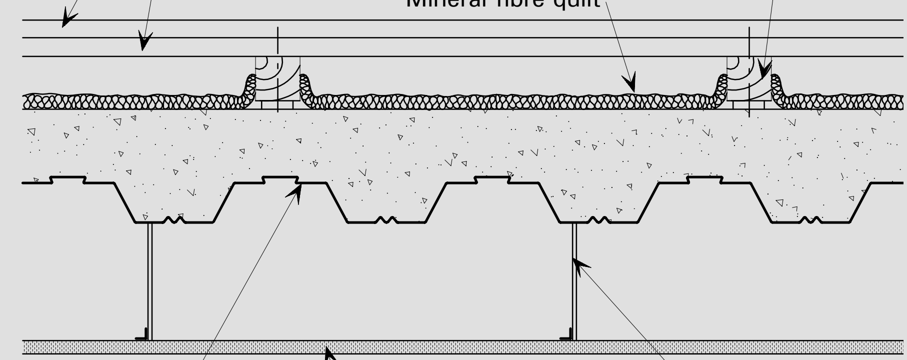
The Steel Construction Institute

Acoustic Performance of Composite Floors

Meeting the new requirements of Part E of the Building Regulations (2003)

Technical Information Sheet



Typical cross-section through a composite floor

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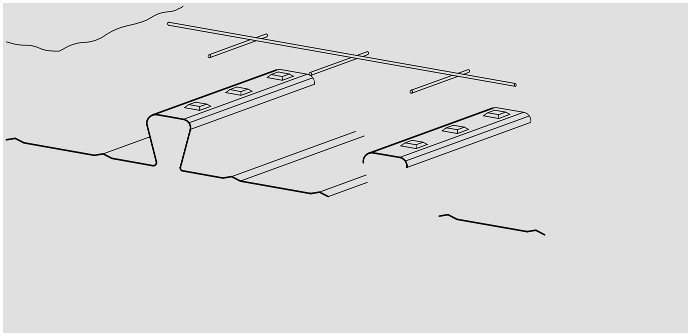
- Acoustic performance is increasing in importance in residential buildings as developers and occupants demand higher standards.
- Amendments to Part E of the Building Regulations came into effect in July 2003. The new regulations set more demanding requirements for the performance of separating floors and walls between dwellings.
- This Technical Information Sheet sets out how acoustic requirements can be satisfied using shallow deck composite floors in steel framed construction.
- Composite floors are a very effective way of constructing separating floors with good acoustic performance.
- Composite floors rely on the use of some structural mass, a suspended plasterboard ceiling and a resilient floor system on the top surface to achieve excellent acoustic performance.
- In buildings with composite floors, separating walls can be in light steel framed or masonry construction. This leaflet shows typical details.
- The design of junctions between separating walls, separating floors and external walls, and the integration of the primary steel frame are all important to avoid flanking sound transmission.
- Good site practice is important to ensure that details are correctly constructed, and that the primary steel frame is isolated from direct sound transfer.

INSIDE

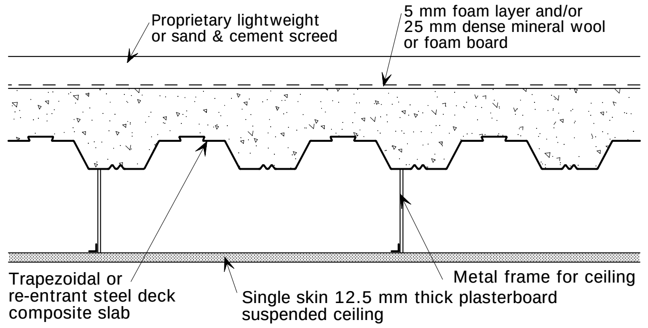
Introduction to composite floors

Traditional shallow decking profiles are between 45 mm and 60 mm deep with a rib spacing usually of between 150 mm and 300 mm and a steel thickness of 0.9 mm to 1.2 mm. This type of decking spans 3 m to 3.6 m without propping. Typically, primary frame grids of 9 m × 9 m with secondary supports at 3 m spacings can be achieved. Recently, profiles up to 80 mm deep, which can achieve 4.5 m spans without temporary propping, have been developed. Overall slab depths range from 120 mm to 200 mm.

The structural design of composite slabs using shallow decking is covered by BS 5950-4, BS 5950-6 and EC3-1-3.



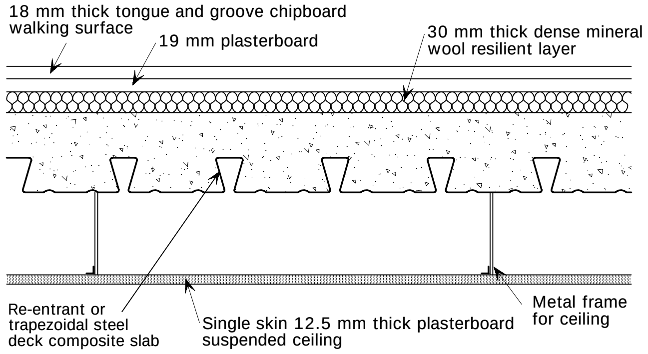
Alternative composite floor constructions



Screed floor

- Sand and cement or proprietary lightweight screed.
- Resilient layer of dense mineral wool, plastic insulant, or a polyethylene layer carefully installed to ensure continuity. The resilient layer should be turned up at the edges of the floor to isolate the walls from the screed.
- Re-entrant or trapezoidal composite floor slab (see Note 1).
- Gypsum plasterboard ceiling (see Note 2).

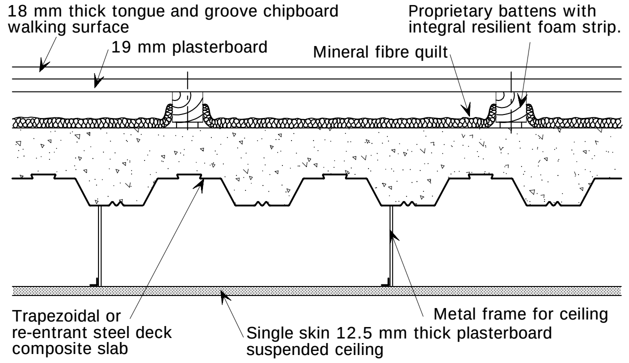
($D_{nT,w} + C_{tr}$ = 50 to 57 dB, $L'_{nT,w}$ = 40 to 50 dB)



Platform floor *(RSD)*

- 18 mm chipboard or similar finish layer
- Optional 19 mm gypsum board
- A resilient layer of dense mineral wool or plastic insulant. The resilient layer should be turned up at the edges of the floor to isolate the walls from the chipboard.
- Re-entrant or trapezoidal composite floor slab (see Note 1).
- Gypsum plasterboard ceiling (see Note 2).

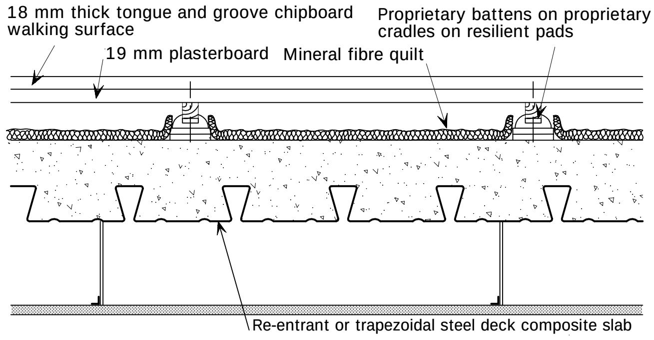
($D_{nT,w} + C_{tr}$ = 52 to 57 dB, $L'_{nT,w}$ = 40 to 45 dB)



Raft Floor *(RSD)*

- 18 mm chipboard or similar finish layer.
- Optional 19 mm gypsum board for improved performance.
- Proprietary timber batten bonded to foam strip (optional thin layer of insulation between the battens).
- Re-entrant or trapezoidal composite floor slab (see Note 1).
- Gypsum plasterboard ceiling (see Note 2).

($D_{nT,w} + C_{tr}$ = 54 to 58 dB, $L'_{nT,w}$ = 35 to 45 dB)



Cradle floor *(RSD)*

- 18 mm chipboard or similar finish layer.
- Optional 19 mm gypsum board for improved performance.
- Proprietary cradle floor supporting timber battens (with an optional thin layer of insulation between the battens).
- Re-entrant or trapezoidal composite floor slab (see Note 1).
- Gypsum plasterboard ceiling (see Note 2).

($D_{nT,w} + C_{tr}$ = 54 to 58 dB, $L'_{nT,w}$ = 35 to 45 dB)

Note 1: The composite slab can use either a re-entrant or trapezoidal galvanized steel deck, typically 50 mm to 100 mm deep, with a concrete floor covering to give a typical overall slab depth of 130 mm to 200 mm (typically 250 to 425 kg/m^2).

Note 2: The plasterboard ceiling can be fixed using a proprietary metal frame system fixed to the underside of the deck. One layer of wall board is generally sufficient, but an improvement can be achieved by using acoustic boards or 2 layers of wall board.

Note 3: The indicative performance figures are based on 45 test results from 9 buildings using composite floors.

Separating walls used with composite floors

Separating walls must meet the requirement for airborne sound insulation. The most common separating walls used with composite floors are light steel framing, cavity masonry and solid masonry walls.

Examples of typical light steel frame walls are shown on page 7. Non load-bearing light steel frame walls can be either double leaf, staggered stud or single leaf constructions. The double leaf construction is well established as providing a very good level of acoustic separation.

Light steel frame separating walls rely on the mass provided by gypsum boards and decoupling of the boards either side of the wall. These are lightweight solutions that add little dead loading to the primary steel structure frame.

Masonry separating walls are more reliant on mass to provide the necessary acoustic separation, which leads to additional structural loads.

Separating walls must be detailed to avoid flanking transmission through the primary steel structure. This requires careful detailing at the junctions with separating floors, as is illustrated in the details on pages 8 to 12.

Any columns that are on the line of the separating wall must be integrated so they do not act as a bridge through the wall for sound transmission. It is important to ensure that the gypsum lining is not fixed back to the columns, and to provide some resilience between the column and separating wall structure. See Figures 4 and 5 for good practice details.

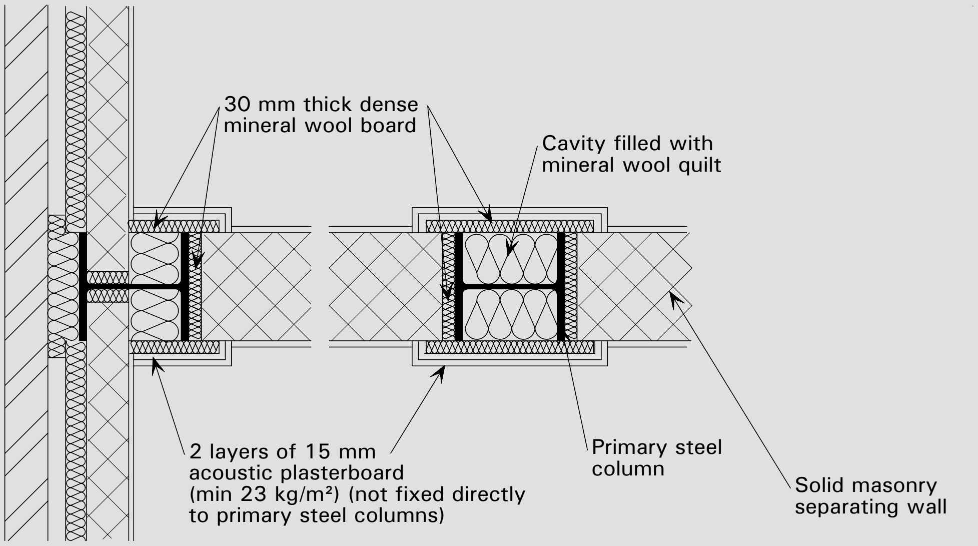


Figure 4 Integration of column into a solid masonry separating wall

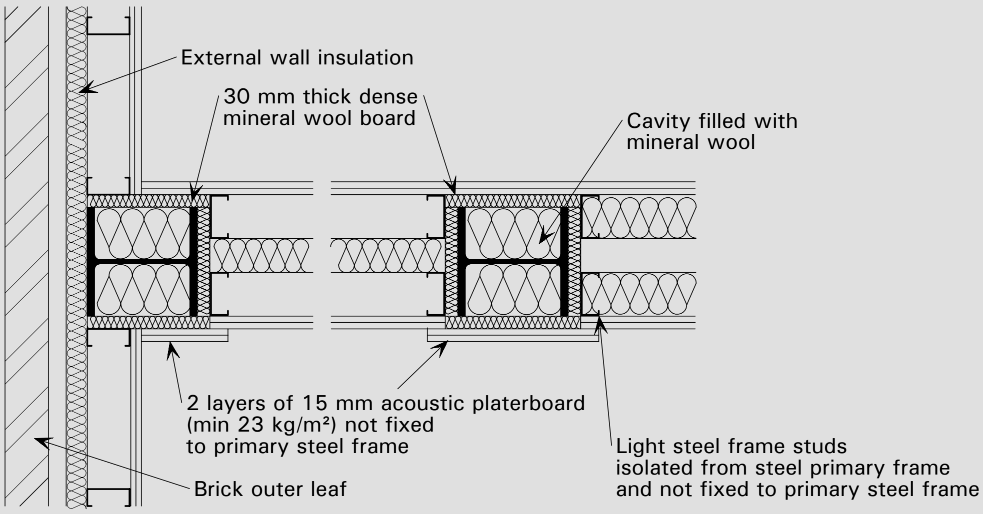
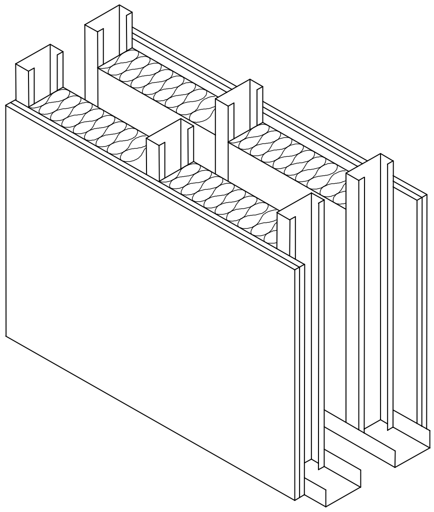


Figure 5 Integration of a column into a light steel separating wall

Typical light steel frame separating walls – constructions and performance

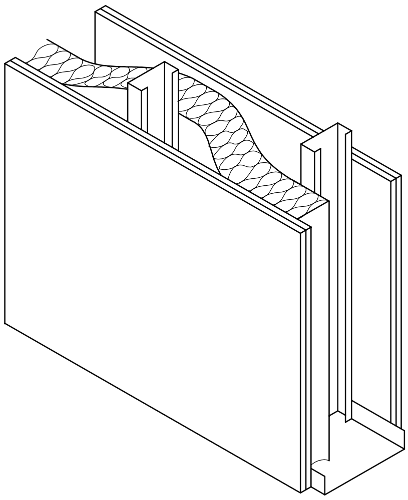


Double leaf light steel separating wall

The double leaf separating wall includes:

- An independent structure for each leaf with minimal connections between.
- A minimum weight of 23 kg/m² in each leaf (two layers of 12.5 mm fire resistant plasterboard, with staggered joint, or equivalent).
- A minimum of 200 mm separation between the two plasterboard inner surfaces.
- Good sealing of all joints and junctions.
- 50 mm unfaced mineral fibre quilt (10 - 30 kg/m³) within both of the leaves or between the leaves.
- Optional inner sheathing of 10 mm plasterboard or OSB
- Minimum 25 mm space between the leaves

$D_{nT,w} + C_{tr}$ = *52 to 58 dB*
Fire rating = *60 minutes*



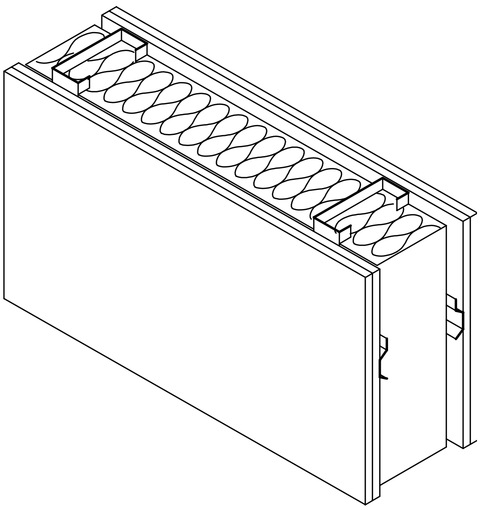
Staggered stud light steel separating wall

The staggered separating stud wall includes:

- Studs at 300 mm centres, staggered so alternate studs supporting the lining board on each side.
- A gypsum lining with minimum of 23 kg/m² in on each face (two layers of 12.5 mm fire resistant plasterboard, with staggered joint, or equivalent).
- A minimum gap of 25 mm between the back side of each stud and the lining board.
- Good sealing of all joints and junctions
- 25 mm (min) continuous unfaced mineral fibre (10 to 30 kg/m³) threaded through the studs.

The performance will be improved where there is a minimum of 200 mm separation between the two plasterboard inner surfaces.

$D_{nT,w} + C_{tr}$ = *48 to 51 dB*
Fire rating = *60 minutes*



Single stud separating wall with resilient bars

The single stud separating wall includes:

- A single line of studs of at least 140 mm depth.
- Resilient bars fixed horizontally
- A gypsum lining with minimum of 23 kg/m² on each face (two layers of 12.5 mm fire resistant plasterboard, with staggered joint, or equivalent).
- Good sealing of all joints and junctions
- 50 mm (min) continuous unfaced mineral fibre (10 to 30 kg/m³) between the studs.

$D_{nT,w} + C_{tr}$ = *46 to 51 dB*
Fire rating = *60 minutes*

Note: Indicative performance figures are based on test results from a range of buildings using light steel frame walls

Details of composite floors

Figures 6 to 14 show a series of typical details of junctions between composite floors and separating and external walls. Note the following:

- Trapezoidal decks are shown in the details. However, both re-entrant and trapezoidal decks can be used with appropriate fillers in the deck voids at the junctions with separating walls.
- Any of the floor finishes shown on page 5 can be used.
- A separating strip at the edge of the floor finish should be provided to prevent the floor boarding or screed from contacting directly with the external or separating walls.
- All flashing or separating strips should be a minimum of 5 mm polyethylene.
- Mineral wool insulation can be added to the ceiling void to improve acoustic performance.
- The downstand beams that support the composite slab should not be in direct contact with the plasterboard lining the ceiling or walls.
- Exposed steel columns or beams should be avoided within the habitable space. These should be encased in plasterboard.

Soft floor coverings

In some cases, Approved Document E allows the use of an integral or bonded soft floor finish directly fixed to a concrete floor. Using a bonded soft floor covering with a composite floor should meet the minimum standards of the Building Regulations for airborne and impact sound. However, it is not a recommended construction, as it relies on the floor finish remaining permanently in place to maintain acoustic performance.

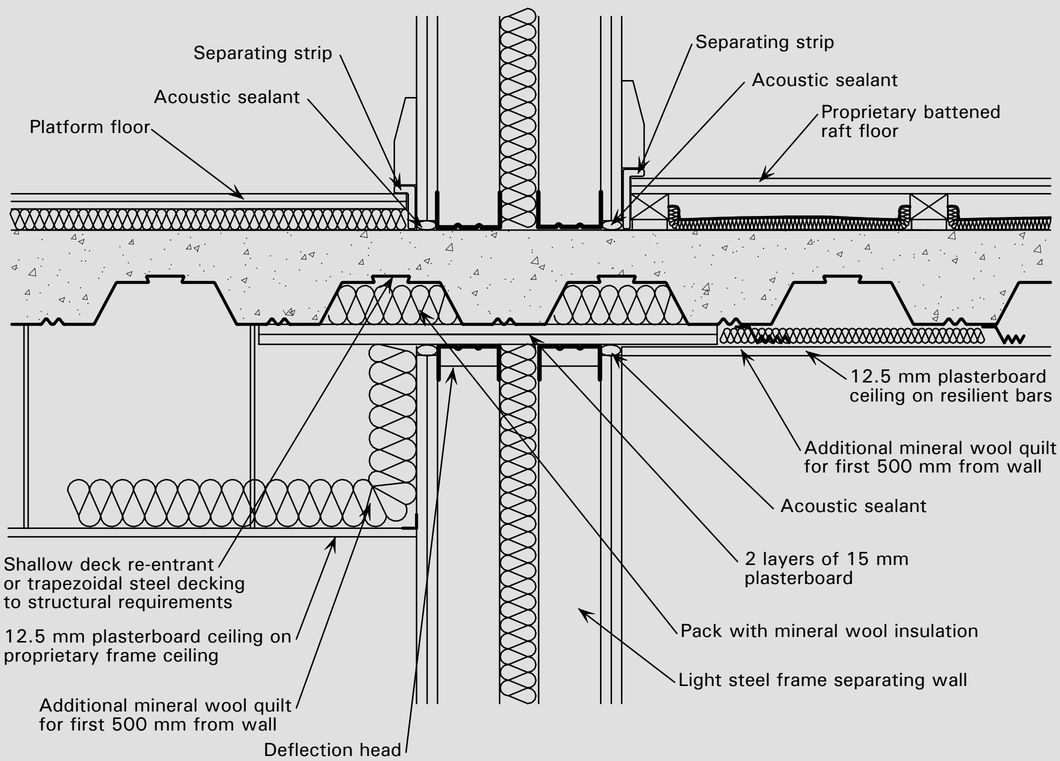


Figure 6 Junction of a composite floor with a light steel separating wall

Junction details of composite floors with light steel frame walls

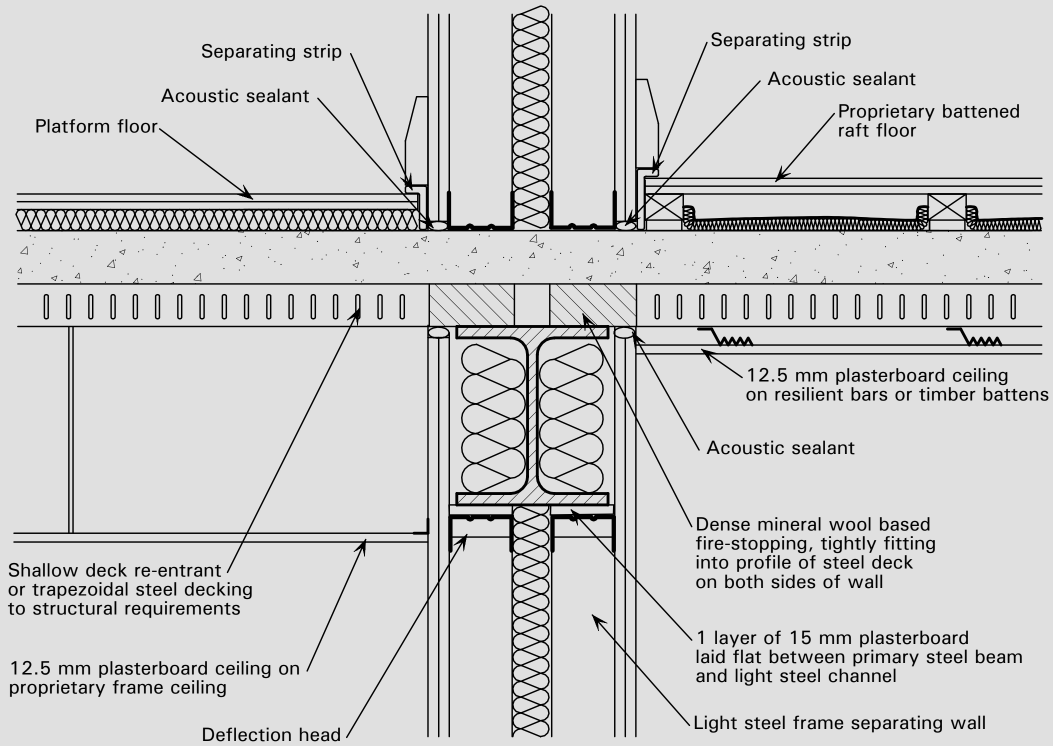


Figure 7 Junction of a light steel separating wall with a composite floor and downstand beam

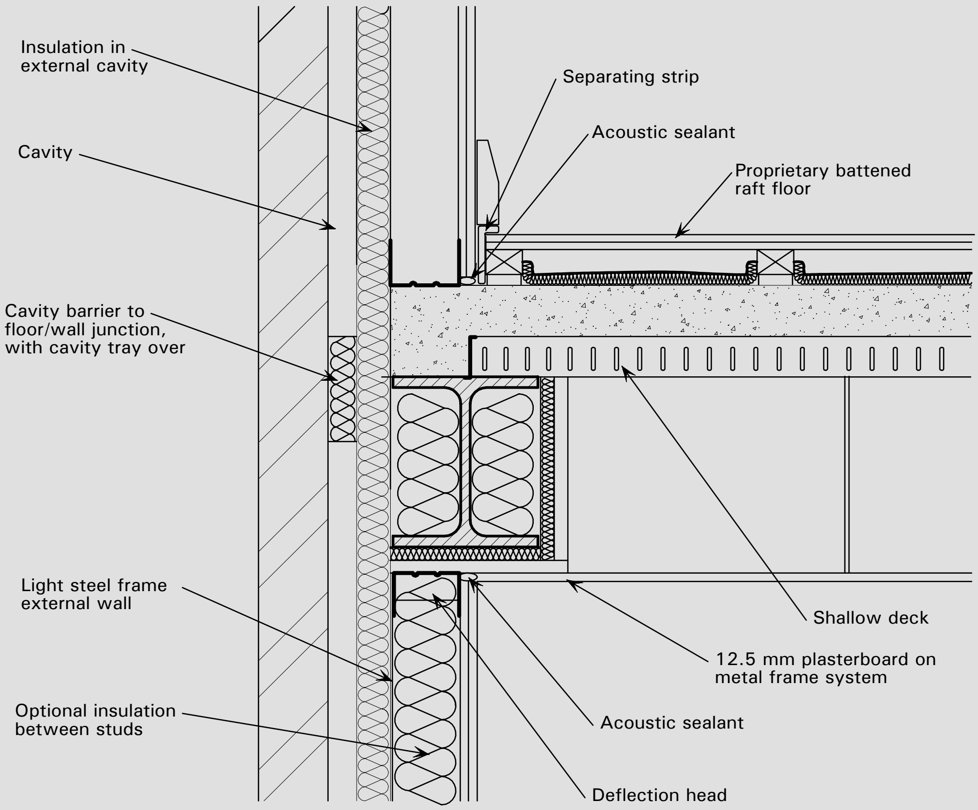


Figure 8 Junction of a composite floor with external wall using light steel inner leaf

Note: Trapezoidal profile decks are shown, but the details are also appropriate for re-entrant profiles

Junction details of composite floors with solid masonry walls

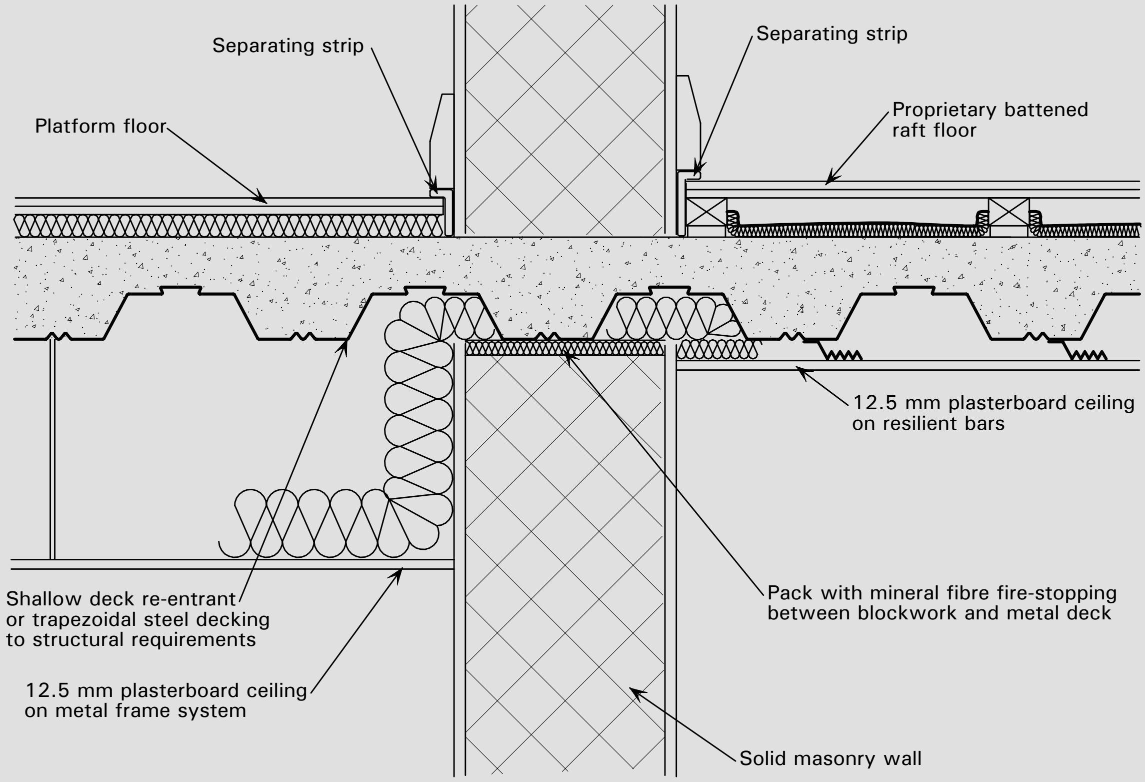


Figure 9 Junction of a composite floor with solid masonry separating wall

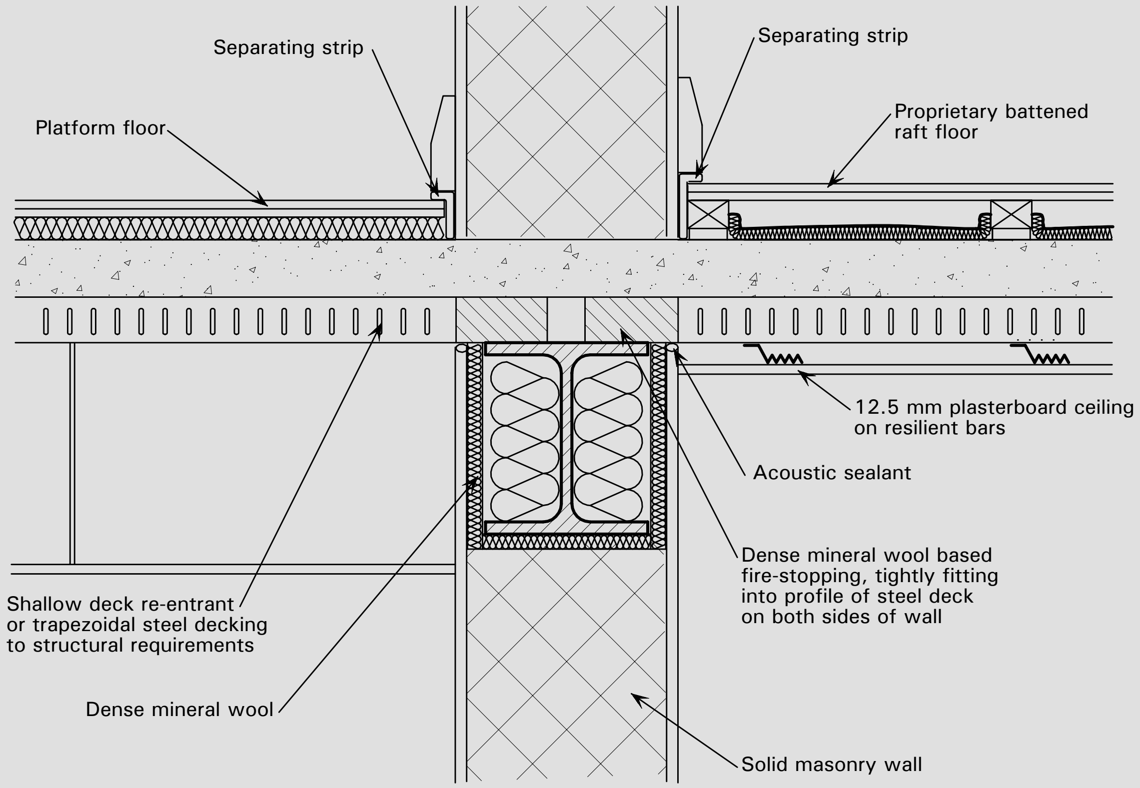


Figure 10 Junction of solid masonry separating wall with a composite floor and downstand beam

Note: Trapezoidal profile decks are shown, but the details are also appropriate for re-entrant profiles

Site tests data

Acoustic site test data has been collected at several residential buildings using composite floors to demonstrate the high standard of acoustics that can be achieved. Short case studies of three buildings are presented below:

Building 1

This is a large multi-storey residential development in Sheffield, constructed in several phases, using a hot rolled primary steel frame and composite floors.

Test No	Separating floors		
	$D_{nT,w}$	$D_{nT,w} + C_{tr}$	$L'_{nT,w}$
1	65 dB	57 dB	32 dB
2	68 dB	60 dB	35 dB
3	65 dB	59 dB	32 dB
4	71 dB	64 dB	35 dB
Mean	***67 dB***	***60 dB***	***34 dB***

The separating floor consists of a composite slab with a 50 mm re-entrant deck, and 100 mm concrete topping to give an overall thickness of 150 mm (330 kg/m^2) on downstand steel beams. The acoustic floor finish consists of T&G floor boarding on 50 × 50 mm timber battens on a 25 mm mineral wool quilt. The ceiling consists of 2 sheets of 12.5 mm *Soundblock* plasterboard on a metal frame suspended below the decking. The steel downstand beams are located within in the ceiling void.

The separating walls are solid 215 mm dense concrete blockwork (minimum density 1800 kg/m^3) with a wet plaster finish applied to both faces. External walls are masonry cavity walls.

Building 2

A residential development of 3 blocks of between 5 and 7 storeys in Cardiff with a hot rolled primary steel frame, composite floors and light steel frame separating and external walls finished in a rendered cladding.

Test No	Separating floors		
	$D_{nT,w}$	$D_{nT,w} + C_{tr}$	$L'_{nT,w}$
1	61 dB	54 dB	26 dB*
2	64 dB	57 dB	26 dB*
3	64 dB	57 dB	27 dB*
4	62 dB	56 dB	21 dB*
Mean	***63 dB***	***56 dB***	***25 dB****

*The impact tests were carried out with an integral, permanent soft floor finish (carpet).

The separating floor consists of composite slab with a 50 mm deep re-entrant deck and a 100 mm concrete topping (330 kg/m^2) on downstand beams. The floor finish is a 70 mm floating screed on 5 mm polyethelyne foam resilient layer turned up at the edges. The ceiling consists of 12.5 mm plasterboard on a metal frame system with 85 mm of mineral wool in the ceiling void. Separating walls are a single leaf wall using 140 mm light steel studs with 25 mm *Gyproc* plank and 12.5 mm plasterboard on either side, and a quilt between.

Site test data

Building 3

A large multi-storey residential development in several phases in Southampton using a hot rolled primary steel frame with composite floors and masonry cavity external walls.

Test No	Separating floors		
	$D_{nT,w}$	$D_{nT,w} + C_{tr}$	$L'_{nT,w}$
1	68 dB	59 dB	38 dB*
2	69 dB	60 dB	38 dB*
3	63 dB	56 dB	38 dB*
4	68 dB	59 dB	39 dB*
Mean	***68 dB***	***59 dB***	***38 dB****

The separating floor consists of a composite slab with a re-entrant creating a 200 mm deep slab (430 kg/m^2) on downstand steel beams. The acoustic floor finish is an *Instacoustic* IM20 floor - 18 mm T&G MDF flooring on 10 mm dense mineral fibre resilient layer. The ceiling consists of two layers of 15 mm wallboard board fixed below the deck using metal frame system.

Separating walls use light steel frames, using a staggered stud arrangement, to create a wall of a 192 mm overall width. The external walls are masonry cavity walls.

SITE ACOUSTIC TESTS

Following the 2003 revisions of Part E of the Building Regulations, pre-completion site testing is required for all constructions unless Robust Standard Details (RSD) are accepted, and used, in newly built houses and apartments. These tests must be carried out when the building is largely complete, with doors, skirting boards, electrical sockets and switches in place, but unfurnished and without a carpet (except with certain concrete and composite floors). Cupboards and kitchen units should have their doors open and be unfilled. The site must be reasonably quiet during the tests.

Site measurements should be carried out in accordance with BS EN ISO 140-4-1998 for airborne sound and BS EN ISO 140-7-1998 for impact sound. For airborne sound measurements, a steady sound of a particular frequency is generated in the source room and the sound pressure level in the source and receiving rooms are compared to ascertain the reduction. For impact sound measurements, a standard impact sound source (tapping machine) is used to strike the floor and the impact sound pressure level is measured in the room below. For both airborne and impact measurements, the receiving room levels must be corrected to 0.5 s reverberation time before comparison with the performance standards. Measurements are taken at 16 one third-octave frequency bands across the hearing spectrum from 100 Hz to 3150 Hz.

To convert the site measurements into a single figure rating, the method set out in EN ISO 717 (Parts 1 and 2) compares the set of 16 measured results with a reference curve. The rating is made by considering only those measured values which fall short of the reference curve and choosing a reference curve where the sum of the negative deviations (over the 16 measured one third-octave bands) is as large as possible but not greater than 32 dB. The value of the reference curve at 500 Hz gives the single figure rating. For rating measurements of airborne insulation, C_{tr} must also be calculated using the measured figures.

Composite floors

Acoustic performance

- Composite floors can achieve excellent standards of acoustic performance.
- Good acoustic insulation is achieved through a mixture of mass provided by the composite slab and an appropriately designed acoustic floor covering.
- Acoustic *raft* or *platform* floors are preferred on separating floors to deal with impact sound transmission.
- Details have been developed for junctions between separating walls and floors and external walls to avoid flanking transmission
- Composite floors in steel framed buildings can be used with a variety of separating wall constructions.
- Double leaf separating walls with mineral wool quilt between and two layers of plasterboard either side have a good record of acoustic performance.
- Good site practice is important to ensure that details are correctly constructed (see the details in this Information Sheet).

Sustainability

- Low waste in construction.
- High recycled content.
- Can be recycled at end of life.
- Adaptability for changing future requirements.
- Increased quality.
- Reduced site times.

Rethinking Construction

- Greater speed of construction.
- Just in time delivery.
- Increased value to client.
- Increased productivity.
- Increased rate of return for the builder.
- Predictability of process.
- Early return on investment.
- Less 'call backs' for making good.

Sources of information

The Steel Construction Institute
01344 623345
www.steel-sci.org

Corus Construction Centre
Construction Advisory Service
Tel: 01724 405060
www.corusconstruction.com

Corus Panels and Profiles
Tel 01684 856600
www.coruspanelsandprofiles.co.uk

Metal Cladding and Roofing Manufacturers Association (MCRMA)
0151 652 3846
www.mcrma.co.uk

Relevant publications

Composite slabs and beams using steel decking: Best practice for design and construction (P300)
SCI, 2000 (Also available as MCRMA Technical Paper No.13).

Fire resistance of composite floors with steel decking (P056), SCI 1991.

Acoustic Performance of *Slimdek* (P321)
SCI, 2003

Acoustic performance of light steel framing (P320)
SCI, 2003

The acoustic data included in this Technical Information Sheet was obtained from a Partners in Innovation Project, part funded by the Department of Trade and Industry, Corus, Richard Lees Steel Decking, and Metsec

Web sites:

For information on steel construction: www.steel-sci.org

For 24x7 information on steel construction : www.steelbiz.org

For information on Robust Standard Details: www.rsd.napier.ac.uk

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