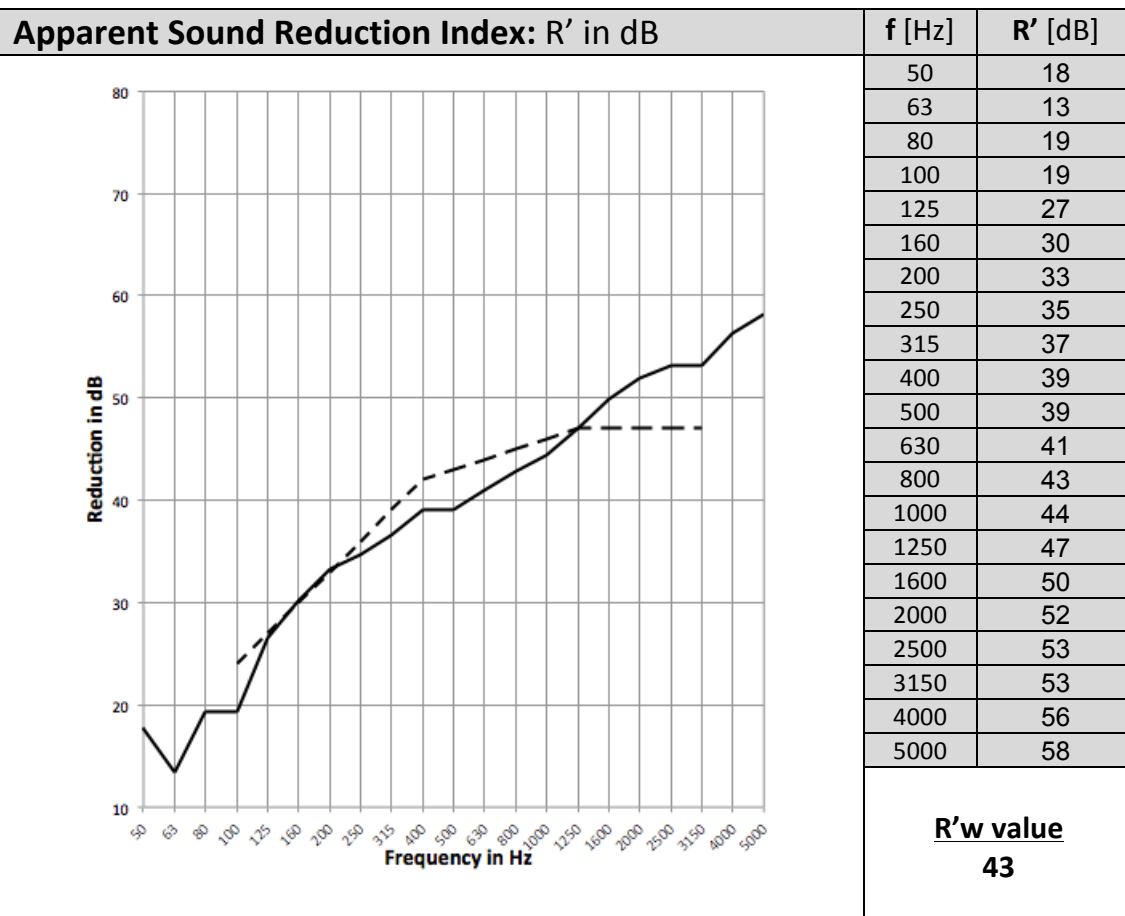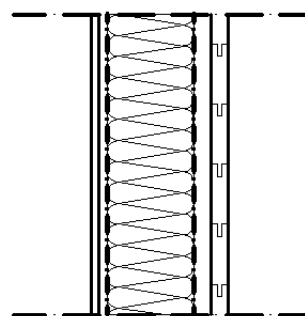
Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	18
	63	13
	80	19
	100	19
	125	27
	160	30
	200	33
	250	35
	315	37
	400	39
	500	39
	630	41
	800	43
	1000	44
	1250	47
	1600	50
	2000	52
	2500	53
	3150	53
	4000	56
	5000	58
	R'w value **43**	
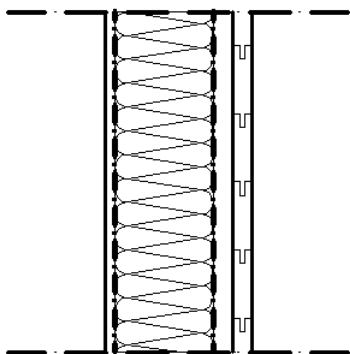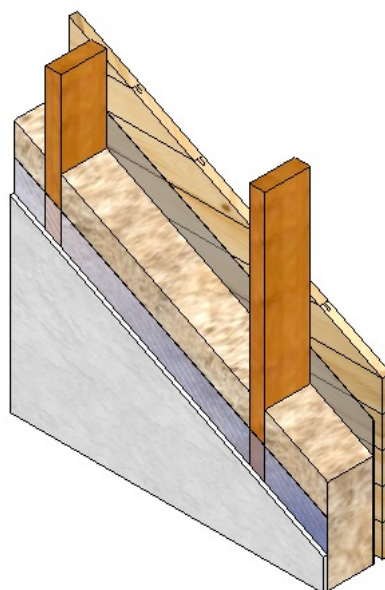
Case 26: Alternative versions	Wood panels facade on wooden frame

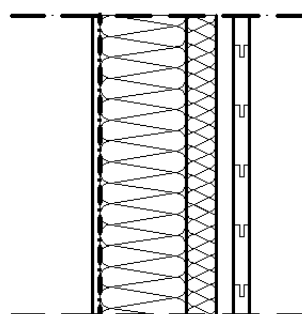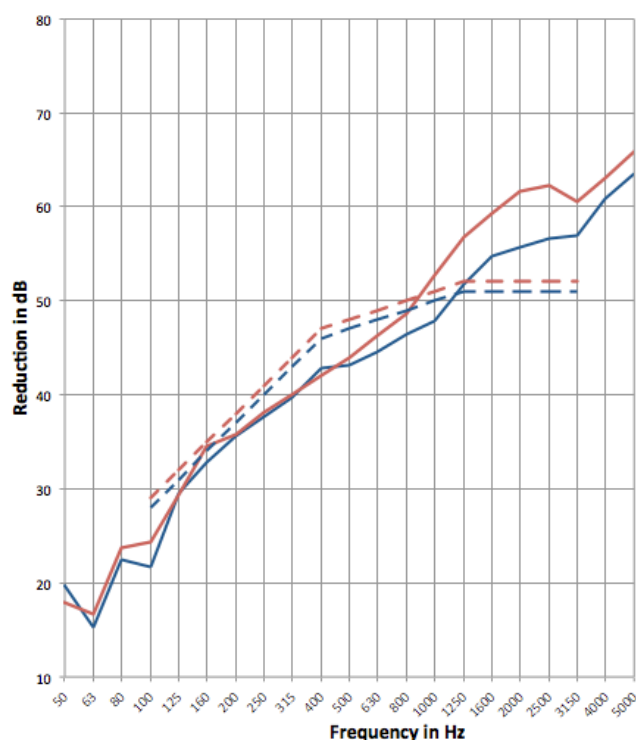|	Material layers in [mm]	
Case 26.1	- 28 wood panels - 28 air gap - nylon sheet - 145 wooden studs frame with rock wool - plastic sheet - 2*13 gypsum board	 **Technical Details**

	Material layers in [mm]	
Case 26.2	- 28 wood panels - 28 air gap - nylon sheet - 50 glass wool board - 145 wooden studs frame with rock wool - plastic sheet - 13 gypsum board	 **Technical Details**

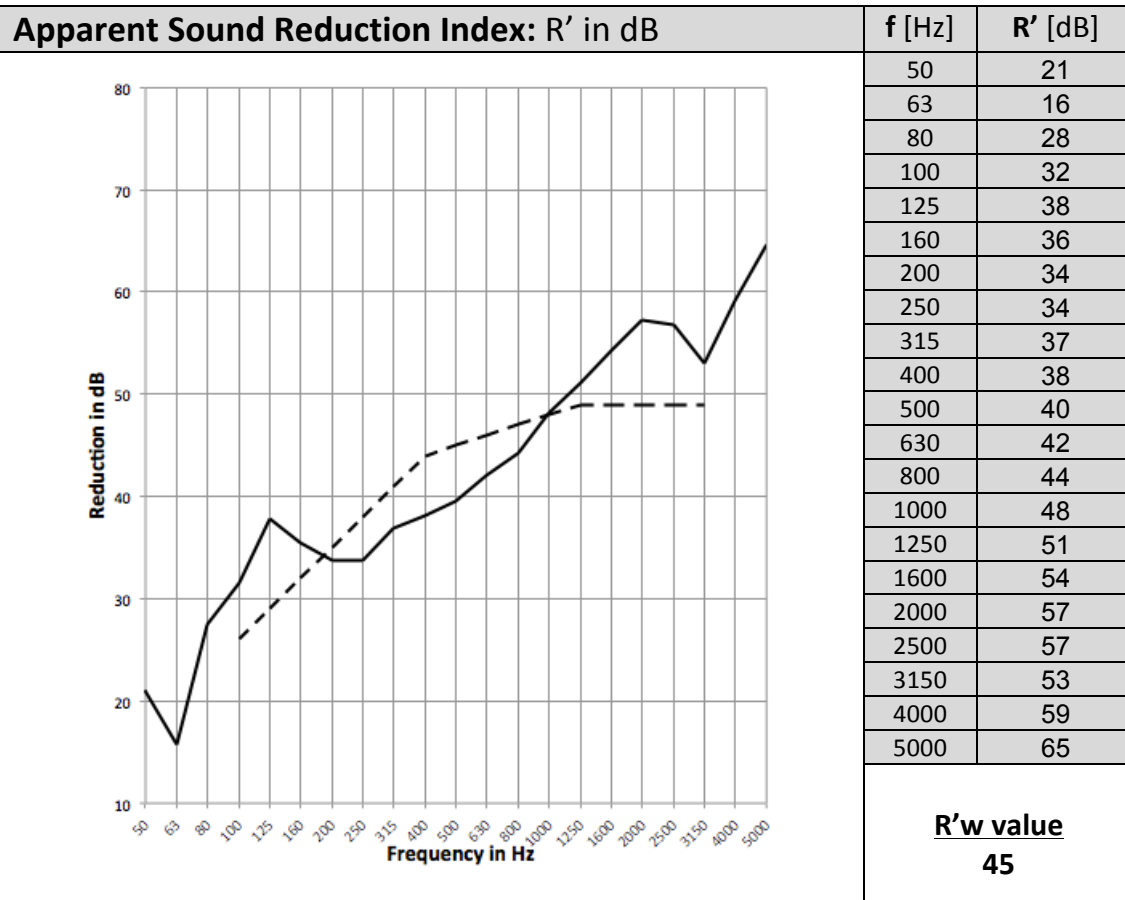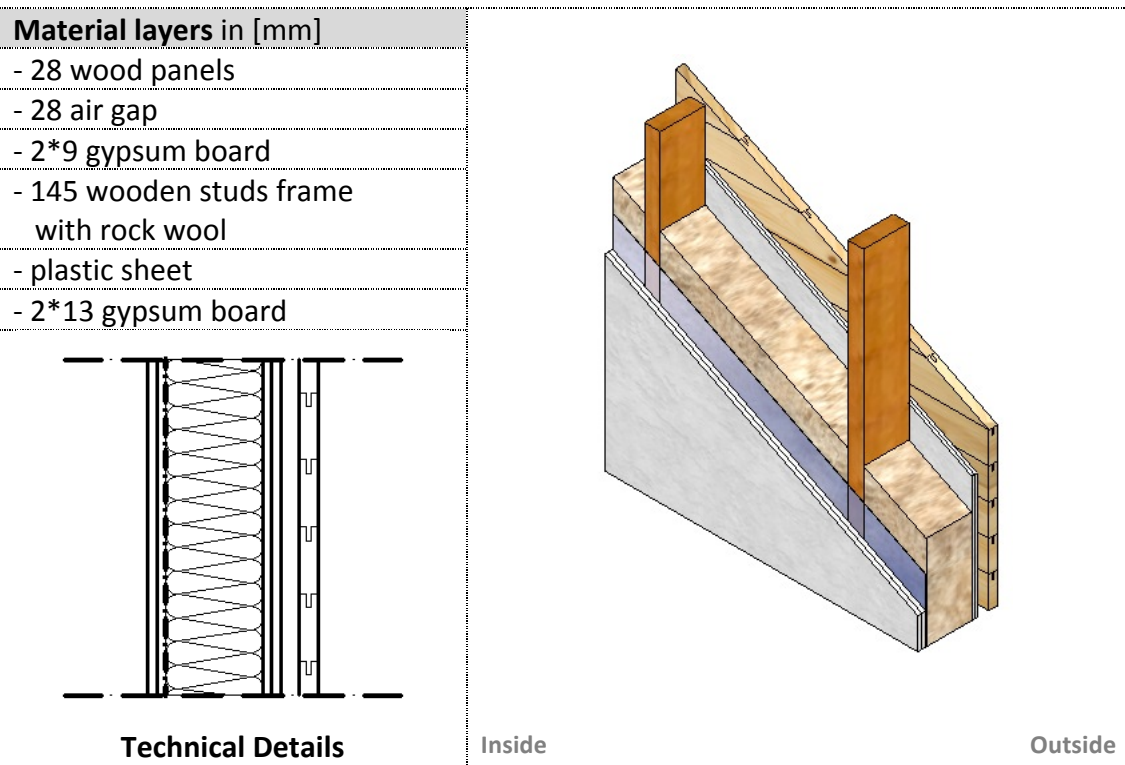| Apparent Sound Reduction Index: R′ in dB	f [Hz]	R′ [dB]	R′ [dB]
	50	20	18
	63	15	17
	80	23	24
	100	22	24
	125	30	29
	160	33	35
	200	36	36
	250	38	38
	315	40	40
	400	43	42
	500	43	44
	630	45	46
	800	46	49
	1000	48	53
	1250	52	57
	1600	55	59
	2000	56	62
	2500	57	62
	3150	57	61
	4000	61	63
	5000	64	66
	R′w values	**47**	**48**

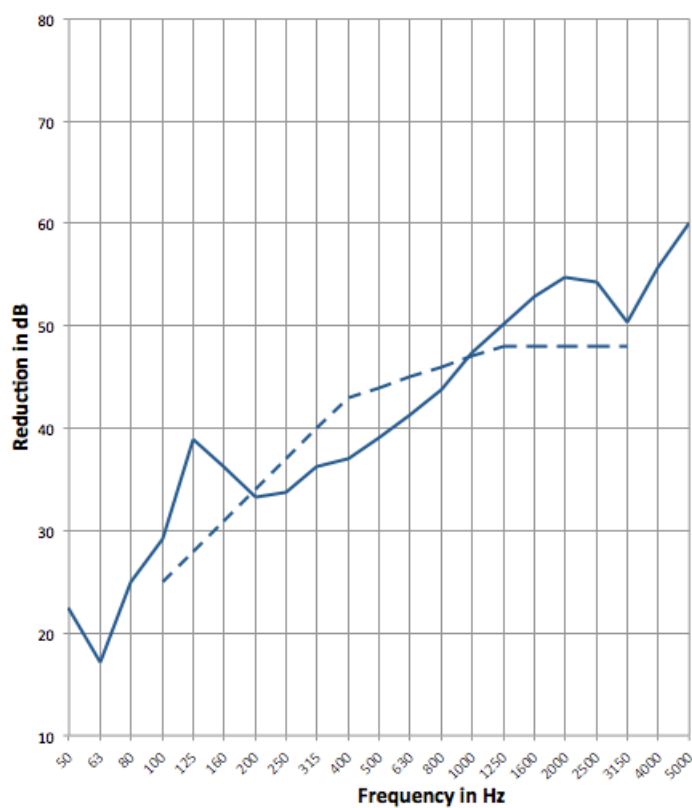| Case 27	Wood panels facade on wooden frame

Material layers in [mm]
- 28 wood panels
- 28 air gap
- 2*9 gypsum board
- 145 wooden studs frame
  with rock wool
- plastic sheet
- 2*13 gypsum board

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	21
	63	16
	80	28
	100	32
	125	38
	160	36
	200	34
	250	34
	315	37
	400	38
	500	40
	630	42
	800	44
	1000	48
	1250	51
	1600	54
	2000	57
	2500	57
	3150	53
	4000	59
	5000	65
	R'w value	
	45	

Case 27: Alternative versions	Wood panels facade on wooden frame

	Material layers in [mm]
Case 27.1	- 28 wood panels
	- 28 air gap
	- 9 gypsum board
	- 145 wooden studs frame with rock wool
	- plastic sheet
	- 2*13 gypsum board
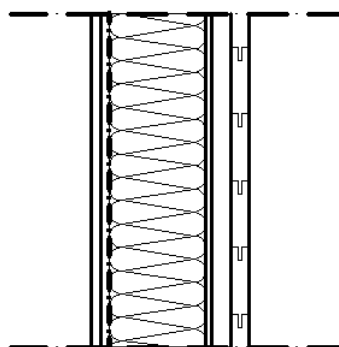
Technical Details

Apparent Sound Reduction Index: R' in dB	**f [Hz]**	**R' [dB]**
	50	22.4
	63	17.1
	80	24.9
	100	29.2
	125	38.9
	160	36.3
	200	33.2
	250	33.7
	315	36.2
	400	37.1
	500	39.1
	630	41.3
	800	43.7
	1000	47.3
	1250	50.2
	1600	52.8
	2000	54.7
	2500	54.3
	3150	50.3
	4000	55.7
	5000	60.1

R'w value

44

| Case 28 | Wood panels facade on wooden frame |

Material layers in [mm]

- 28 wood panels
- 28 air gap
- plastic sheet
- 240 wooden studs frame
  with rock wool
- nylon sheet
- 13 gypsum board

Technical Details

Inside   Outside
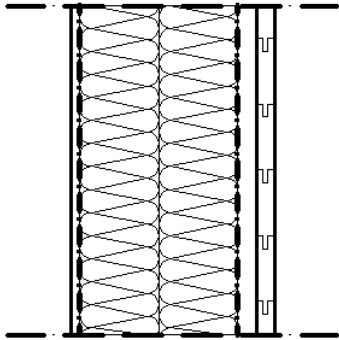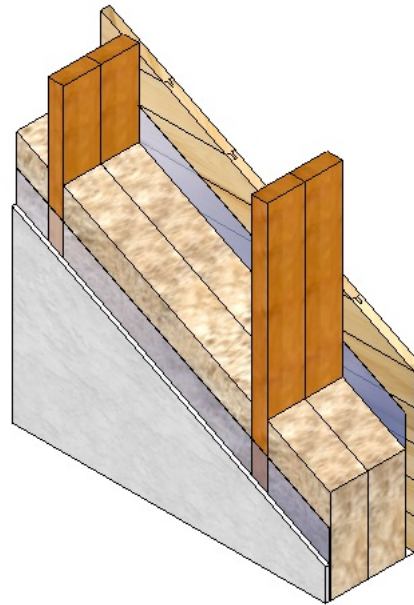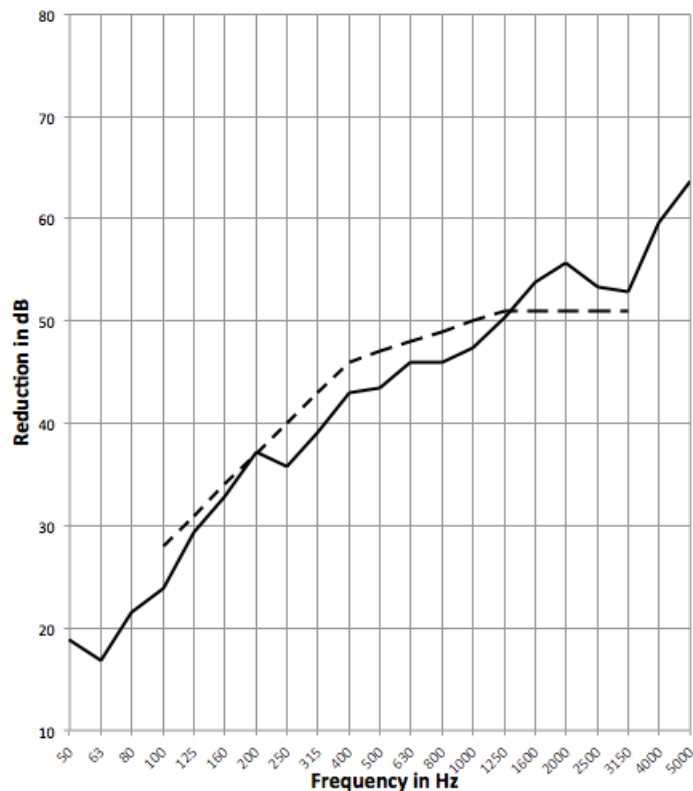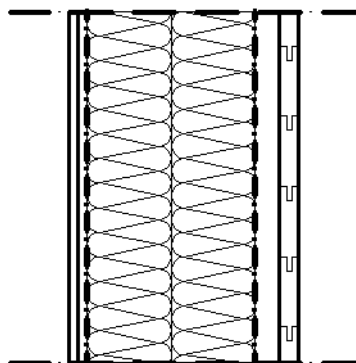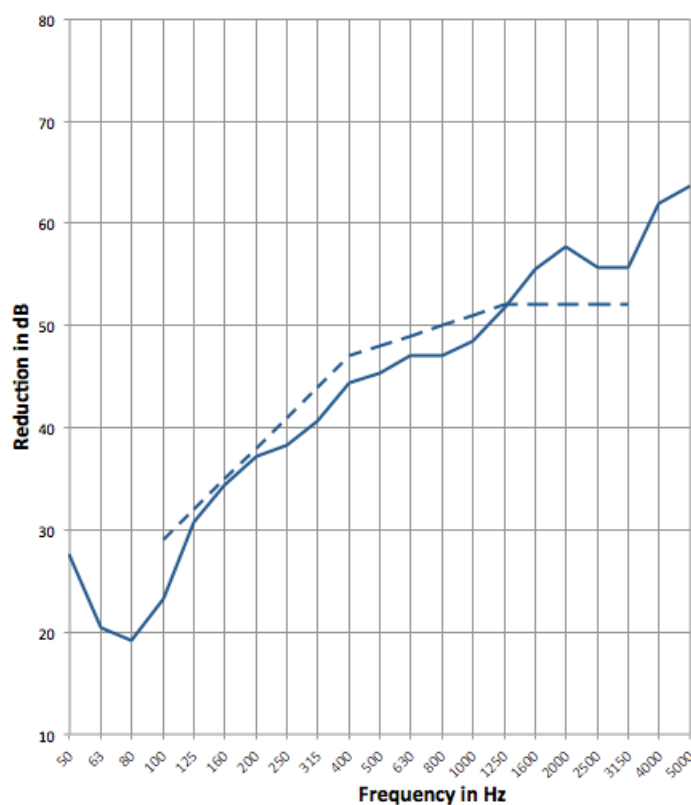
Sound Reduction Index: R in dB		f [Hz]	R' [dB]
		50	19
		63	17
		80	22
		100	24
		125	29
		160	33
		200	37
		250	36
		315	39
		400	43
		500	44
		630	46
		800	46
		1000	47
		1250	50
		1600	54
		2000	56
		2500	53
		3150	53
		4000	60
		5000	64
		Rw value	
		47	

Case 28: Alternative versions	Wood panels facade on wooden frame

	Material layers in [mm]
Case 28.1	- 28 wood panels
	- 28 air gap
	- plastic sheet
	- 240 wooden studs frame with rock wool
	- nylon sheet
	- 2*13 gypsum board

Technical Details

Sound Reduction Index: R in dB	**f** [Hz]	**R'** [dB]
	50	28
	63	20
	80	19
	100	23
	125	31
	160	34
	200	37
	250	38
	315	41
	400	44
	500	45
	630	47
	800	47
	1000	49
	1250	52
	1600	56
	2000	58
	2500	56
	3150	56
	4000	62
	5000	64
	Rw value	
	48	

Case 29	Wood panels facade on wooden frame

Material layers in [mm]
- 28 wood panels
- 28 air gap
- plastic sheet
- 240 wooden studs frame
  with rock wool
- nylon sheet
- 13 reinforced gypsum panel
- 15 fiber gypsum board

Technical Details
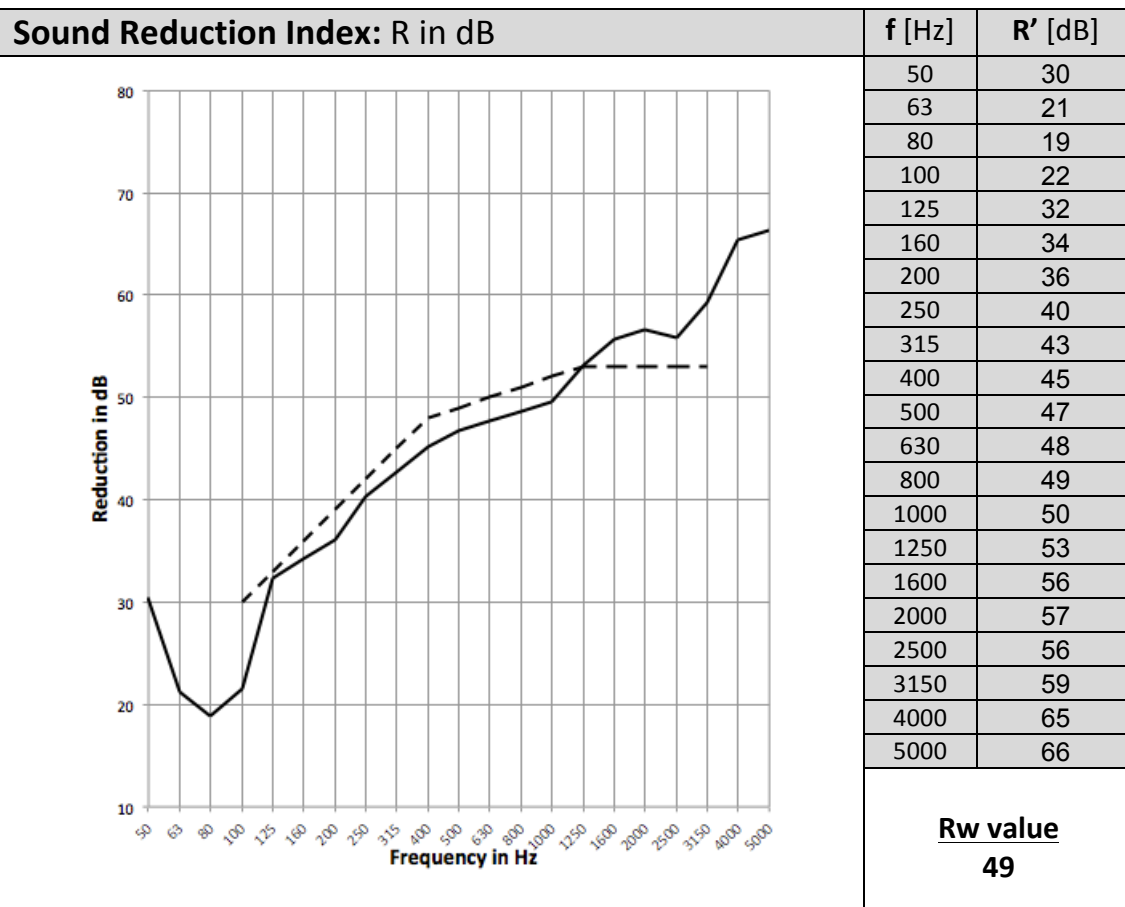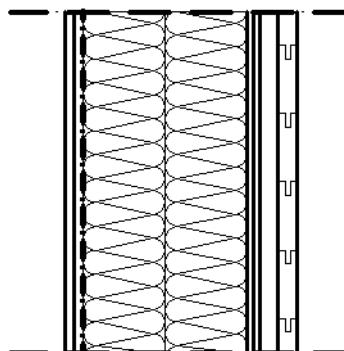
Inside   Outside

Sound Reduction Index: R in dB	f [Hz]	R' [dB]
	50	30
	63	21
	80	19
	100	22
	125	32
	160	34
	200	36
	250	40
	315	43
	400	45
	500	47
	630	48
	800	49
	1000	50
	1250	53
	1600	56
	2000	57
	2500	56
	3150	59
	4000	65
	5000	66

Rw value
49

Case 29: Alternative versions	Wood panels facade on wooden frame

Material layers in [mm]

Case 29.1
- 28 wood panels
- 28 air gap
- 2*9 gypsum board
- 240 wooden studs frame
  with rock wool
- 13 reinforced gypsum panel
- 15 fiber gypsum board

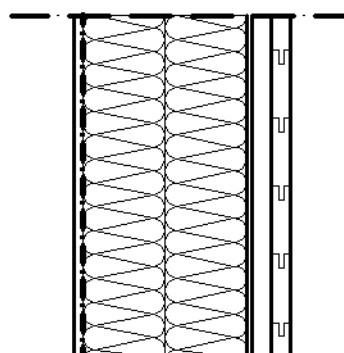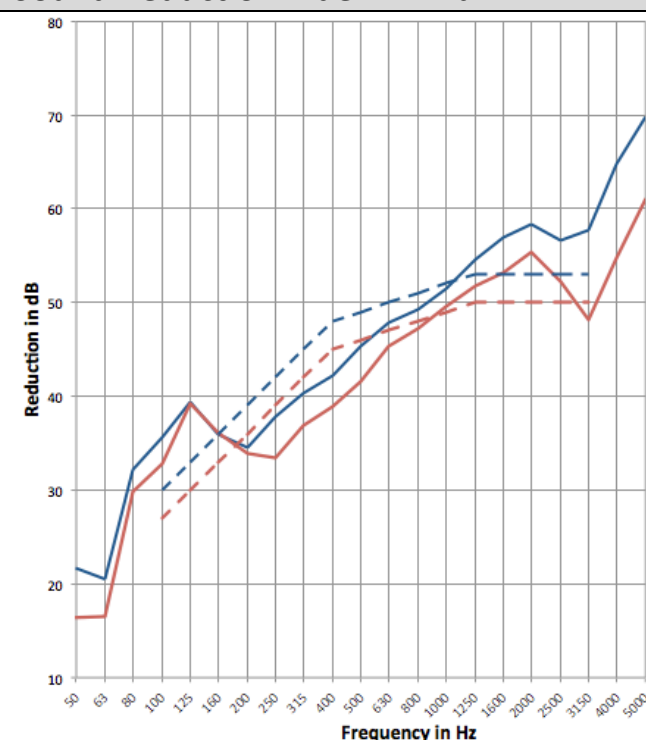**Technical Details**

Material layers in [mm]

Case 29.2
- 28 wood panels
- 28 air gap
- 9 gypsum board
- 240 wooden studs frame
  with rock wool
- 13 reinforced gypsum panel

Technical Details

Sound Reduction Index: R in dB

f [Hz]	R' [dB]	R' [dB]
50	22	16
63	21	17
80	32	30
100	36	33
125	39	39
160	36	36
200	35	34
250	38	33
315	40	37
400	42	39
500	45	42
630	48	45
800	49	47
1000	52	50
1250	55	52
1600	57	53
2000	58	55
2500	57	52
3150	58	48
4000	65	55
5000	70	61
Rw values	**49**	**46**

Case 29: Alternative versions	Wood panels facade on wooden frame

	Material layers in [mm]
Case 29.3	- 28 wood panels
	- 28 air gap
	- 50 glass wool
	- 240 wooden studs frame with rock wool
	- plastic sheet
	- 13 reinforced gypsum panel

Technical Details

Sound Reduction Index: R in dB		f [Hz]	R' [dB]
		50	19
		63	18
		80	27
		100	27
		125	33
		160	35
		200	40
		250	43
		315	47
		400	49
		500	51
		630	52
		800	54
		1000	56
		1250	58
		1600	62
		2000	64
		2500	61
		3150	60
		4000	66
		5000	64
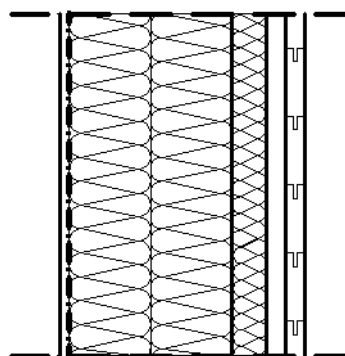
Rw value

52

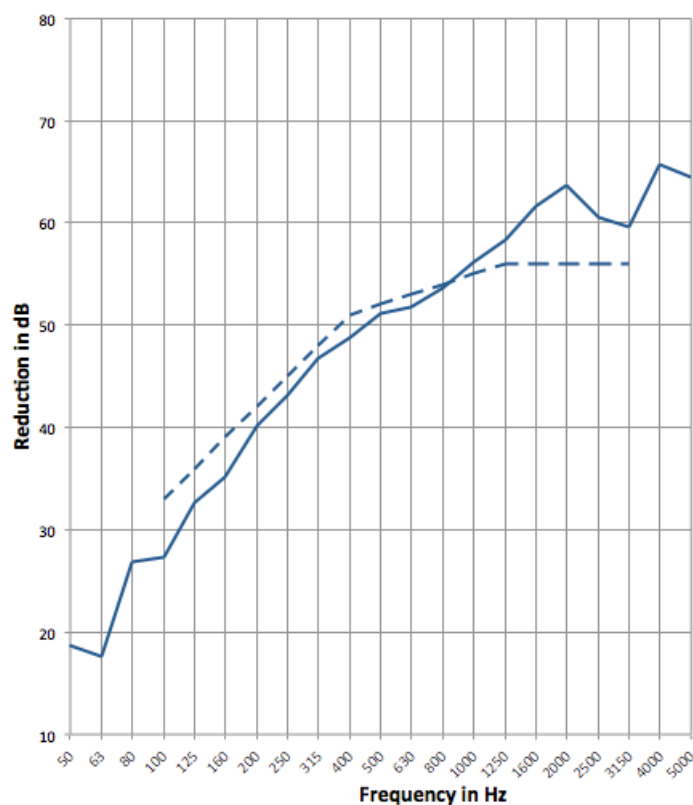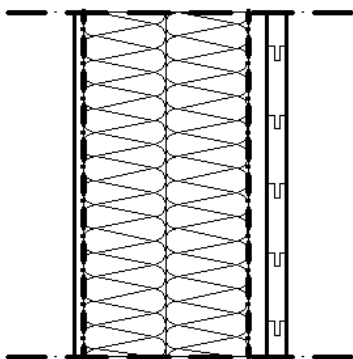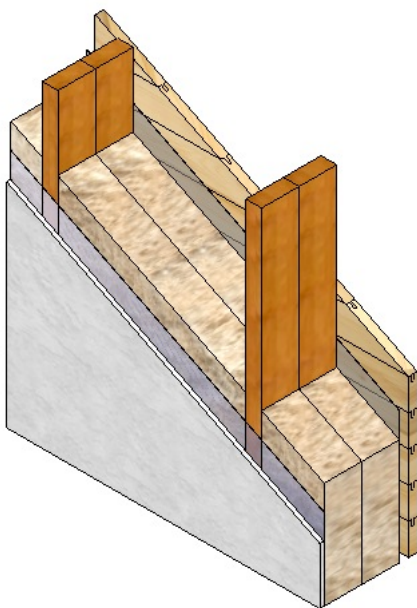| Case 30	Wood panels facade on wooden frame

Material layers in [mm]
- 28 wood panels
- 28 air gap
- plastic sheet
- 240 wooden studs frame
  with heavy rock wool
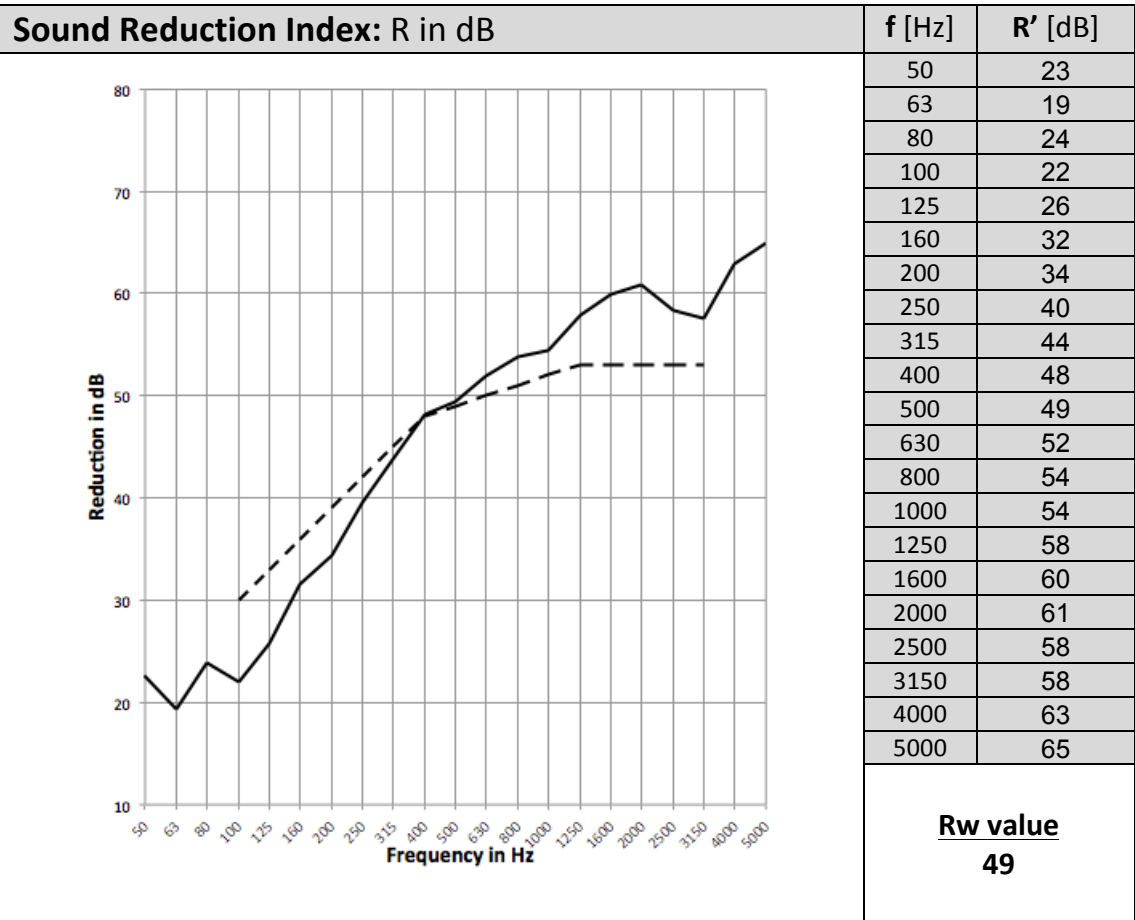- nylon sheet
- 13 reinforced gypsum panel

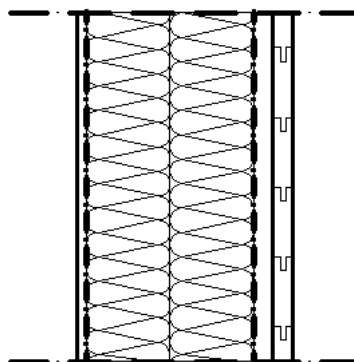**Technical Details**

Inside   Outside

Sound Reduction Index: R in dB	f [Hz]	R' [dB]
	50	23
	63	19
	80	24
	100	22
	125	26
	160	32
	200	34
	250	40
	315	44
	400	48
	500	49
	630	52
	800	54
	1000	54
	1250	58
	1600	60
	2000	61
	2500	58
	3150	58
	4000	63
	5000	65

Rw value
49

Case 30: Alternative versions	Wood panels facade on wooden frame

	Material layers in [mm]
Case 30.1	- 28 wood panels
	- 28 air gap
	- plastic sheet
	- 240 wooden studs frame with glass wool
	- nylon sheet
	- 13 reinforced gypsum panel

Technical Details
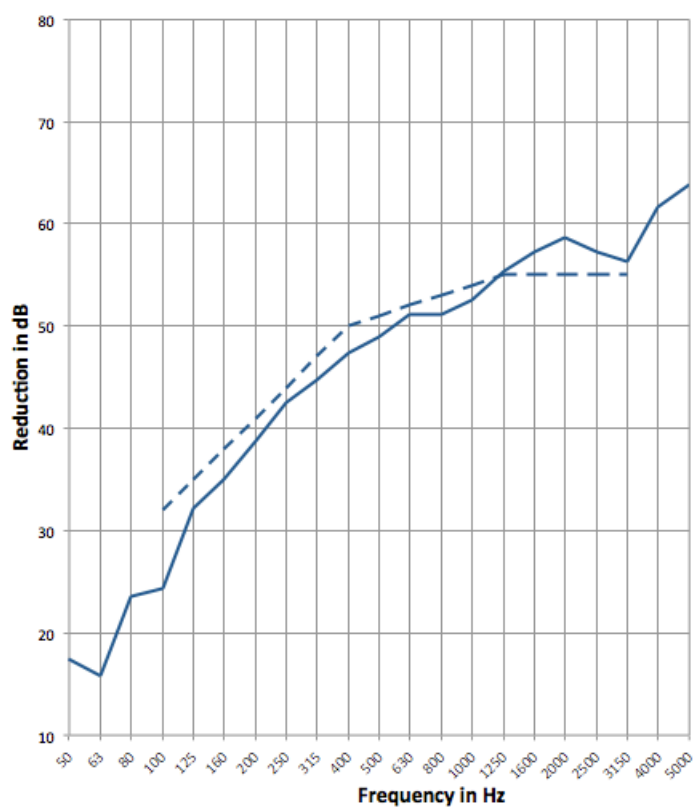
Sound Reduction Index: R in dB		f [Hz]	R' [dB]
		50	17
		63	16
		80	24
		100	24
		125	32
		160	35
		200	39
		250	43
		315	45
		400	47
		500	49
		630	51
		800	51
		1000	53
		1250	55
		1600	57
		2000	59
		2500	57
		3150	56
		4000	62
		5000	64

Rw value

51

Case 31	Wood panels facade on wooden frame

Material layers in [mm]

- 28 wood panels
- 28 air gap
- plastic sheet
- 300 wooden studs frame
  with heavy rock wool
- nylon sheet
- 13 reinforced gypsum panel

Technical Details
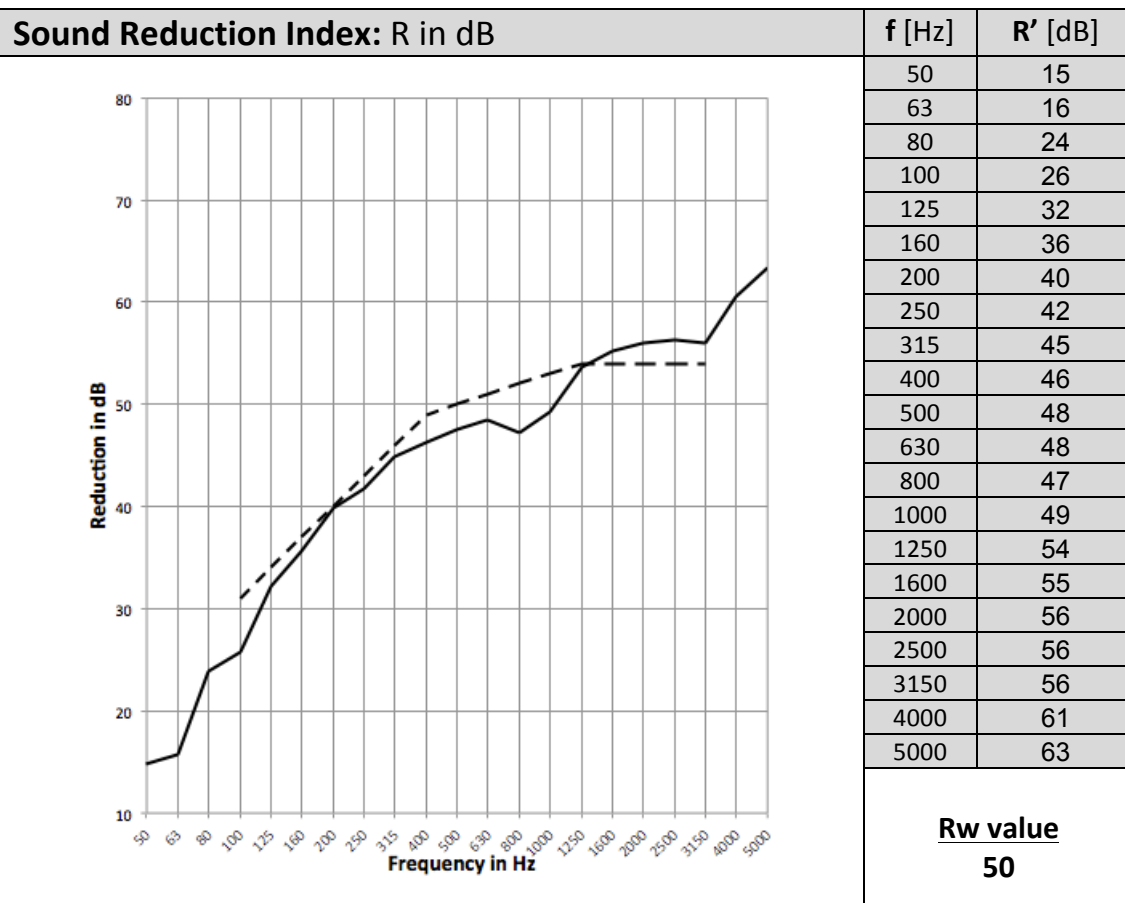
Inside   Outside

Sound Reduction Index: R in dB	f [Hz]	R' [dB]
	50	15
	63	16
	80	24
	100	26
	125	32
	160	36
	200	40
	250	42
	315	45
	400	46
	500	48
	630	48
	800	47
	1000	49
	1250	54
	1600	55
	2000	56
	2500	56
	3150	56
	4000	61
	5000	63

Rw value
50
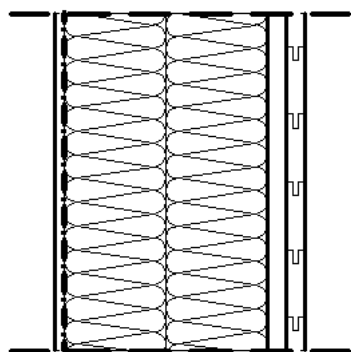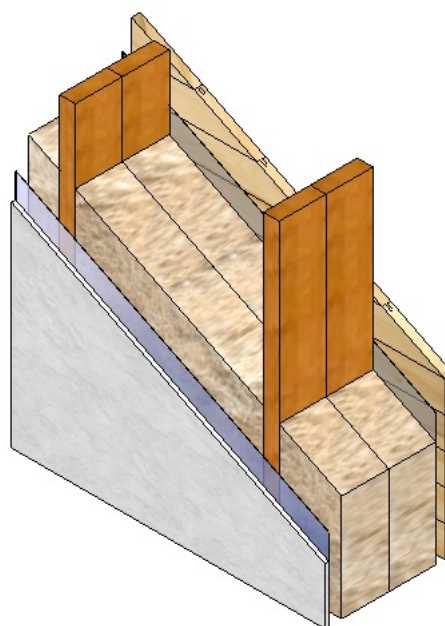
Case 31: Alternative versions	Wood panels facade on wooden frame

Case 31.1

Material layers in [mm]
- 28 wood panels
- 28 air gap
- plastic sheet
- 240 wooden studs frame
  with heavy rock wool
- nylon sheet
- 13 reinforced gypsum panel
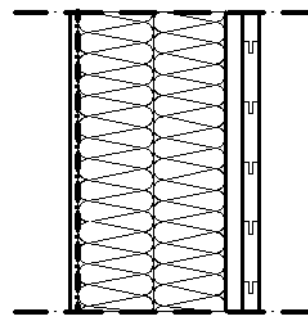
Technical Details

Case 31.2

Material layers in [mm]
- 28 wood panels
- 28 air gap
- plastic sheet
- 170 wooden studs frame
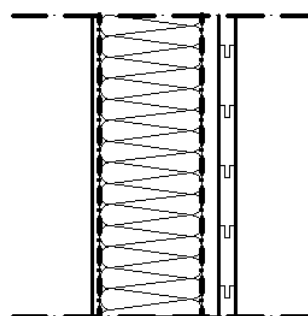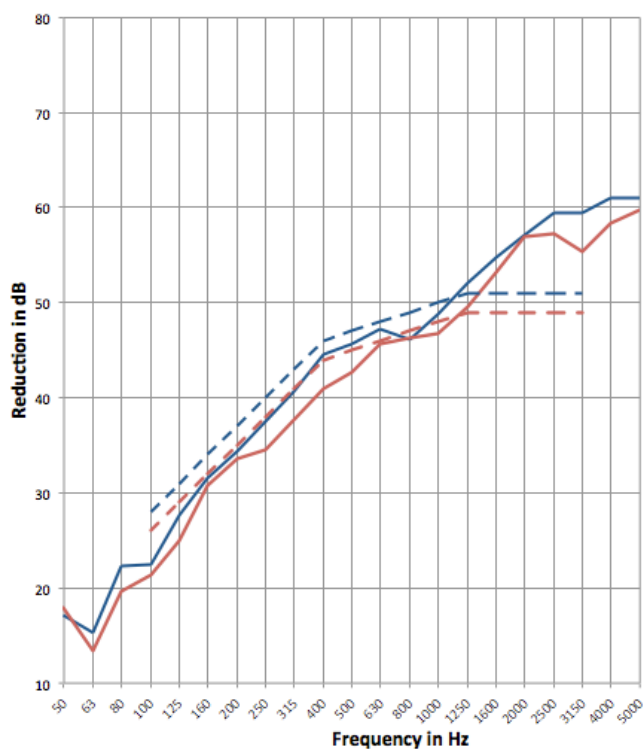 with heavy rock wool
- nylon sheet
- 13 reinforced gypsum panel

Technical Details

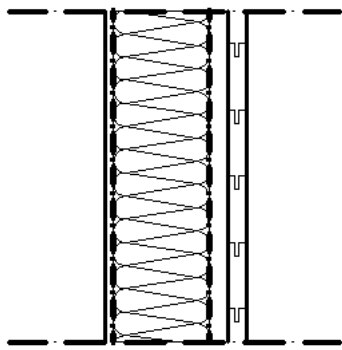| Sound Reduction Index: R in dB	f [Hz]	R' [dB]	R' [dB]
	50	17	18
	63	15	13
	80	22	20
	100	22	21
	125	28	25
	160	32	31
	200	34	34
	250	38	35
	315	41	38
	400	45	41
	500	46	43
	630	47	46
	800	46	46
	1000	49	47
	1250	52	50
	1600	55	53
	2000	57	57
	2500	59	57
	3150	60	55
	4000	61	58
	5000	61	60
	Rw values	**47**	**45**

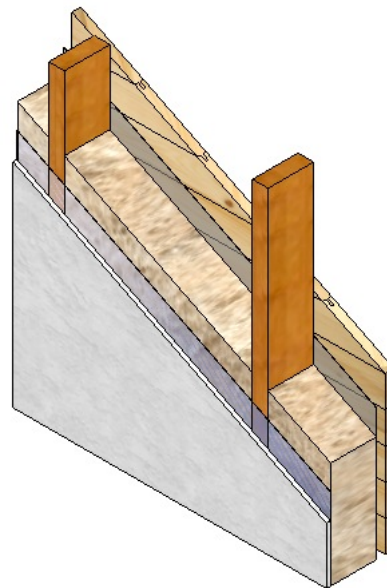Reduction in dB — Frequency in Hz

Case 32	Wood panels facade on wooden frame

Material layers in [mm]
- 28 wood panels
- 28 air gap
- plastic sheet
- 145 wooden studs frame
  with heavy rock wool
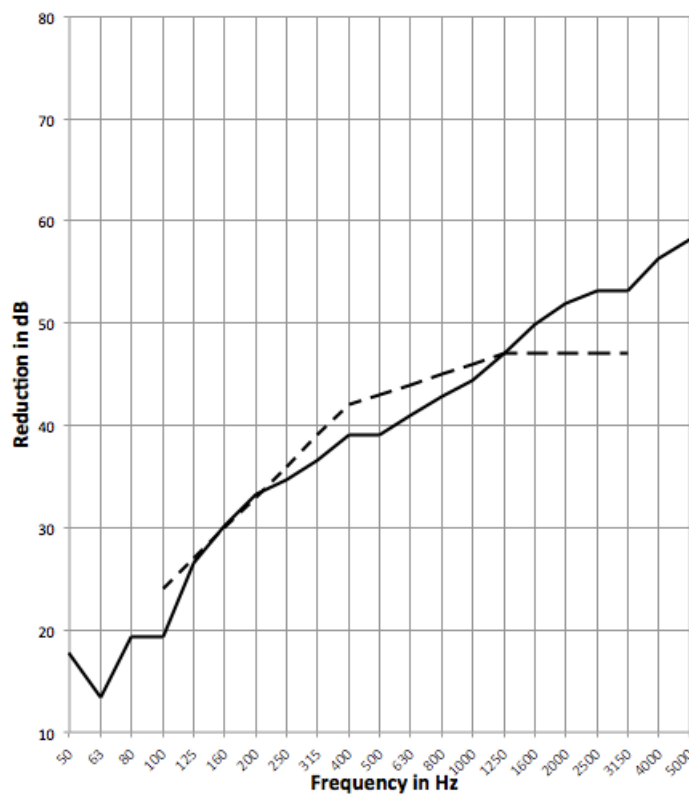- nylon sheet
- 13 reinforced gypsum panel

Technical Details

Inside   Outside

Sound Reduction Index: R in dB	f [Hz]	R' [dB]
	50	18
	63	13
	80	19
	100	19
	125	27
	160	30
	200	33
	250	35
	315	37
	400	39
	500	39
	630	41
	800	43
	1000	44
	1250	47
	1600	50
	2000	52
	2500	53
	3150	53
	4000	56
	5000	58
	Rw value **43**	

Case 32: Alternative versions	Wood panels facade on wooden frame

	Material layers in [mm]	
Case 32.1	- 28 wood panels	
	- 28 air gap	
	- vapor barrier	
	- 145 wooden studs frame	
	with heavy rock wool	**Technical Details**
	- nylon sheet	
	- 13 reinforced gypsum panel	
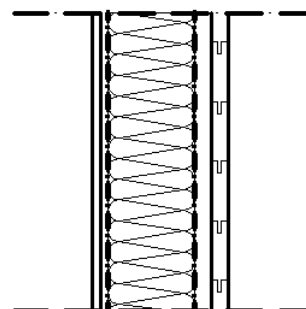
	Material layers in [mm]	
Case 32.2	- 28 wood panels	
	- 28 air gap	
	- 9 gypsum board	
	- 145 wooden studs frame	
	with heavy rock wool	**Technical Details**
	- nylon sheet	
	- 2*13 reinforced gypsum panel	

Sound Reduction Index: R in dB

f [Hz]	R' [dB]	R' [dB]
50	20	22
63	15	17
80	23	25
100	22	29
125	30	39
160	33	36
200	36	33
250	38	34
315	40	36
400	43	37
500	43	39
630	45	41
800	46	44
1000	48	47
1250	52	50
1600	55	53
2000	56	55
2500	57	54
3150	57	50
4000	61	56
5000	64	60
Rw values	**47**	**44**

Case 32: Alternative versions	Wood panels facade on wooden frame

Case 32.3

Material layers in [mm]
- 28 wood panels
- 28 air gap
- 2*9 gypsum board
- 145 wooden studs frame
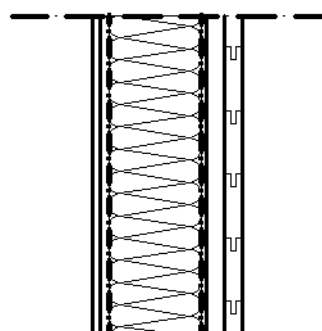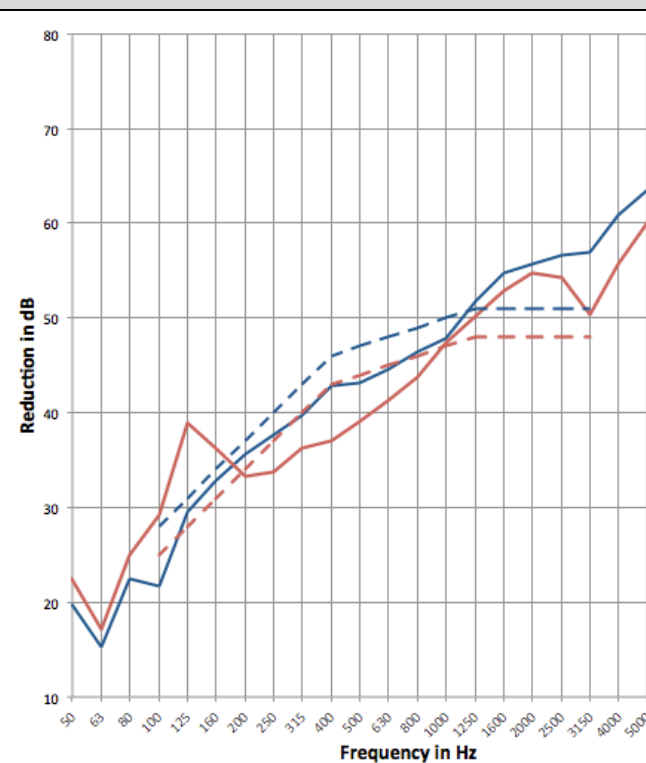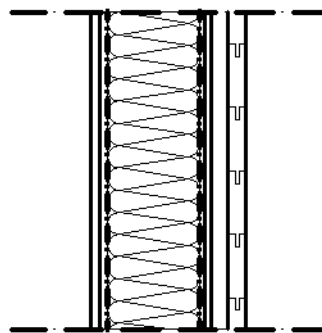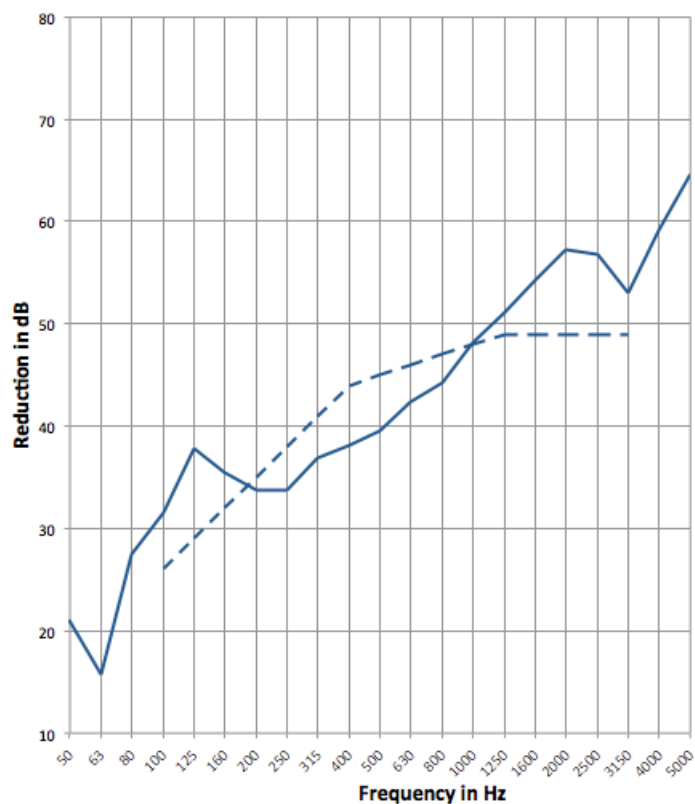 with heavy rock wool
- nylon sheet
- 2*13 reinforced gypsum panel

Technical Details

Sound Reduction Index: R in dB		f [Hz]	R' [dB]
		50	21
		63	16
		80	28
		100	32
		125	38
		160	36
		200	34
		250	34
		315	37
		400	38
		500	40
		630	42
		800	44
		1000	48
		1250	51
		1600	54
		2000	57
		2500	57
		3150	53
		4000	59
		5000	65

Rw value
45

Case 33	Wood panels facade on crosswise frame

Material layers in [mm]

- 22 outer wood paneling
- 28 wood panels
- 70 wooden studs with air gap
- 9 gypsum board
- 45+95 wooden studs frame
  with mineral wool
- 13 gypsum board

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	18
	63	16
	80	19
	100	25
	125	29
	160	28
	200	27
	250	27
	315	30
	400	38
	500	37
	630	41
	800	45
	1000	47
	1250	50
	1600	52
	2000	49
	2500	46
	3150	48
	4000	53
	5000	57
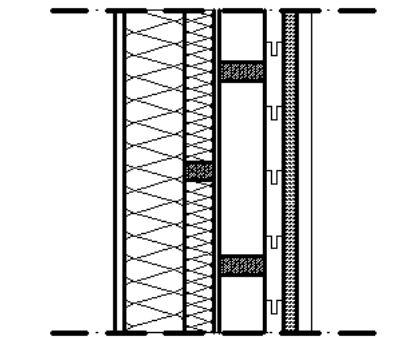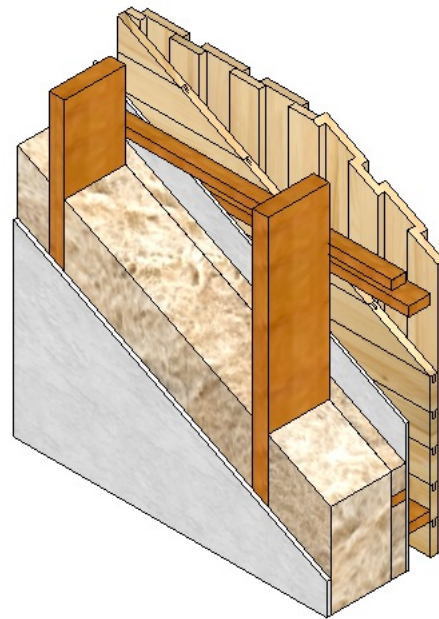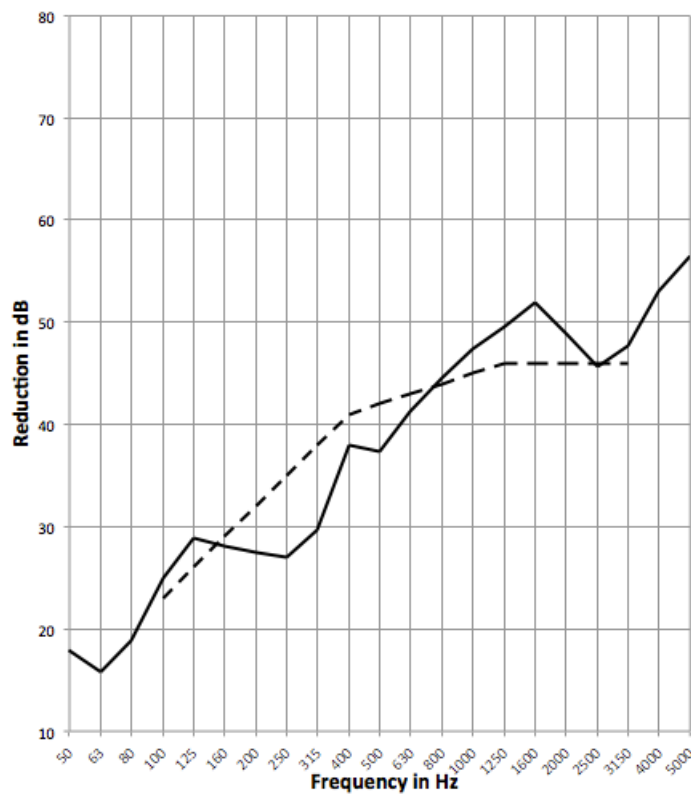
R'w value

42

Case 34	Wood panels facade on crosswise frame

Material layers in [mm]
- 22 outer wood paneling
- 50+95 wooden studs frame with mineral wool
- 13 fiber board

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	21
	63	18
	80	13
	100	19
	125	23
	160	26
	200	24
	250	29
	315	30
	400	31
	500	39
	630	39
	800	41
	1000	44
	1250	45
	1600	48
	2000	51
	2500	51
	3150	54
	4000	53
	5000	52

R'w value
39
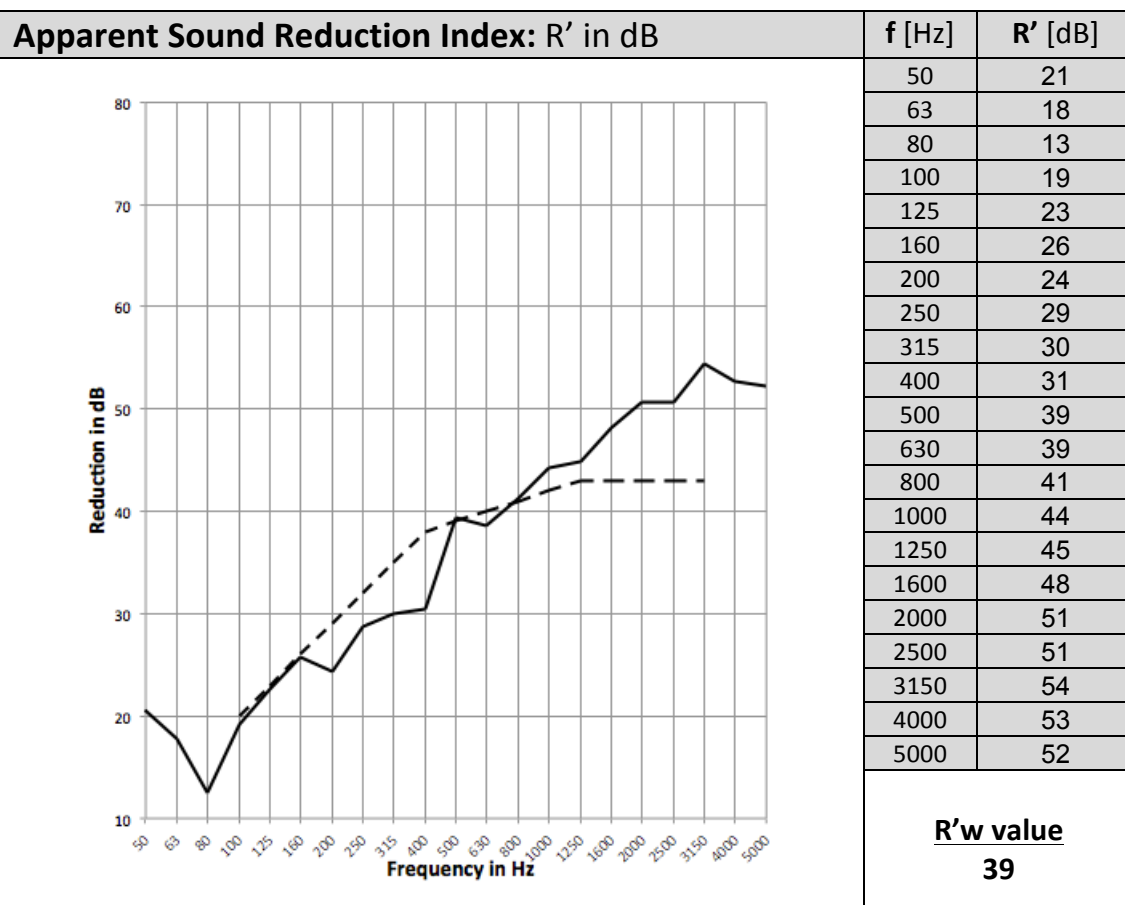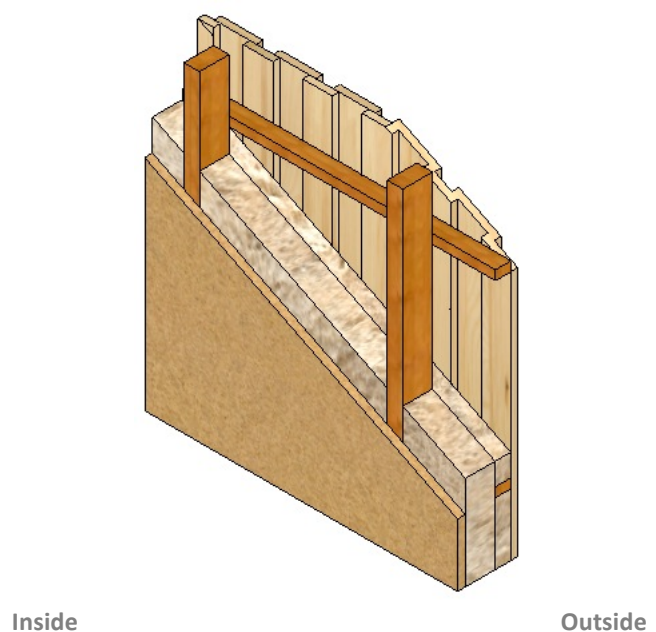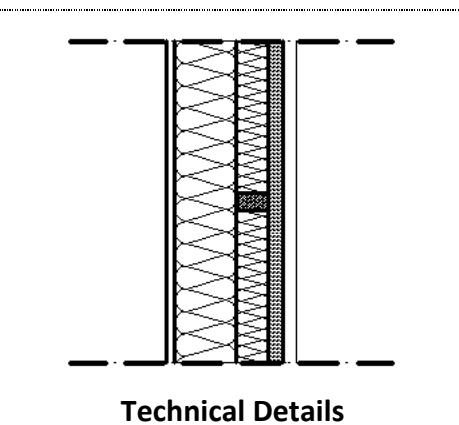
Case 35	Wood panels facade on crosswise frame

Material layers in [mm]
- 22 outer wood paneling
- 20 air gap
- 13 asphalt board
- 45+195 wooden studs frame with mineral wool
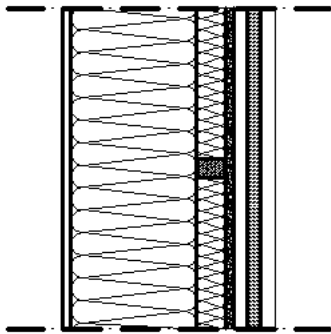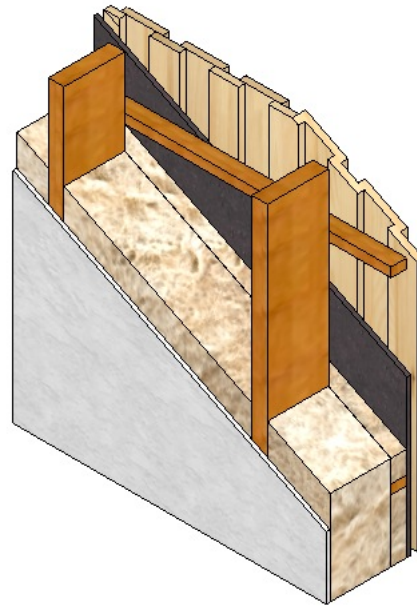- 12 gypsum panel

Technical Details

Inside   Outside
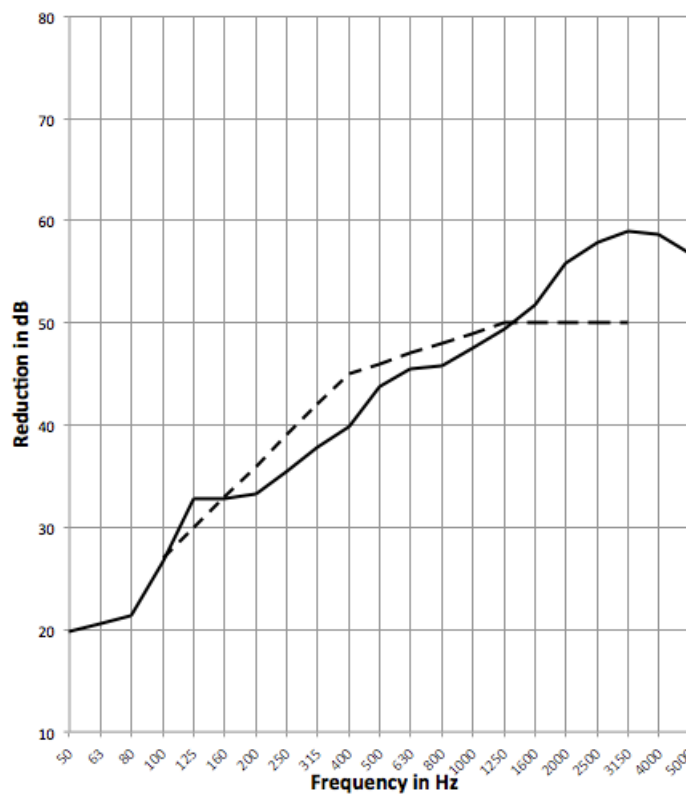
Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	20
	63	21
	80	21
	100	27
	125	33
	160	33
	200	33
	250	35
	315	38
	400	40
	500	44
	630	46
	800	46
	1000	48
	1250	49
	1600	52
	2000	56
	2500	58
	3150	59
	4000	59
	5000	57
	R'w value **46**	

Case 36	Wood panels facade on crosswise frame

Material layers in [mm]
- 22 outer wood paneling
- 60+120 wooden studs frame
  with mineral wool
- 13 gypsum board

Technical Details

Inside   Outside
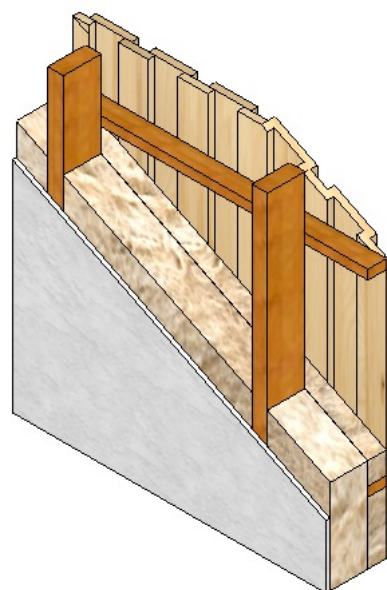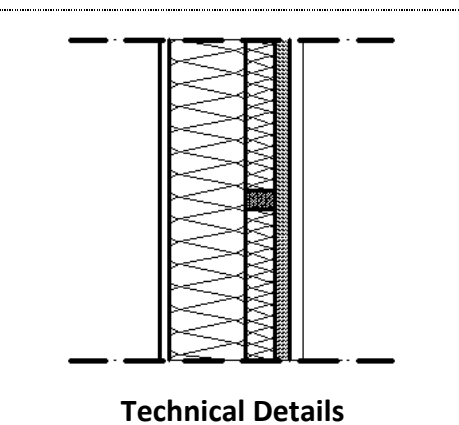
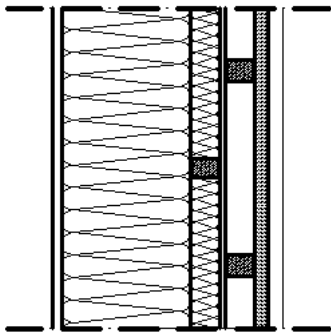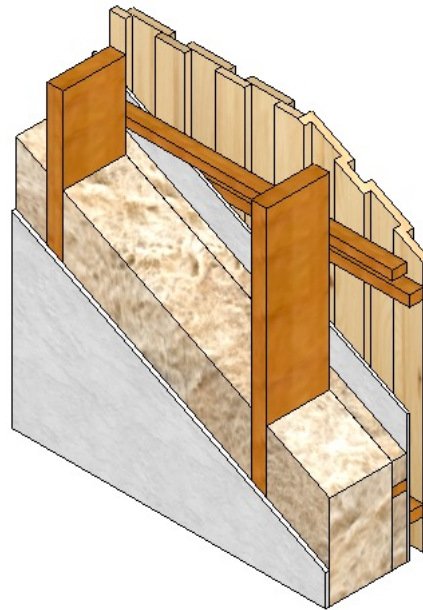| Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	17
	63	16
	80	16
	100	27
	125	36
	160	33
	200	32
	250	32
	315	34
	400	40
	500	39
	630	42
	800	43
	1000	44
	1250	50
	1600	53
	2000	50
	2500	46
	3150	49
	4000	56
	5000	58

R'w value
44
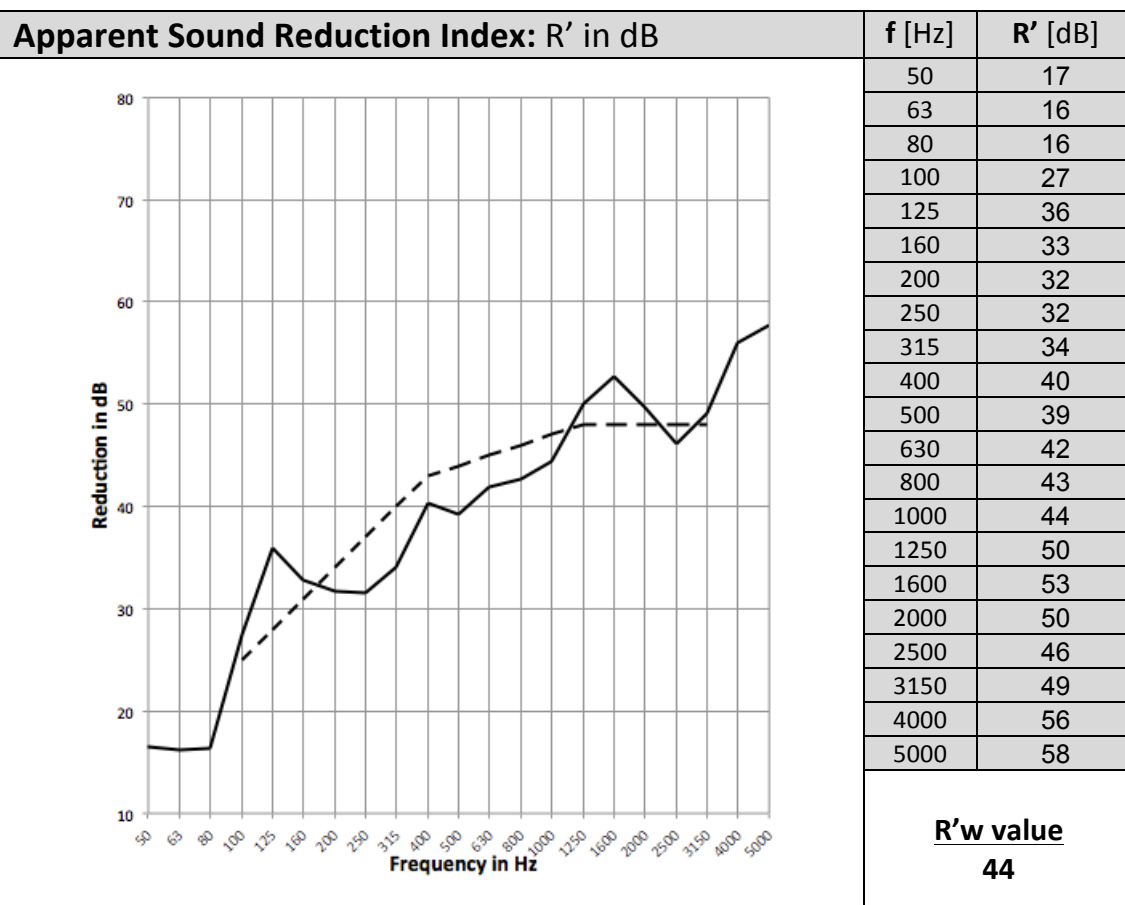
Case 37	Wood panels facade on crosswise frame

Material layers in [mm]
- 22 outer wood paneling
- 45 wooden studs with air gap
- 9 gypsum board
- 45+200 wooden studs frame
  with mineral wool
- 13 gypsum board

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	22
	63	24
	80	23
	100	26
	125	31
	160	28
	200	32
	250	33
	315	33
	400	38
	500	43
	630	45
	800	47
	1000	50
	1250	51
	1600	52
	2000	53
	2500	51
	3150	53
	4000	58
	5000	58
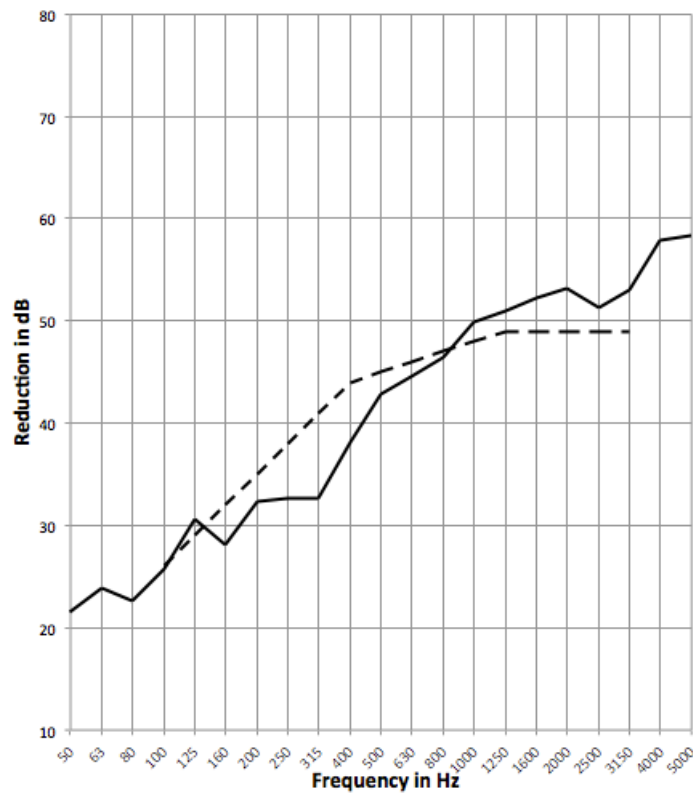
R'w value
45

Case 38	Wood panels facade on crosswise frame

Material layers in [mm]
- 28 wood panels
- 28 air gap
- 9 gypsum board
- 45+95 wooden studs frame with rock wool
- nylon sheet
- 13 gypsum board

Technical Details
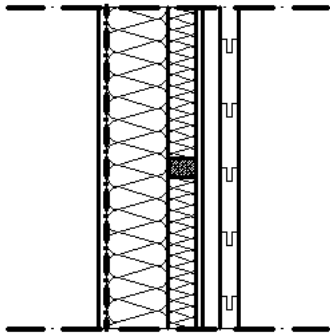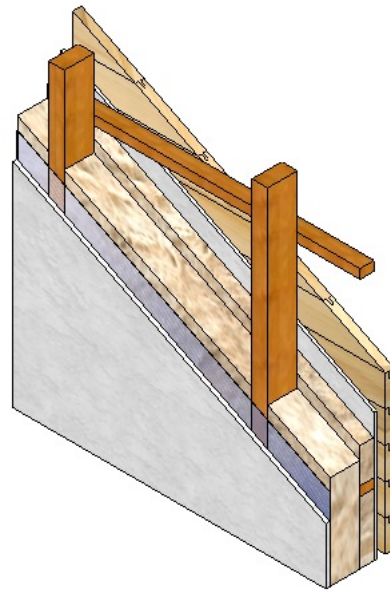
Inside   Outside
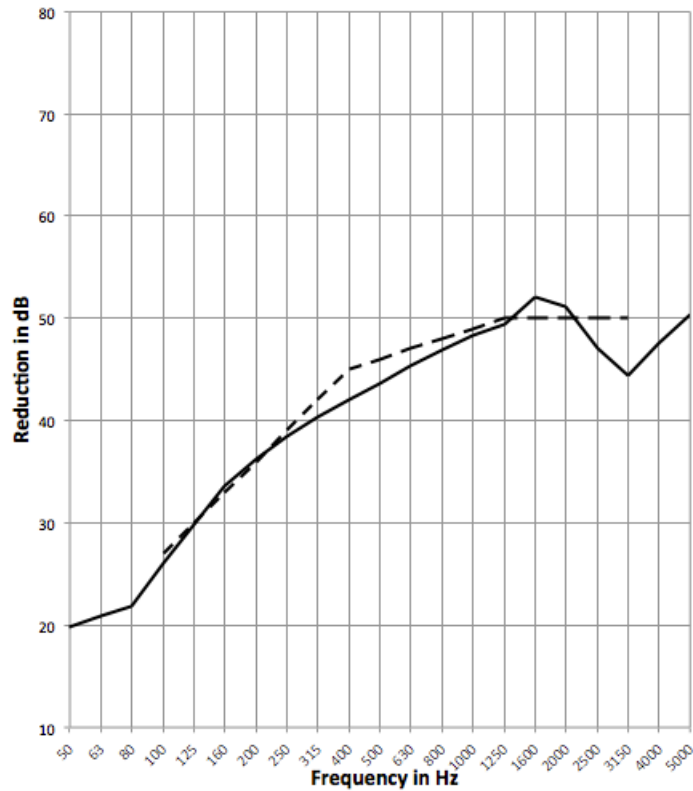
Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	20
	63	21
	80	22
	100	26
	125	30
	160	34
	200	36
	250	38
	315	40
	400	42
	500	44
	630	45
	800	47
	1000	48
	1250	49
	1600	52
	2000	51
	2500	47
	3150	44
	4000	48
	5000	50

R'w value
46

Case 38: Alternative versions	Wood panels facade on crosswise frame

Case 38.1	**Material layers** in [mm]
	- 28 wood panels
	- 28 air gap
	- 2*9 gypsum board
	- 25 acoustic profile with wool
	- 45+95 wooden studs frame with rock wool
	- nylon sheet
	- 13 gypsum board
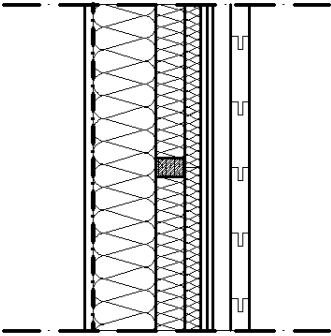
Technical Details

Apparent Sound Reduction Index: R' in dB		f [Hz]	R' [dB]
		50	22
		63	20
		80	25
		100	30
		125	35
		160	39
		200	44
		250	47
		315	50
		400	52
		500	54
		630	56
		800	57
		1000	59
		1250	60
		1600	61
		2000	62
		2500	61
		3150	56
		4000	58
		5000	61
		R'w value	
		55	
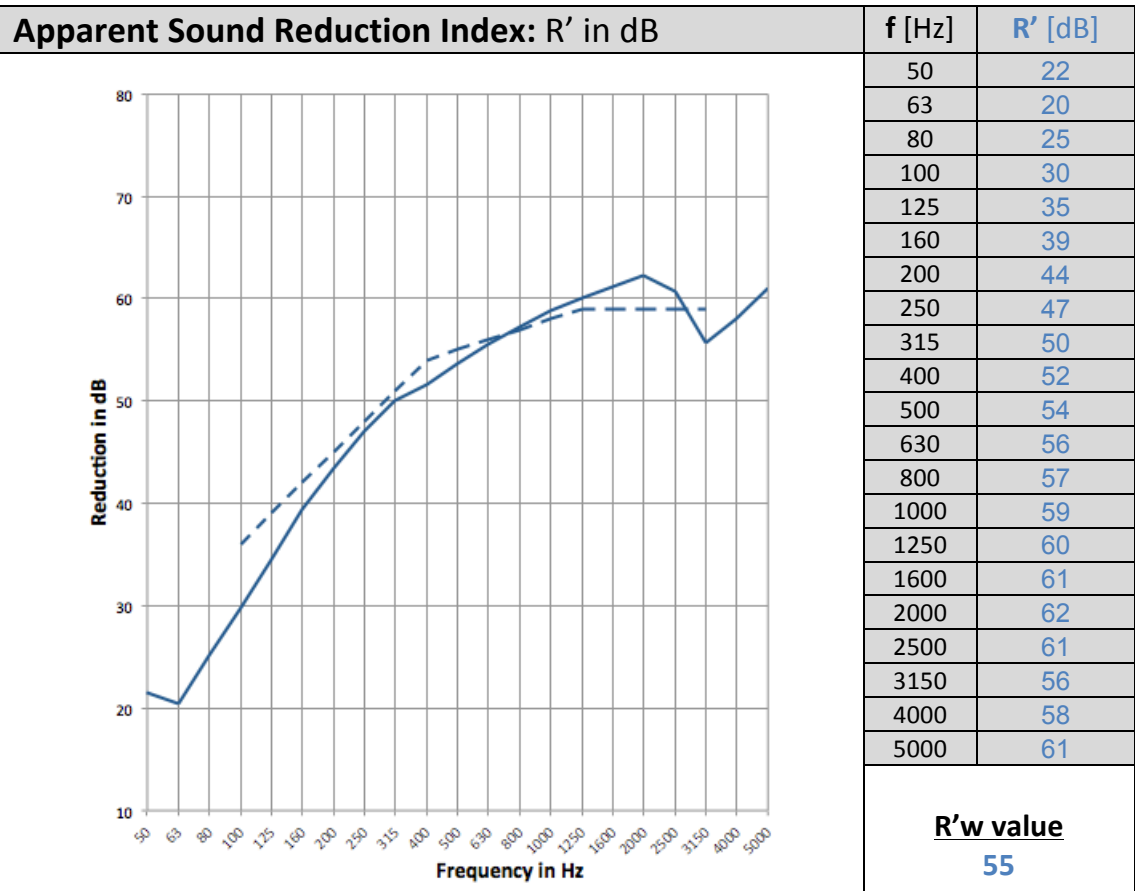
Case 39	Wood panels facade on crosswise frame

Material layers in [mm]
- 28 wood panels
- 28 air gap
- vapor barrier
- 45+145 wooden studs frame
  with rock wool
- nylon sheet
- 13 gypsum board
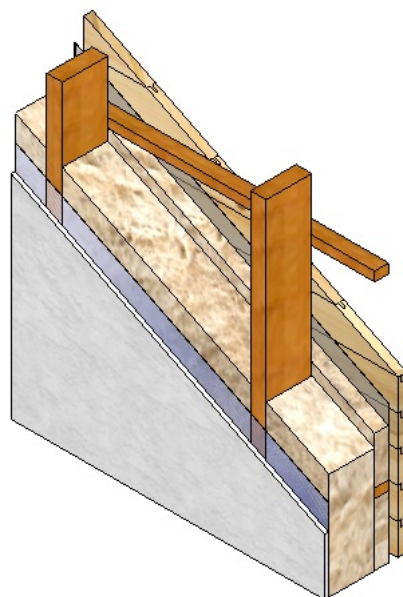
Technical Details

Inside   Outside

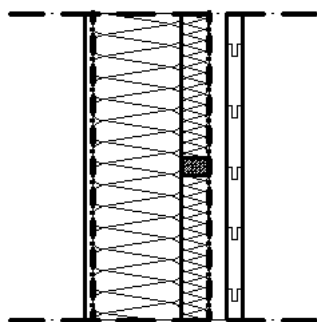| Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	18
	63	15
	80	22
	100	24
	125	29
	160	33
	200	36
	250	38
	315	41
	400	44
	500	44
	630	47
	800	50
	1000	51
	1250	54
	1600	57
	2000	59
	2500	61
	3150	61
	4000	67
	5000	68
	R'w value **48**	
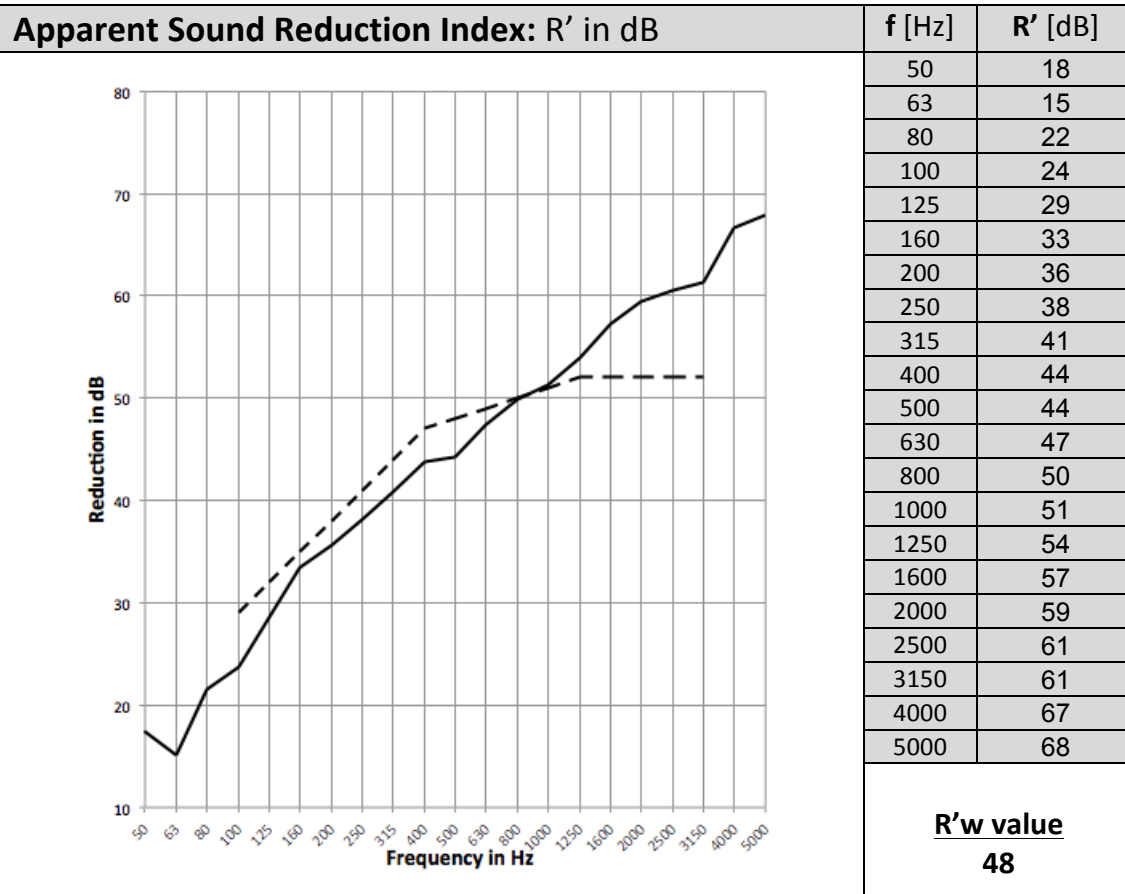
Case 39: Alternative versions	Wood panels facade on crosswise frame

Case 39.1

Material layers in [mm]
- 28 wood panels
- 28 air gap
- 9 gypsum board
- 45+145 wooden studs frame with rock wool
- nylon sheet
- 13 gypsum board

Technical Details

Case 39.2

Material layers in [mm]
- 28 wood panels
- 28 air gap
- 9 gypsum board
- 45+145 wooden studs frame with rock wool
- nylon sheet
- 2*13 gypsum board
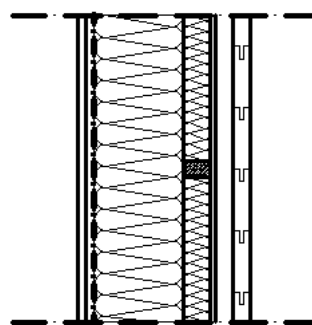
Technical Details
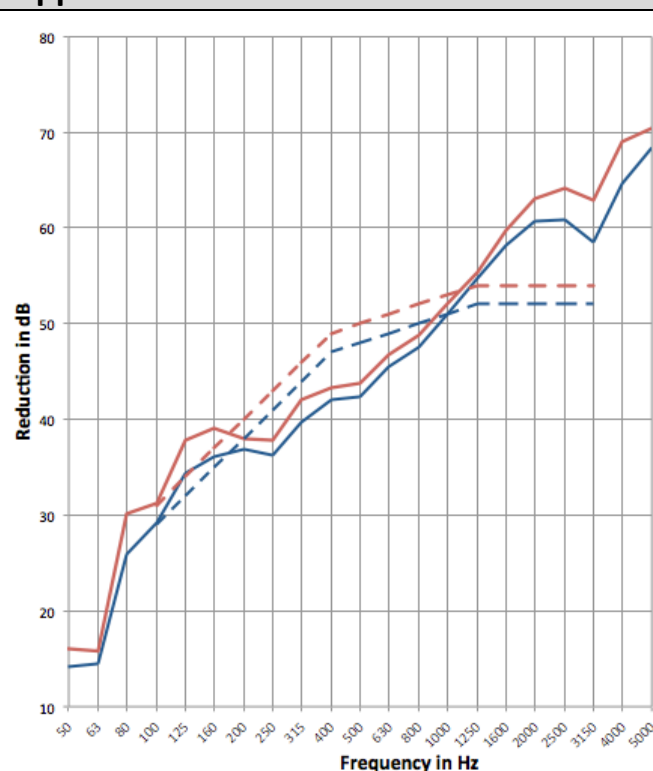
Apparent Sound Reduction Index: R′ in dB	f [Hz]	R′ [dB]	R′ [dB]
	50	14	16
	63	14	16
	80	26	30
	100	29	31
	125	34	38
	160	36	39
	200	37	38
	250	36	38
	315	40	42
	400	42	43
	500	42	44
	630	46	47
	800	48	49
	1000	51	52
	1250	55	55
	1600	58	60
	2000	61	63
	2500	61	64
	3150	59	63
	4000	65	69
	5000	68	70
	R′w values	48	50

Case 39: Alternative versions	Wood panels facade on crosswise frame

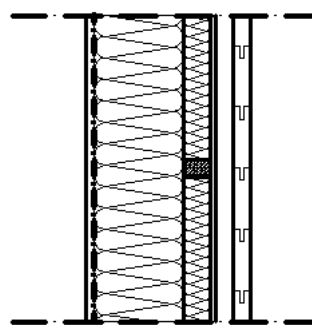|	**Material layers** in [mm]	
Case 39.3	- 28 wood panels - 28 air gap - 2*9 gypsum board - 45+145 wooden studs frame with rock wool - nylon sheet - 2*13 gypsum board	 **Technical Details**
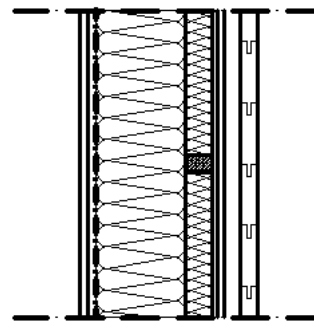
	Material layers in [mm]	
Case 39.4	- 28 wood panels - 28 air gap - 2*9 gypsum board - 25 acoustic profile with wool - 45+145 wooden studs frame with rock wool - nylon sheet - 13 gypsum board	 **Technical Details**
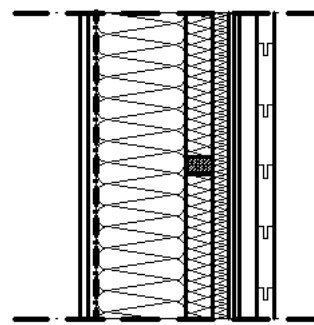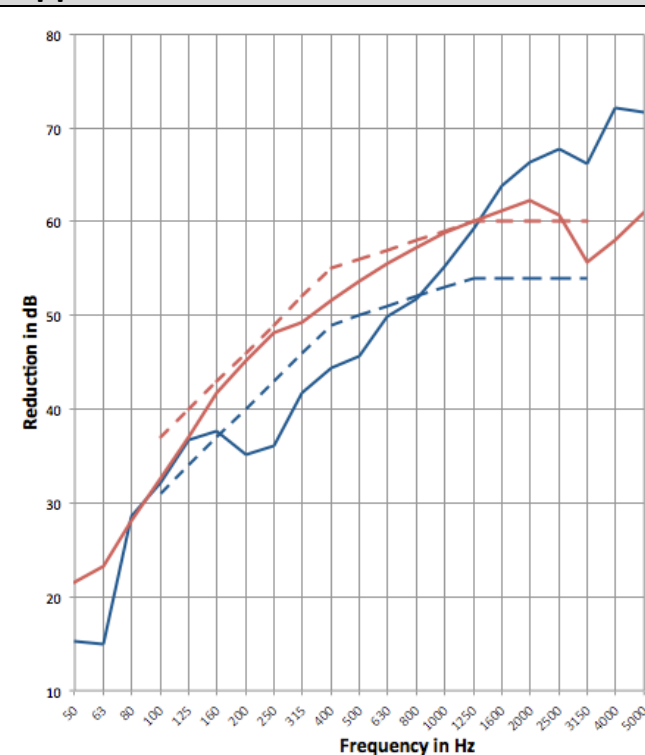
Apparent Sound Reduction Index: R' in dB	**f** [Hz]	**R'** [dB]	**R'** [dB]
	50	15	22
	63	15	23
	80	29	28
	100	32	33
	125	37	37
	160	38	42
	200	35	45
	250	36	48
	315	42	49
	400	44	52
	500	46	54
	630	50	56
	800	52	57
	1000	55	59
	1250	59	60
	1600	64	61
	2000	66	62
	2500	68	61
	3150	66	56
	4000	72	58
	5000	72	61
	R'w values	**50**	**56**

Case 39: Alternative versions	Wood panels facade on crosswise frame

Case 39.5

Material layers in [mm]
- 28 wood panels
- 28 air gap
- 9 gypsum board
- 45+195 wooden studs frame
 with rock wool
- nylon sheet
- 13 gypsum board
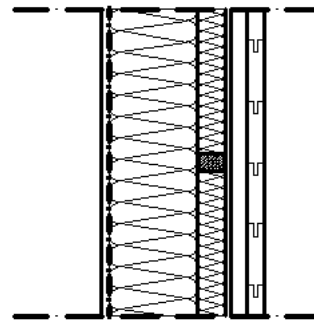
Technical Details

Apparent Sound Reduction Index: R' in dB

f [Hz]	R' [dB]
50	17
63	21
80	26
100	29
125	32
160	35
200	37
250	38
315	40
400	42
500	44
630	45
800	47
1000	48
1250	49
1600	52
2000	51
2500	47
3150	44
4000	48
5000	50

R'w value
47

Case 40	Wood panels facade on crosswise frame

Material layers in [mm]

- 28 wood panels
- 28 air gap
- vapor barrier
- 50+240 wooden studs frame
  with rock wool
- nylon sheet
- 13 gypsum board
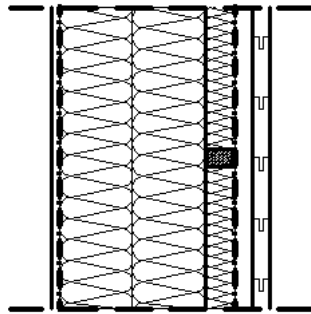
Technical Details

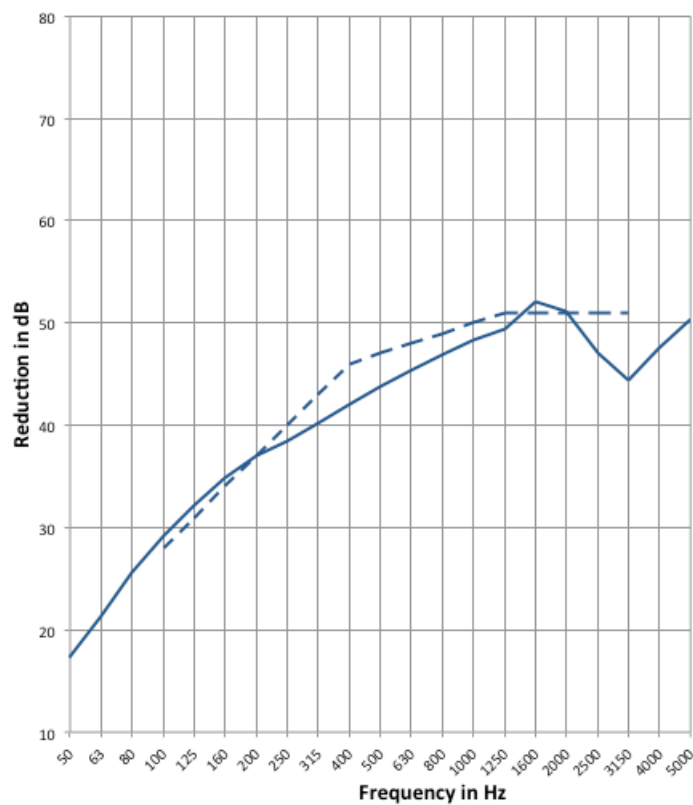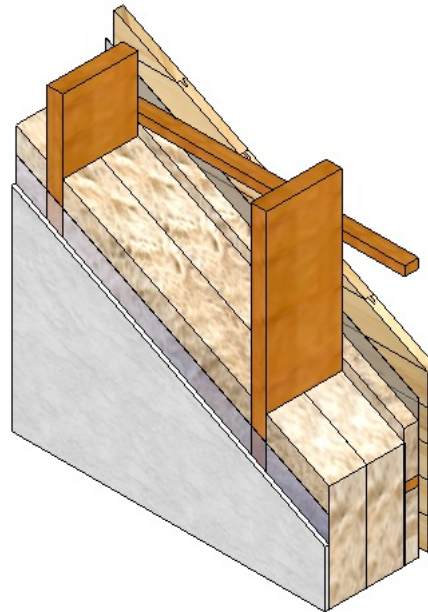Inside   Outside
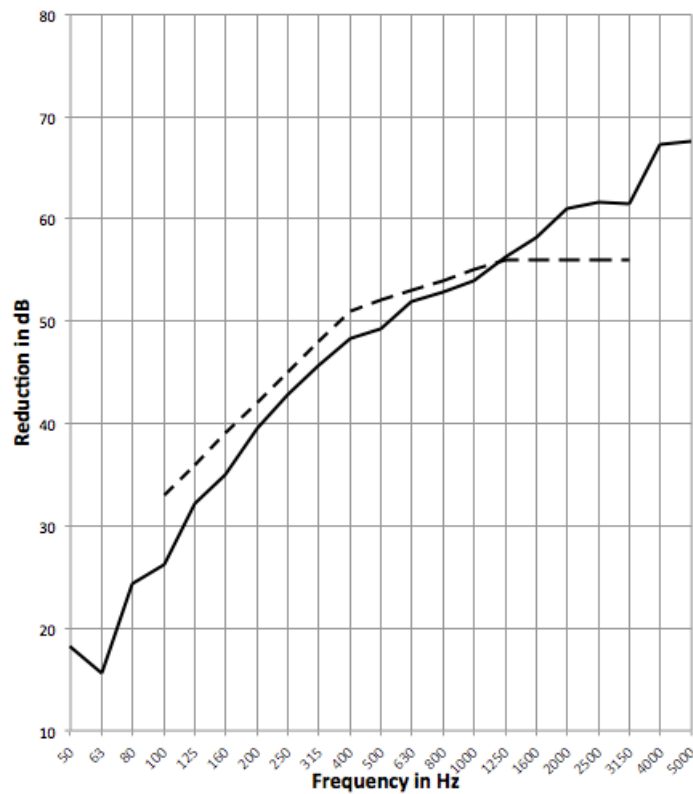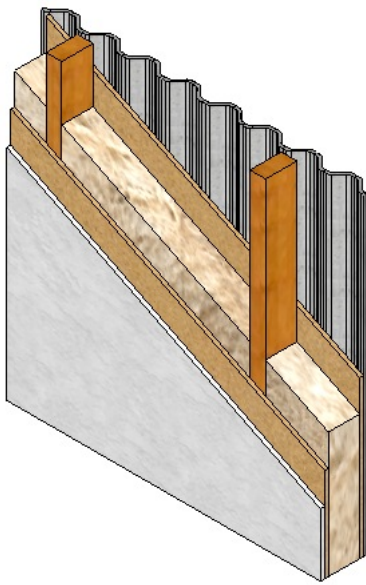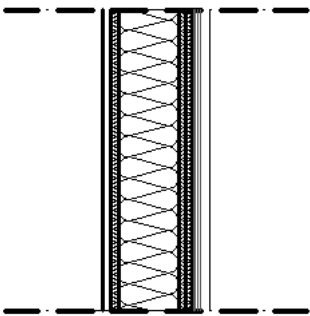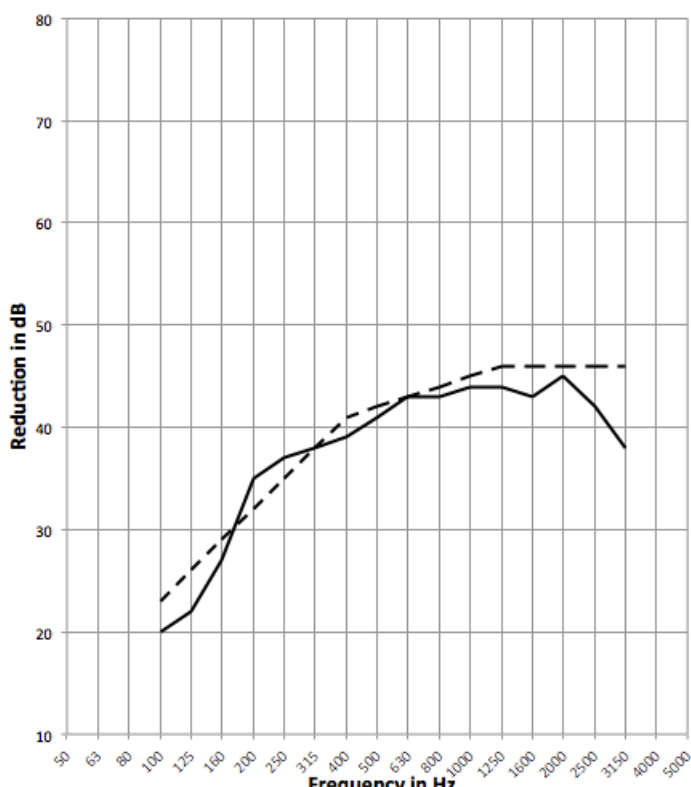
Sound Reduction Index: R in dB	f [Hz]	R' [dB]
	50	18
	63	16
	80	24
	100	26
	125	32
	160	35
	200	40
	250	43
	315	46
	400	48
	500	49
	630	52
	800	53
	1000	54
	1250	56
	1600	58
	2000	61
	2500	62
	3150	62
	4000	67
	5000	68

Rw value
52

Case 41	Concrete panel facade on stud frame

Material layers in [mm]

- 9 fiber concrete board
- 34 air gap
- 12 asphalt board
- 95 wooden studs frame
  with rock wool
- 13 gypsum board

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	17
	63	12
	80	17
	100	19
	125	24
	160	30
	200	33
	250	35
	315	41
	400	44
	500	46
	630	49
	800	50
	1000	53
	1250	55
	1600	58
	2000	60
	2500	59
	3150	57
	4000	57
	5000	61
	R'w value	
	46	
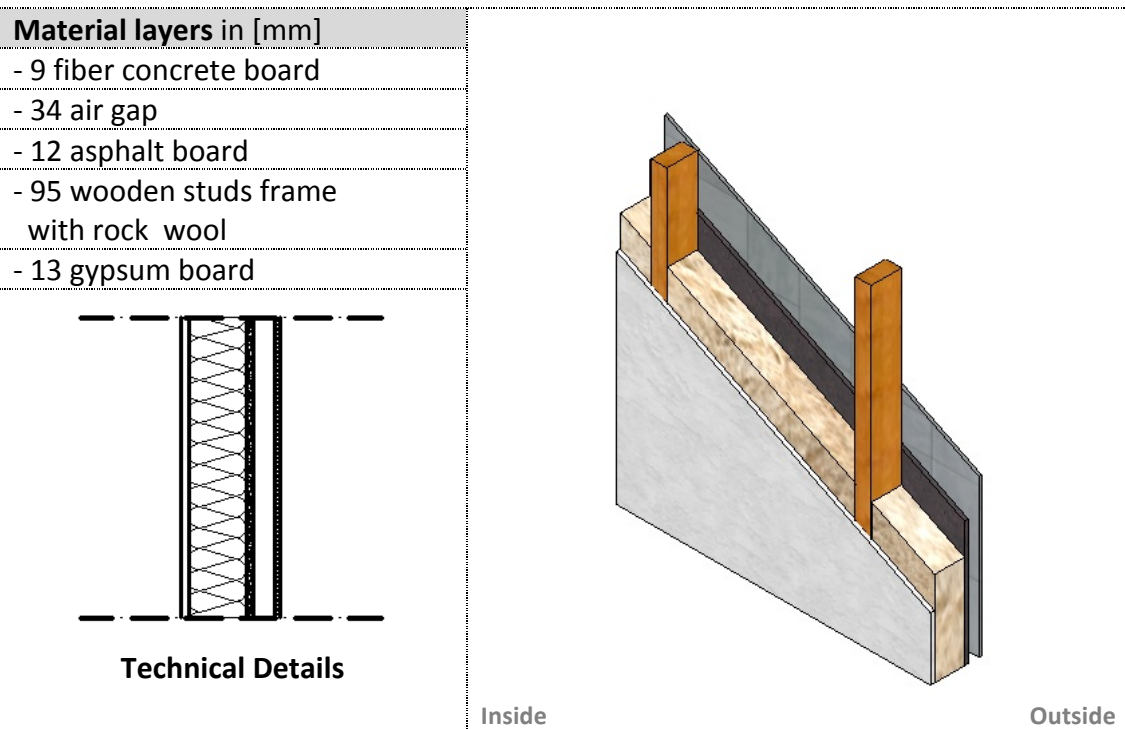
Case 42	Concrete panel facade on stud frame

Material layers in [mm]

- 11 corrugated fiber concrete panel
- 12 fiber board
- 100 wooden studs frame
  with rock wool
- 12 fiber board
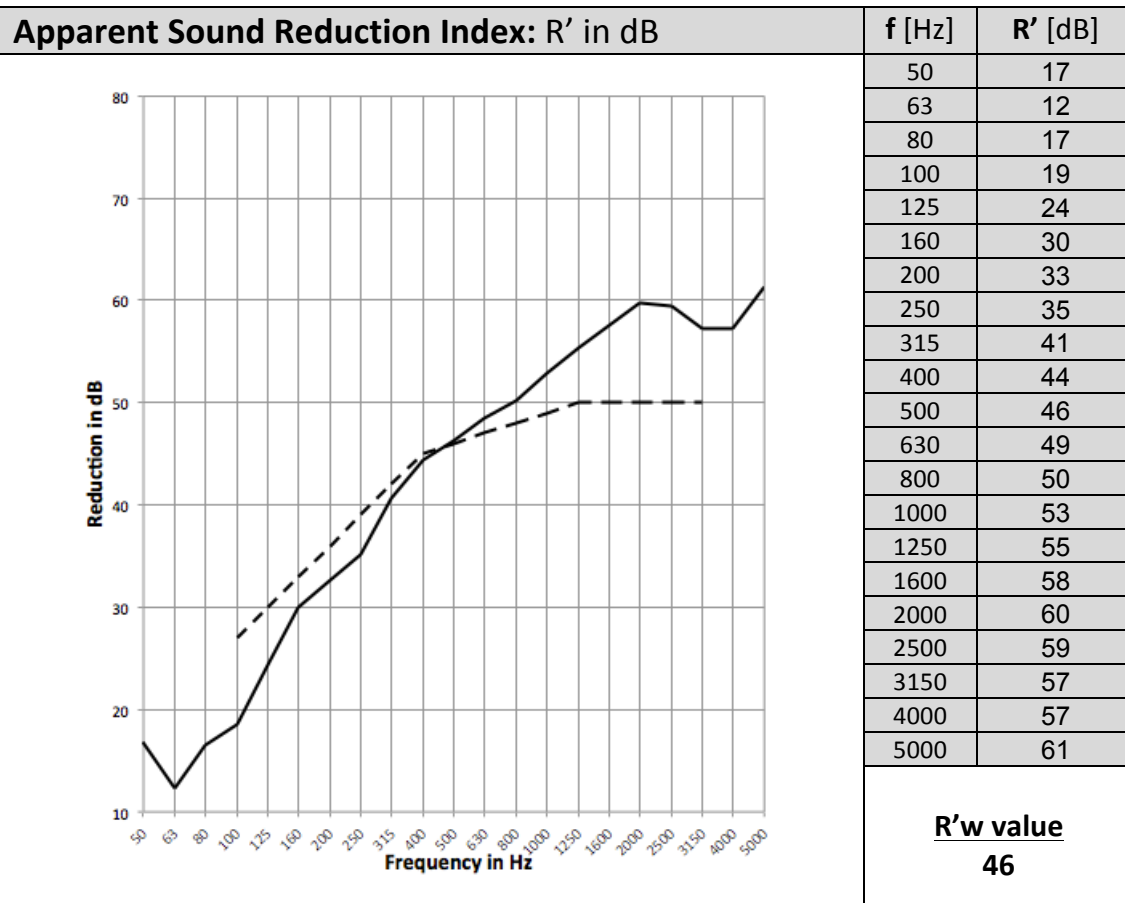- 13 gypsum board

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R′ in dB	f [Hz]	R′ [dB]
	50	
	63	
	80	
	100	20
	125	22
	160	27
	200	35
	250	37
	315	38
	400	39
	500	41
	630	43
	800	43
	1000	44
	1250	44
	1600	43
	2000	45
	2500	42
	3150	38
	4000	
	5000	
	R'w value **42**	

Case 43	Concrete panel facade on stud frame

Material layers in [mm]
- 11 corrugated fiber concrete panel
- 28 wood panel
- 100 wooden studs frame with rock wool
- 12 fiber board

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	14
	63	14
	80	16
	100	19
	125	19
	160	23
	200	35
	250	36
	315	37
	400	38
	500	39
	630	41
	800	42
	1000	42
	1250	43
	1600	43
	2000	44
	2500	43
	3150	38
	4000	37
	5000	36
	R'w value **40**	
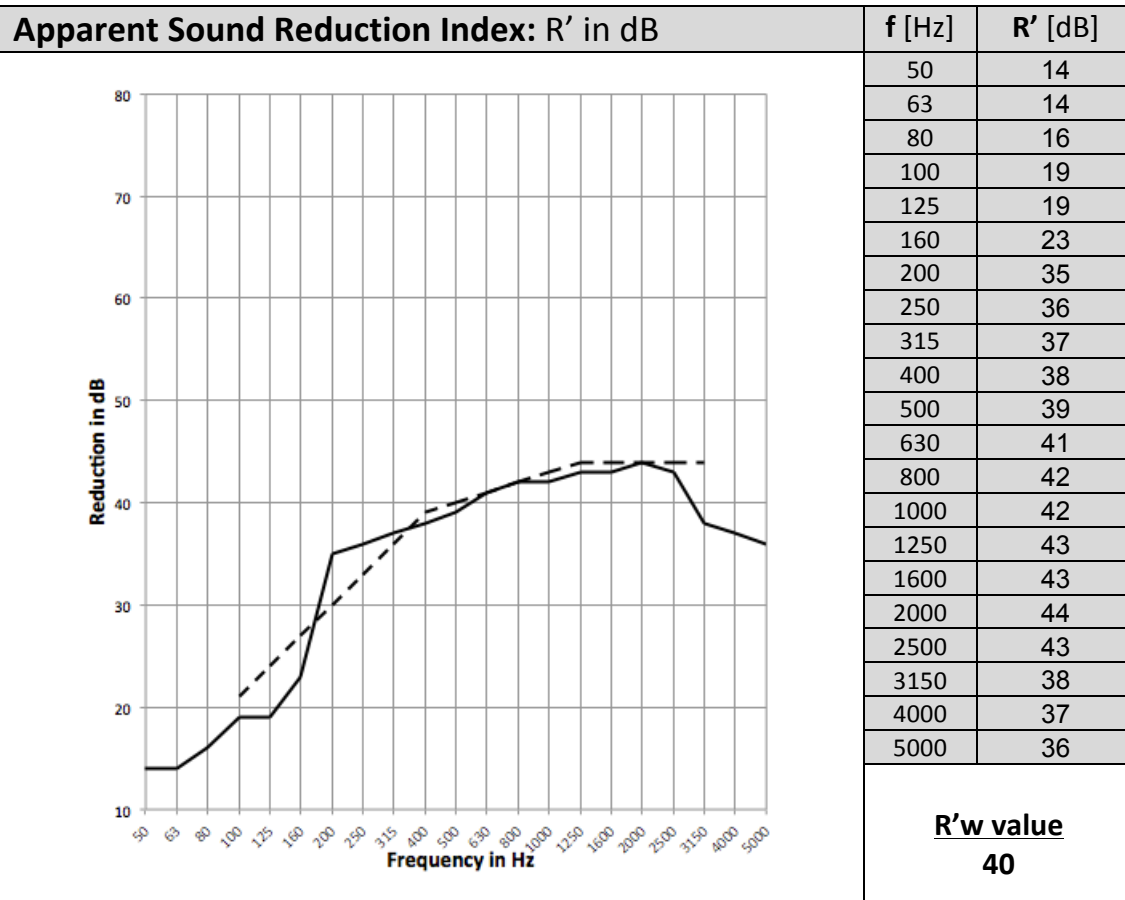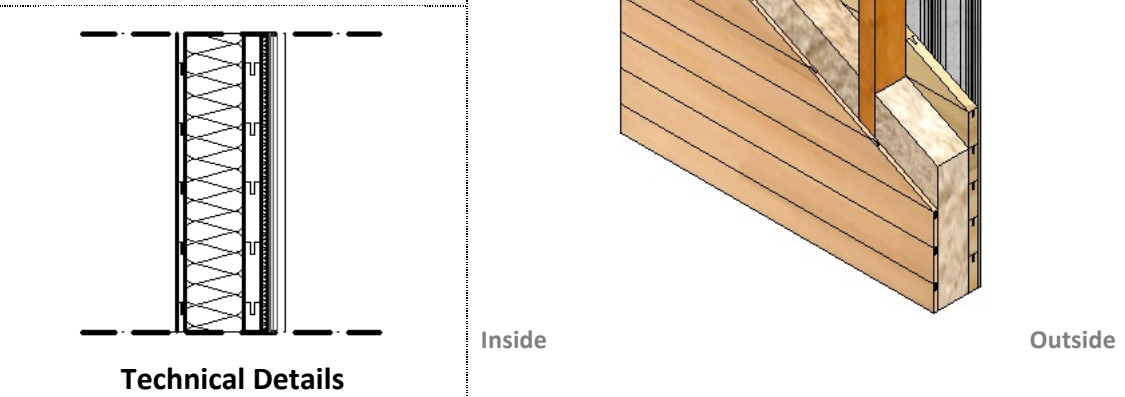
Case 44	Concrete panel facade on stud frame

Material layers in [mm]
- 19 wood panel
- 19 air gap
- 9 fiber concrete board
- 120 wooden studs frame
  with mineral wool
- 13 gypsum board

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	15
	63	10
	80	14
	100	12
	125	16
	160	19
	200	20
	250	20
	315	25
	400	28
	500	29
	630	32
	800	33
	1000	34
	1250	34
	1600	36
	2000	38
	2500	41
	3150	47
	4000	50
	5000	54

R'w value
32
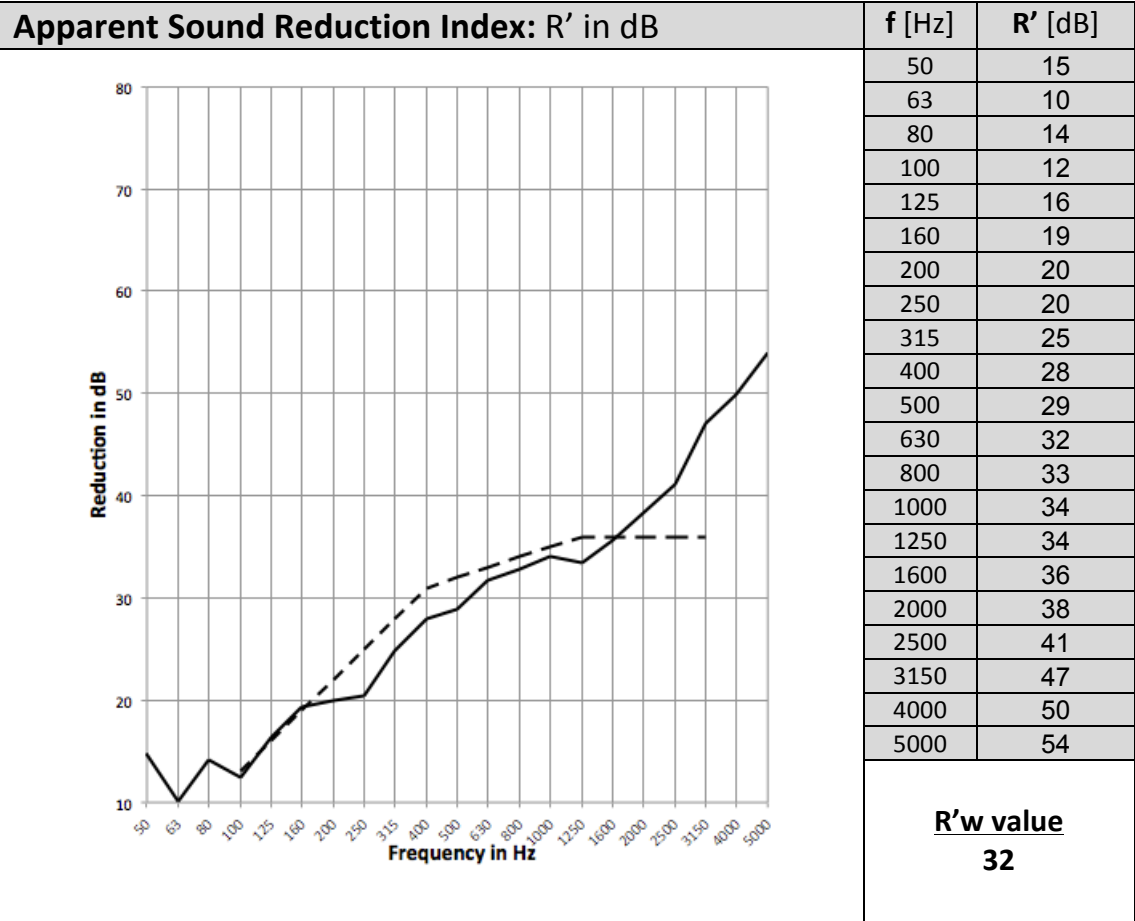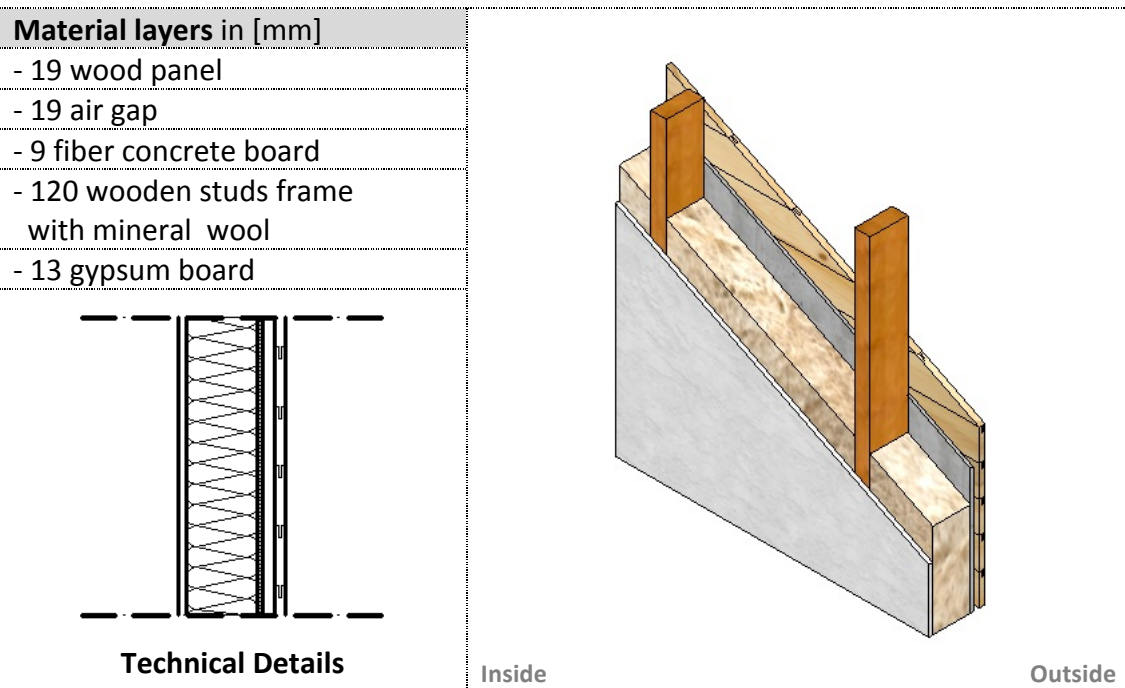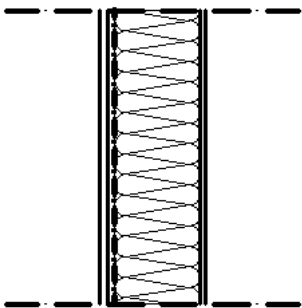
Case 45	Gypsum panel facade on wooden frame
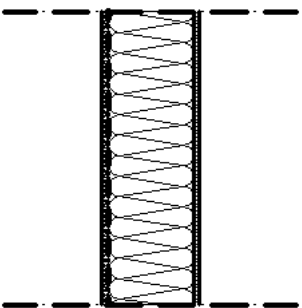
Material layers in [mm]
- 9 gypsum board
- 195 wooden studs frame
  with rock wool
- nylon sheet
- 2*13 gypsum board
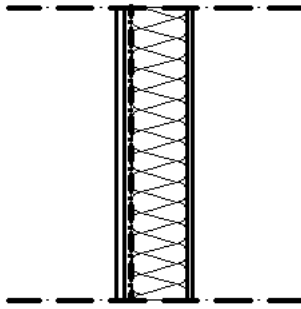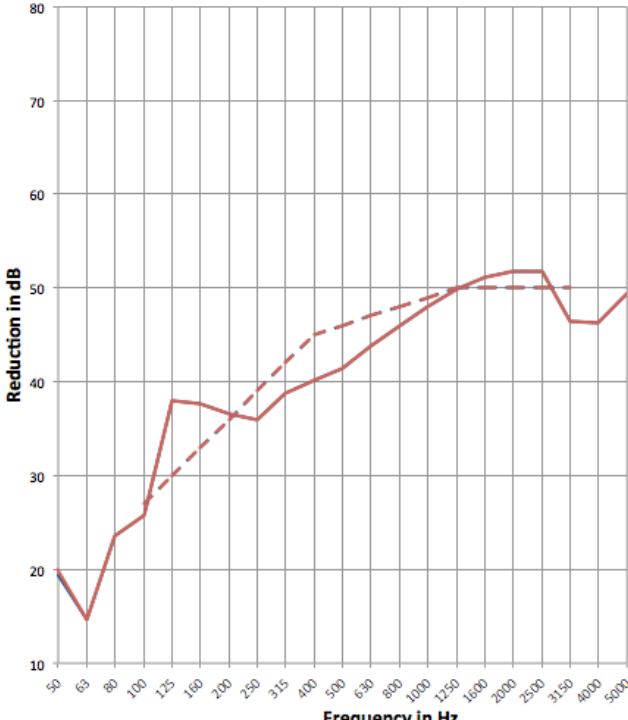
Technical Details
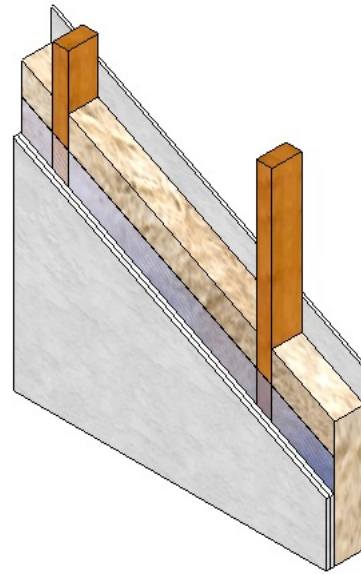
Inside   Outside
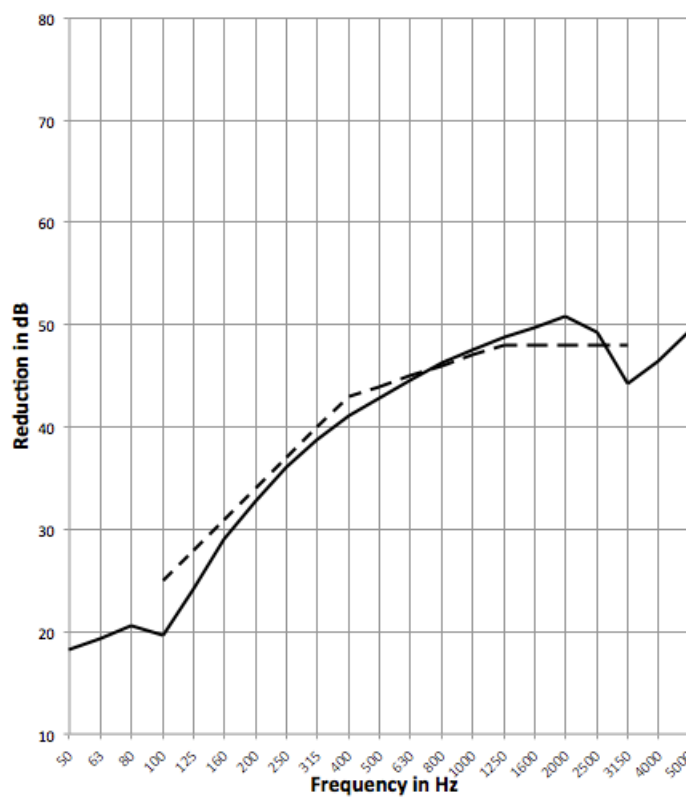
Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	18
	63	19
	80	21
	100	20
	125	24
	160	29
	200	33
	250	36
	315	39
	400	41
	500	43
	630	45
	800	46
	1000	48
	1250	49
	1600	50
	2000	51
	2500	49
	3150	44
	4000	47
	5000	49
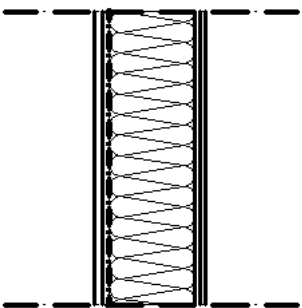
R'w value
44

Case 45: Alternative versions	Gypsum panel facade on wooden frame

Case 45.1

Material layers in [mm]	
- 9 gypsum board	
- 145 wooden studs frame with rock wool	
- nylon sheet	
- 2*13 gypsum board	

Technical Details

Case 45.2

Material layers in [mm]	
- 9 reinforced gypsum board	
- 145 wooden studs frame with rock wool	
- nylon sheet	
- 13 gypsum board	

Technical Details

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]	R' [dB]
	50	20	20
	63	15	15
	80	24	24
	100	26	26
	125	38	38
	160	38	38
	200	37	37
	250	36	36
	315	39	39
	400	40	40
	500	41	41
	630	44	44
	800	46	46
	1000	48	48
	1250	50	50
	1600	51	51
	2000	52	52
	2500	52	52
	3150	47	47
	4000	46	46
	5000	49	49
	R'w values	46	46

Case 45: Alternative versions	Gypsum panel facade on wooden frame

	Material layers in [mm]	
Case 45.3	- 9 gypsum board	
	- 195 wooden studs frame with rock wool	
	- nylon sheet	
	- 2*13 gypsum board	
		Technical Details

	Material layers in [mm]	
Case 45.4	- 2*9 gypsum board	
	- 145 wooden studs frame with rock wool	
	- nylon sheet	
	- 2*13 gypsum board	
		Technical Details

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]	R' [dB]
	50	18	22
	63	19	15
	80	21	25
	100	25	31
	125	29	39
	160	33	39
	200	35	38
	250	38	36
	315	39	39
	400	41	41
	500	43	42
	630	45	44
	800	46	46
	1000	48	49
	1250	49	50
	1600	50	52
	2000	51	54
	2500	49	54
	3150	44	49
	4000	47	50
	5000	49	53
	R'w values	**46**	**47**

Case 46	Gypsum panel facade on wooden frame

Material layers in [mm]
- 9 reinforced gypsum board
- 240 wooden studs frame
  with rock wool
- nylon sheet
- 13 reinforced gypsum board

Technical Details
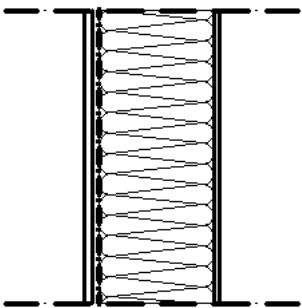
Inside   Outside
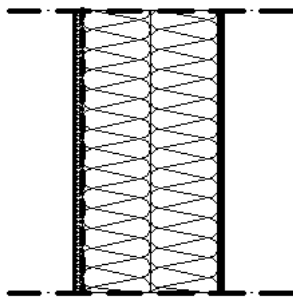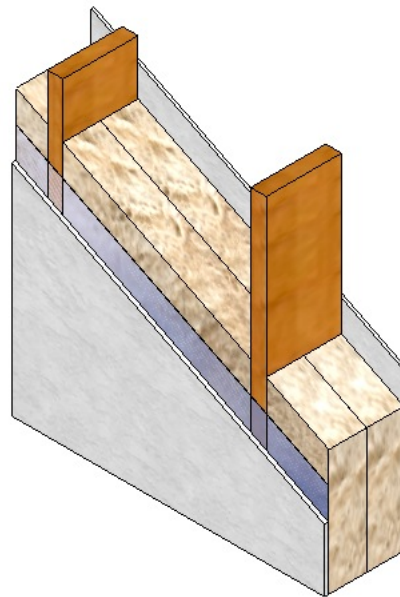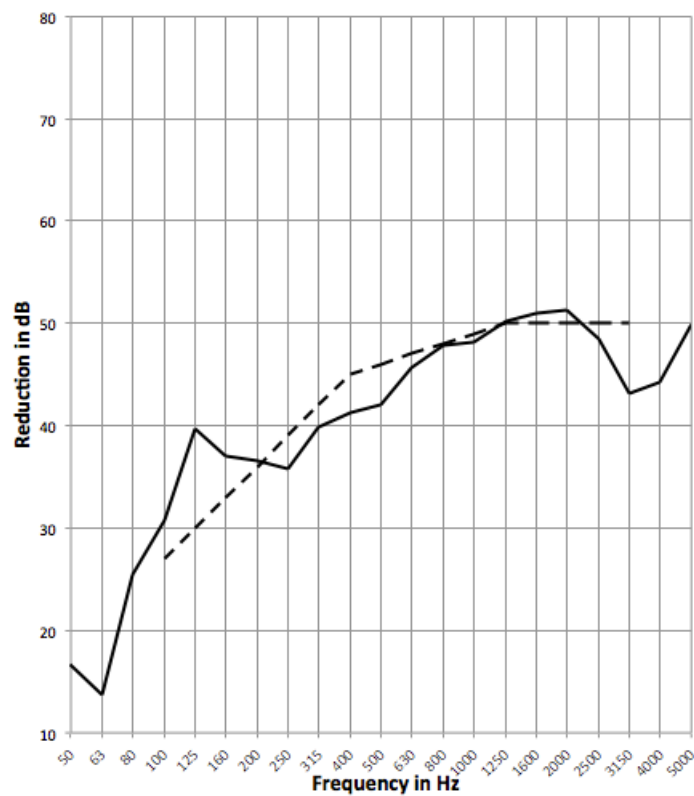
Sound Reduction Index: R in dB	f [Hz]	R' [dB]
	50	17
	63	14
	80	26
	100	31
	125	40
	160	37
	200	37
	250	36
	315	40
	400	41
	500	42
	630	46
	800	48
	1000	48
	1250	50
	1600	51
	2000	51
	2500	48
	3150	43
	4000	44
	5000	50
	Rw value	
	50	

Case 46: Alternative versions	Gypsum panel facade on wooden frame

	Material layers in [mm]	
Case 46.1	- 2*9 reinforced gypsum board	
	- 240 wooden studs frame with rock wool	
	- nylon sheet	
	- 13 reinforced gypsum board	
	- 15 fiber gypsum board	

Technical Details

Sound Reduction Index: R in dB		f [Hz]	R' [dB]
		50	19
		63	18
		80	30
		100	35
		125	41
		160	40
		200	39
		250	40
		315	43
		400	45
		500	46
		630	48
		800	49
		1000	50
		1250	52
		1600	54
		2000	54
		2500	53
		3150	53
		4000	55
		5000	58
		Rw value **50**	
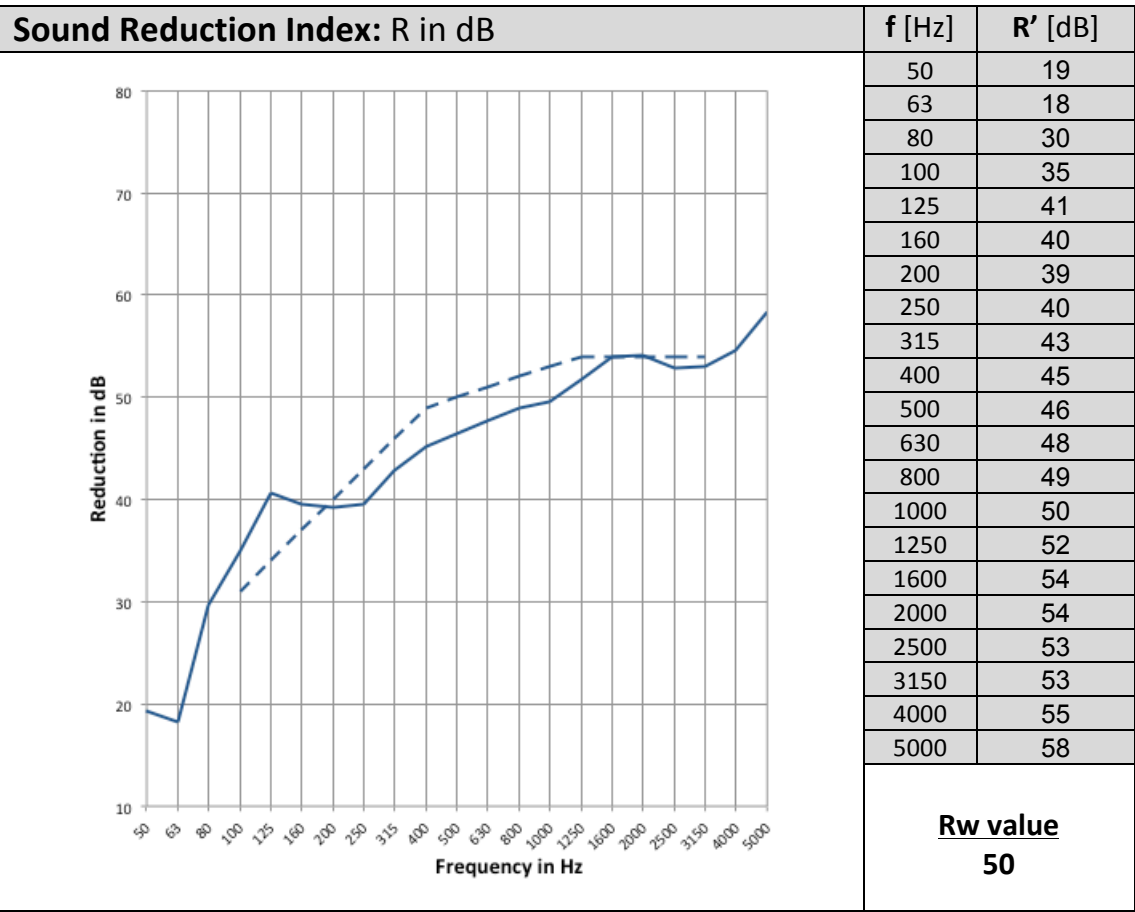
Case 47	Plaster facade

Material layers in [mm]
- 20 plaster
- 50 hard glass wool
- 70+120 wooden studs frame with mineral wool
- 13 gypsum board
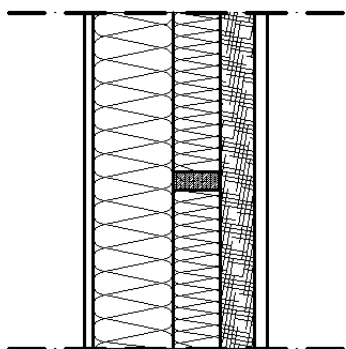
Technical Details
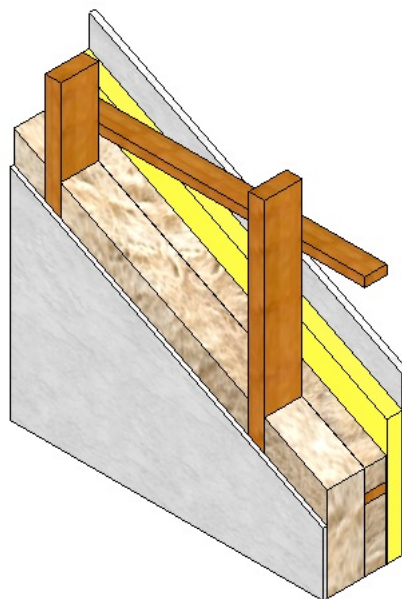
Inside   Outside
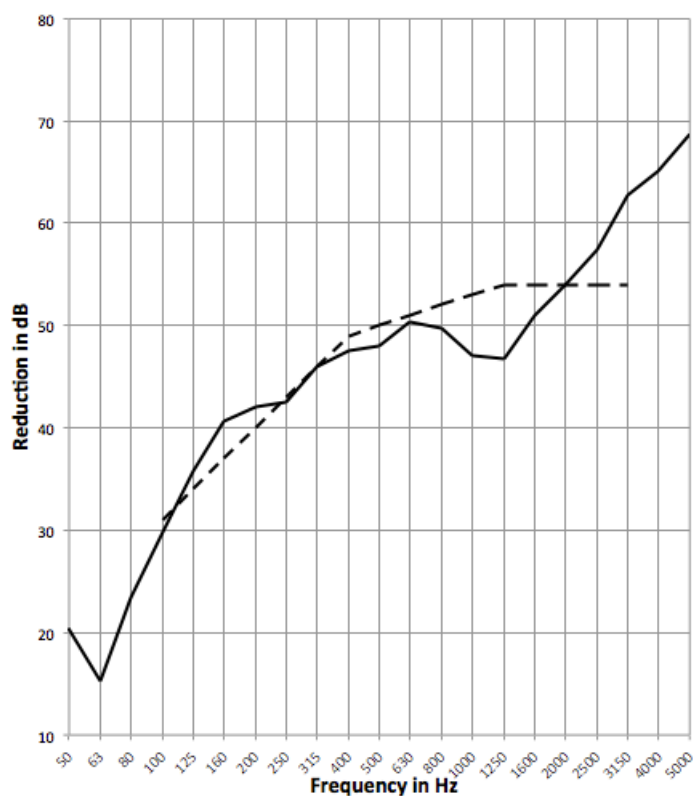
Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	21
	63	15
	80	23
	100	30
	125	36
	160	41
	200	42
	250	43
	315	46
	400	48
	500	48
	630	50
	800	50
	1000	47
	1250	47
	1600	51
	2000	54
	2500	57
	3150	63
	4000	65
	5000	69
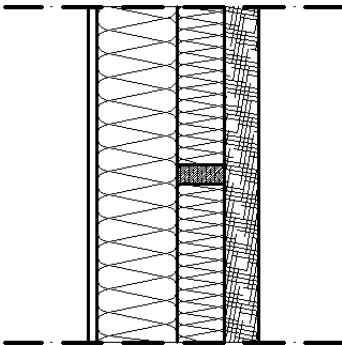
R'w value
50

Case 47: Alternative versions	Plaster facade

	Material layers in [mm]
Case 47.1	- plaster
	- 50 hard glass wool
	- 70+120 wooden studs frame with mineral wool
	- 13 gypsum board

Technical Details

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	14
	63	10
	80	12
	100	19
	125	24
	160	30
	200	32
	250	33
	315	37
	400	38
	500	38
	630	39
	800	38
	1000	35
	1250	39
	1600	43
	2000	46
	2500	50
	3150	55
	4000	57
	5000	61

R'w value

40
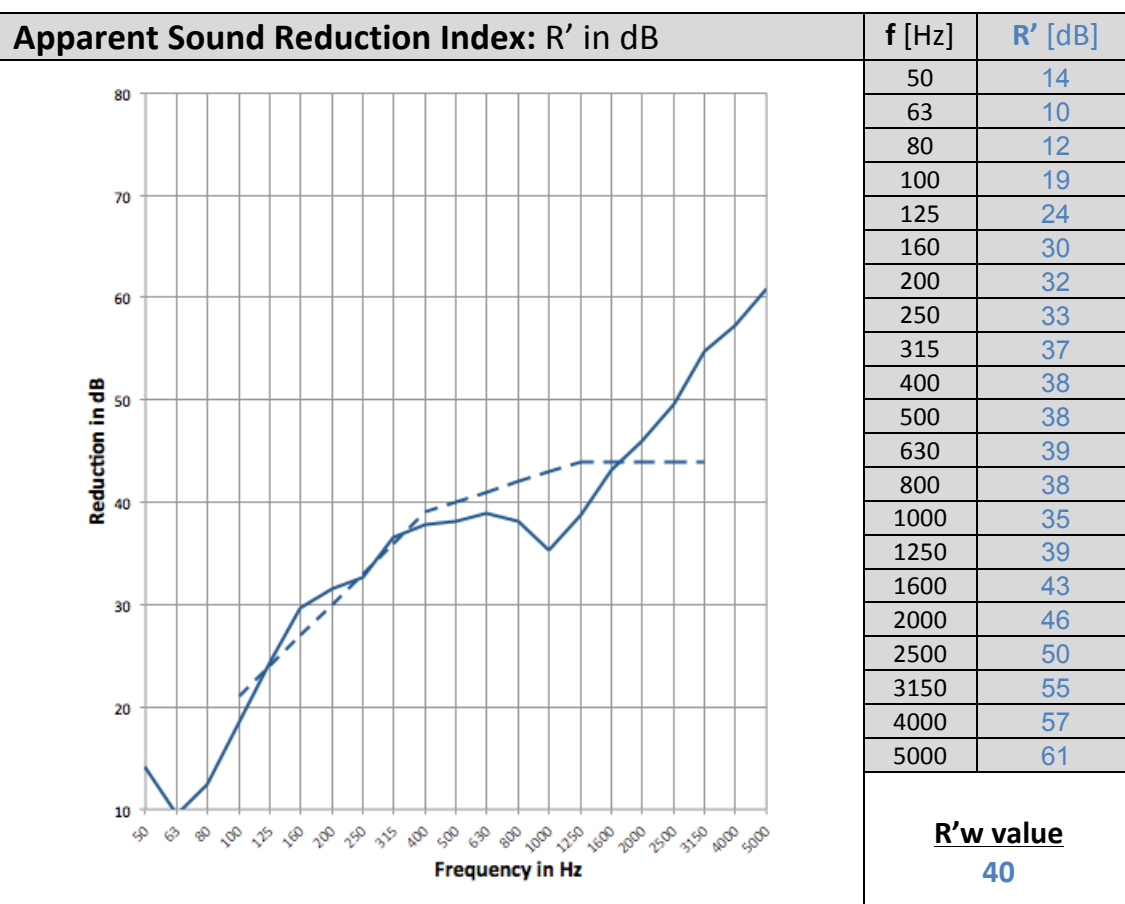
Case 48	Plaster facade

Material layers in [mm]
- 20 plaster
- 200 hollow brick wall
- 70 wooden studs frame
  with glass wool
- vapor barrier
- 12 fiber board
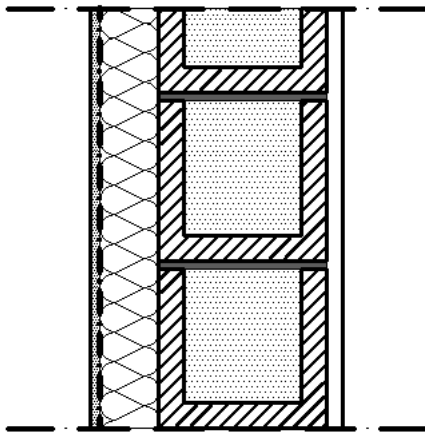
Technical Details
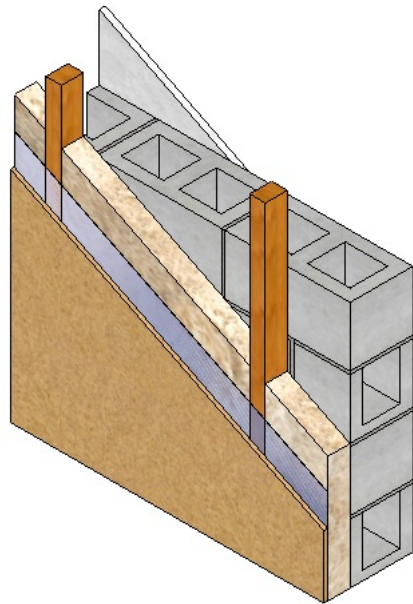
Inside
Outside
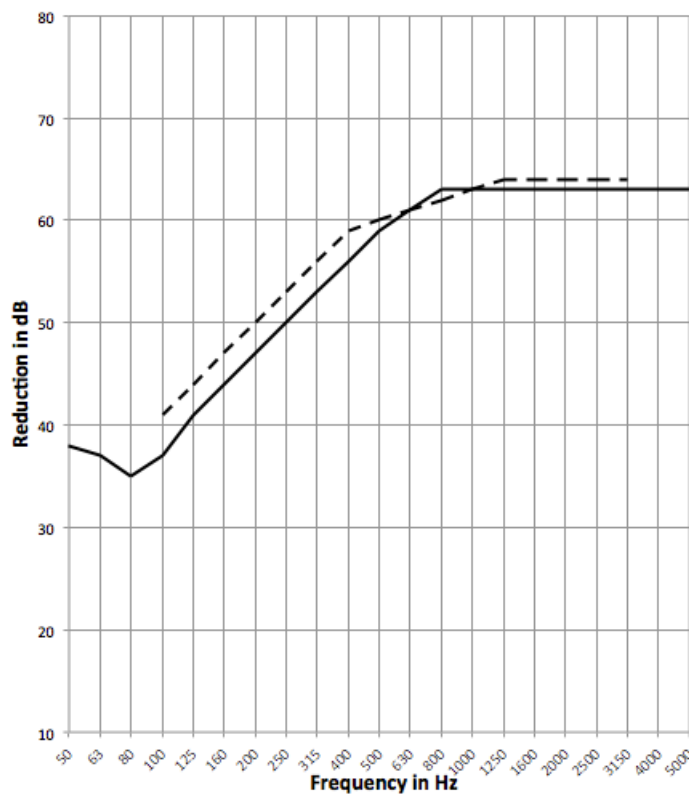
Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	38
	63	37
	80	35
	100	37
	125	41
	160	44
	200	47
	250	50
	315	53
	400	56
	500	59
	630	61
	800	63
	1000	63
	1250	63
	1600	63
	2000	63
	2500	63
	3150	63
	4000	63
	5000	63
	R'w value	
	60	

Case 48: Alternative versions	Plaster facade

	Material layers in [mm]
Case 48.1	- 20 plaster
	- 200 hollow brick wall
	- 70 wooden studs frame with glass wool
	- vapor barrier
	- 12 fiber board
	- 2*13 gypsum board

Technical Details

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	41
	63	40
	80	38
	100	40
	125	44
	160	47
	200	50
	250	53
	315	56
	400	59
	500	61
	630	62
	800	64
	1000	65
	1250	65
	1600	65
	2000	65
	2500	65
	3150	65
	4000	65
	5000	65

R'w value
62
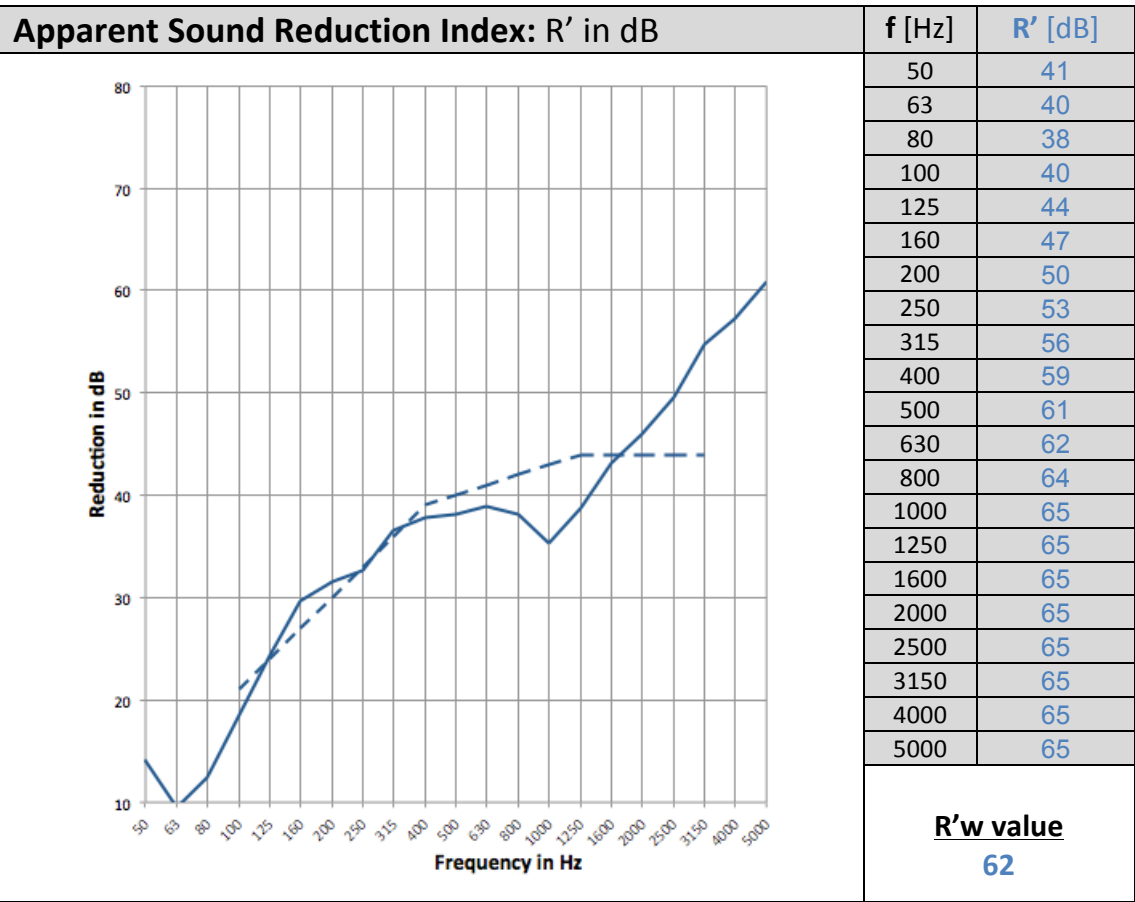
Case 49	Concrete facade

Material layers in [mm]
- 20 plaster
- 350 light concrete
- 20 plaster

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	38
	63	38
	80	36
	100	36
	125	36
	160	39
	200	42
	250	42
	315	44
	400	47
	500	48
	630	49
	800	54
	1000	57
	1250	60
	1600	63
	2000	66
	2500	70
	3150	73
	4000	75
	5000	78
	R'w value **53**	
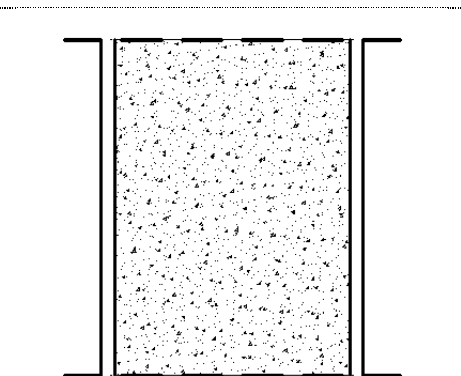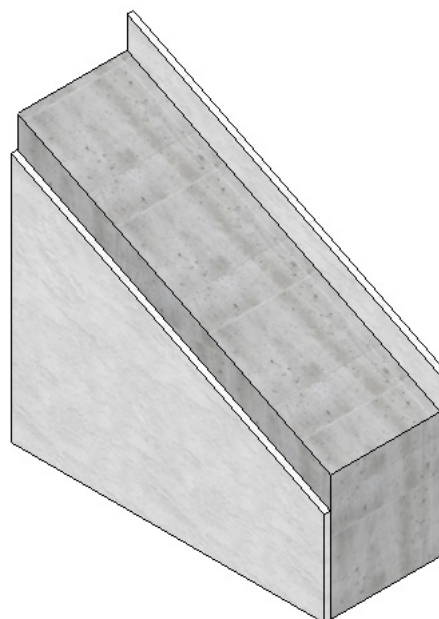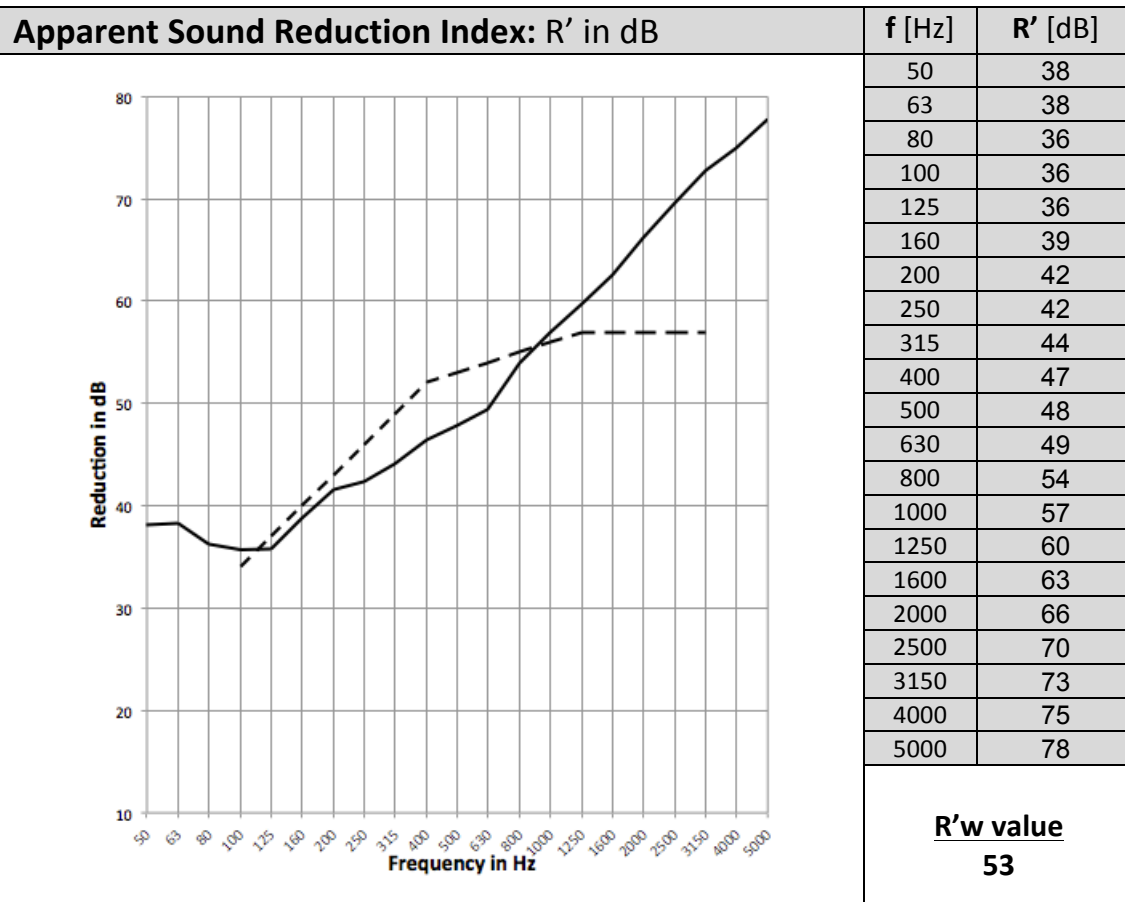
Case 49: Alternative versions	Concrete facade

Case 49.1

Material layers in [mm]
- 20 plaster
- 250 light concrete
- 20 plaster
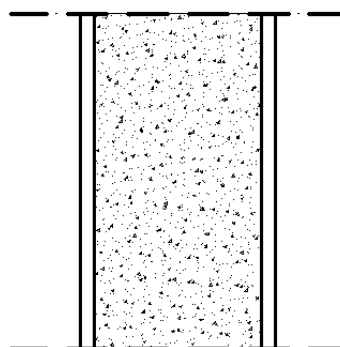
Technical Details

Case 49.2

Material layers in [mm]
- 20 plaster
- 250 light concrete
- 20 plaster
- 70 acoustic profile with wool
- 2*13 gypsum board

Technical Details
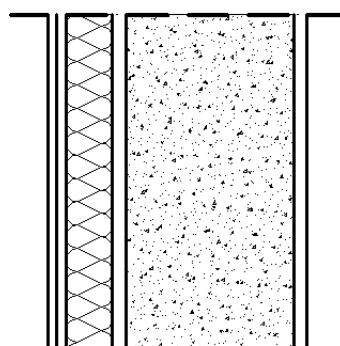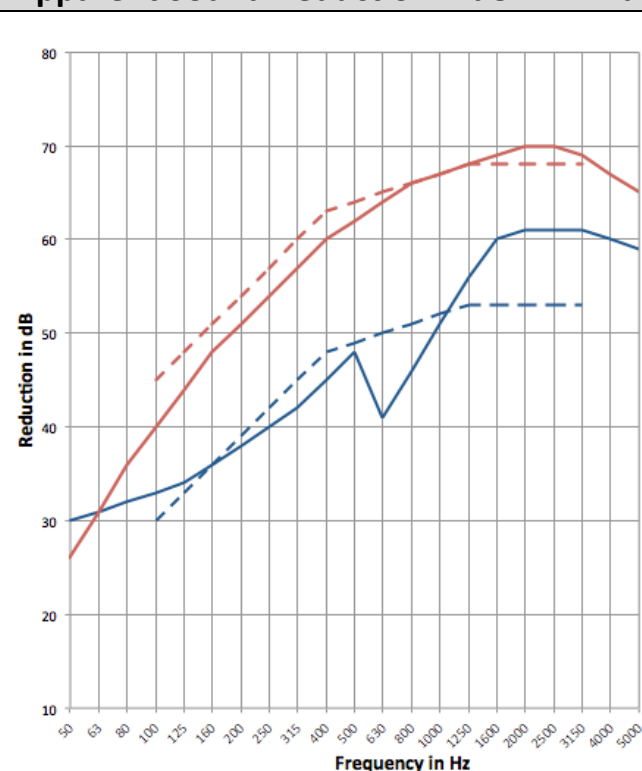
Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]	R' [dB]
	50	30	26
	63	31	31
	80	32	36
	100	33	40
	125	34	44
	160	36	48
	200	38	51
	250	40	54
	315	42	57
	400	45	60
	500	48	62
	630	41	64
	800	46	66
	1000	51	67
	1250	56	68
	1600	60	69
	2000	61	70
	2500	61	70
	3150	61	69
	4000	60	67
	5000	59	52
	R'w values	**49**	**64**

Case 50	Concrete facade

Material layers in [mm]
- 20 plaster
- 125 light concrete
- 150 concrete
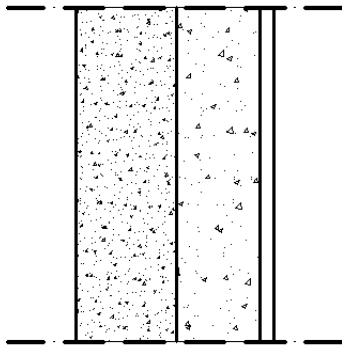
Technical Details

Inside   Outside
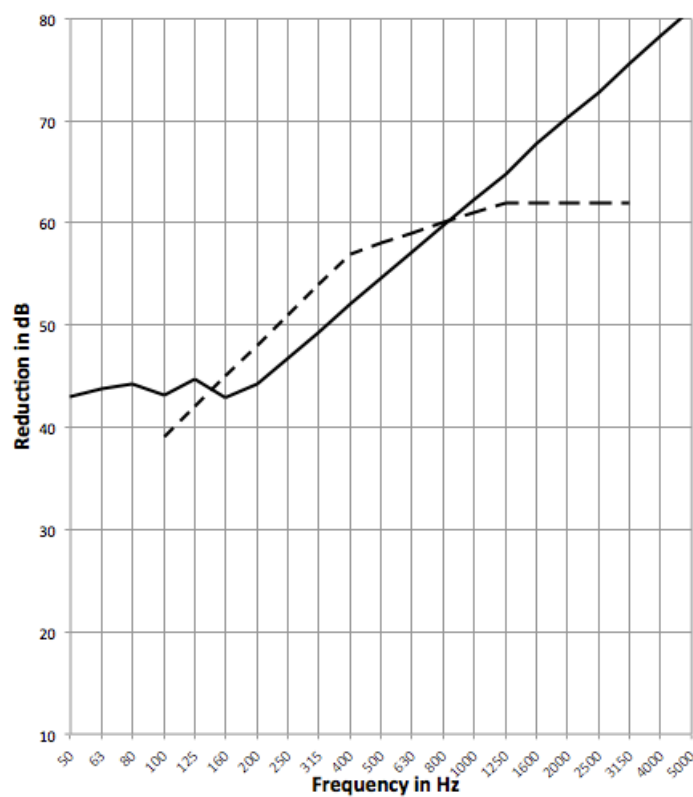
Apparent Sound Reduction Index: R' in dB		f [Hz]	R' [dB]
		50	43
		63	44
		80	44
		100	43
		125	45
		160	43
		200	44
		250	47
		315	49
		400	52
		500	55
		630	57
		800	60
		1000	62
		1250	65
		1600	68
		2000	70
		2500	73
		3150	76
		4000	78
		5000	81
		R'w value	
		58	

Case 50: Alternative versions	Concrete facade

Material layers in [mm]
- 20 plaster
- 125 light concrete
- 150 light concrete

Case 50.1

Technical Details

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	37
	63	38
	80	40
	100	41
	125	41
	160	41
	200	42
	250	39
	315	39
	400	42
	500	45
	630	48
	800	50
	1000	53
	1250	56
	1600	59
	2000	61
	2500	64
	3150	67
	4000	70
	5000	73

R'w value

50
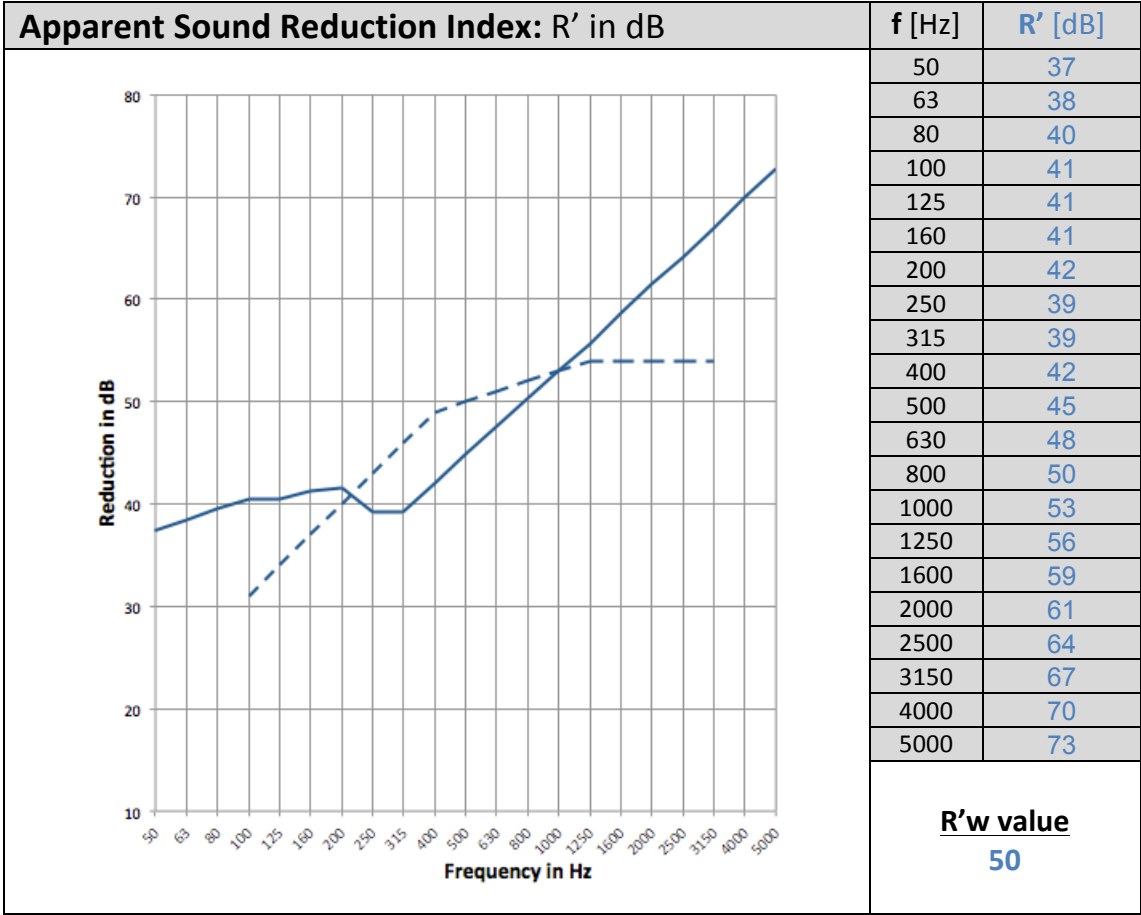
| Case 51 | Concrete facade |

Material layers in [mm]
- 60 concrete
- 100 Styrofoam
- 120 concrete

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	37
	63	37
	80	34
	100	35
	125	33
	160	35
	200	32
	250	33
	315	32
	400	33
	500	39
	630	43
	800	47
	1000	48
	1250	53
	1600	58
	2000	60
	2500	63
	3150	65
	4000	69
	5000	70
	R'w value	
	44	

Reduction in dB / Frequency in Hz

Case 51: Alternative versions	Concrete facade

	Material layers in [mm]	
Case 51.1	- 60 concrete	
	- 140 Styrofoam	
	- 80 concrete	
		Technical Details

	Material layers in [mm]	
Case 51.2	- 60 concrete	
	- 50 Styrofoam	
	- 170 concrete	
		Technical Details

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]	R' [dB]
	50	35	39
	63	35	39
	80	32	35
	100	33	36
	125	34	40
	160	37	31
	200	40	33
	250	32	34
	315	27	34
	400	35	35
	500	41	40
	630	46	44
	800	49	47
	1000	51	48
	1250	55	53
	1600	60	59
	2000	63	62
	2500	66	66
	3150	68	68
	4000	72	72
	5000	72	73
	R'w values	**44**	**45**

Case 52	Concrete facade

Material layers in [mm]
- 80 concrete
- 95 wooden studs frame
  with mineral wool
- 13 gypsum board

Technical Details

Inside   Outside

Apparent Sound Reduction Index: R' in dB	f [Hz]	R' [dB]
	50	36
	63	37
	80	38
	100	42
	125	45
	160	48
	200	50
	250	51
	315	48
	400	47
	500	50
	630	52
	800	55
	1000	58
	1250	60
	1600	63
	2000	66
	2500	69
	3150	71
	4000	74
	5000	77

R'w value

56