4.1 Introduction

The area of acoustics is too broad to be covered in-depth, however, this section provides a brief introduction to the concept of acoustics and an explanation of some common terms, a description of field testing procedure, impact sound transfer, chasing requirements, and current building regulations. As of the 1st of May 2004, the new Building Code of Australia (BCA) requirements have been introduced pertaining to sound insulation. An overview of these requirements can be found in Section 4.9.

At the end of the section, there is a table summarising the sound insulation performance of CSR Hebel products based on data derived from testing at a NATA registered laboratory and/or technical opinions by an acoustic consultants.

4.2 Sound

What we hear as sound is actually small pressure fluctuations in the air. For example, when a drum is struck, the surface vibrates backwards and forwards. These oscillations have a direct affect on the air particles very close to the vibrating surface, causing them also to move backwards and forwards. Oscillations of the first air particles are transferred to adjacent air particles and so the sound spreads outwards from the source. A given sound will have two basic characteristics - amplitude and frequency (or pitch) of the sound. The amplitude of the sound is a measure of the magnitude of the oscillation. The frequency of the sound is a measure of how quickly the vibrating surface is moving back and forth.

4.3 Acoustic Materials – Sound Barriers & Sound Absorbers

When it comes to building materials and acoustics, there are two broad categories of materials. There are materials that *absorb* sound and prevent it reflecting around a room (echo). These materials are sound absorbers and are usually soft to touch (e.g., Glasswool insulation, carpets, curtains, mineral fibres etc.).

The second category of materials are those which reduce transmission of sound through the material from one room to another. These materials are referred to as *sound barriers* (e.g., Hebel block and panel walls, and floor panels).

There is generally very little overlap between the two categories of materials; that is, a material that is an effective sound barrier is generally also a very poor absorber of sound and tends to reflect sound instead, and vice versa. Both types of materials are necessary for providing a satisfactory acoustic environment in a building. In residential situations, the furnishings provide most of the sound absorption materials. It is up to the builder/designer to provide effective sound barriers to satisfactorily reduce external sounds and also transmission of sound between apartments or other units. However, the careful combination of acoustic barriers and sound absorbent materials can provide a very cost effective and space efficient solution.

Increasing the weight of a sound barrier will reduce the sound transfer through it, but will increase costs associated with the walls and supporting structure. One way to make a more efficient sound barrier is to provide a wall system consisting of two barriers separated by an airspace filled with sound absorbent material. In this way, very high levels of sound reduction can be achieved using wall systems that are relatively lightweight and with a narrow footprint.

4.4 STC & R_W Acoustic Rating Systems

The Building Code of Australia (BCA) presents the Performance Requirements for sound insulation ratings. The sound insulation ratings set minimum values to consider for two types of sound: airbourne sound and impact generated sound.

The Performance Requirements for airbourne sound insulation and impact sound insulation rating are dependant upon the form of construction (i.e., walls or floors), Class of Building, and the type of areas being separated. The airborne sound performance requirement is a value that could be the weighted sound reduction index (R_W) or weighted reduction index with spectrum adaptation term ($R_W + C_{tr}$). The impact sound performance requirements is a value called the weighted normalised impact sound pressure level with spectrum adaptation term ($L_{n,w} + C_{tr}$).

A test of R_W is carried out in an acoustic laboratory that has two rooms of massive construction, acoustically isolated from one another, and with a common opening (aperture) between them. The wall partition is installed in the aperture. A sound field is generated in one room, with acoustic energy at all frequency bands from at least 100Hz to 3,150 Hz. The difference in sound level for each room is recorded for each frequency band. The sound level differences are then normalised. The normalisation accounts for differences in area of the test aperture and the amount of absorption in the receive room.

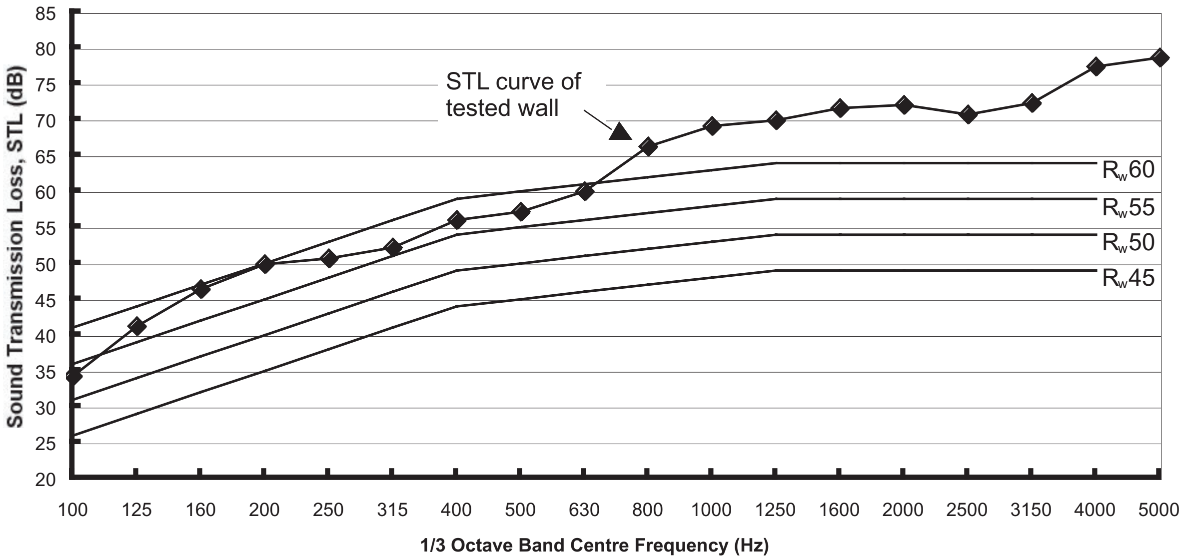
The normalised sound reduction values at each frequency band are then compared to standard contours or performance (see Figure 4.1). The class of each contour is given by its value at 500Hz. The R_W rating is resolved by fitting the highest standard contour to the normalised sound reduction values. There are rules describing best-fit which allow the test values to actually be below the standardised curve for a limited number of frequencies.

The laboratory test reveals the maximum acoustic performance likely to be achieved by the wall or floor. When that wall or floor is installed on site, the resultant performance is always likely to be less than that in the laboratory. This needs to be considered when selecting and specifying acoustic barriers.

The R_W rating curve (similar to the STC curve) was basically derived from sound insulation requirements for speech. Modern living with its use of large television sets, home entertainment units for music and the home cinema with its surround sound has increased the requirements for low frequency sound insulation. In this regard, the R_W spectrum is inadequate. The ISO rating system has a correction factor for traffic noise for external walls, roofs and windows. This correction factor C_{tr} when applied to the Rw curve also provides better relationship of sound insulation for the low frequencies of the various home entertainment systems.The term R_W + C_{tr} has been adopted in the Australian BCA, the United Kingdom equivalent regulation and the Association of Australian Acoustical Consultants Star Rating System for Apartments and Townhouses. The C_{tr} correction is a negative value, the typical range is –4 to –14dB. A typical example of C_{tr} being used to quantify the performance of a building component is:

$R_W + C_{tr} \geq 50$dB

Figure 4.1: "Best Fit" of Partition Wall Test Result to Standardised Curves (R_W60 standardised curve is the highest curve fitting the results)

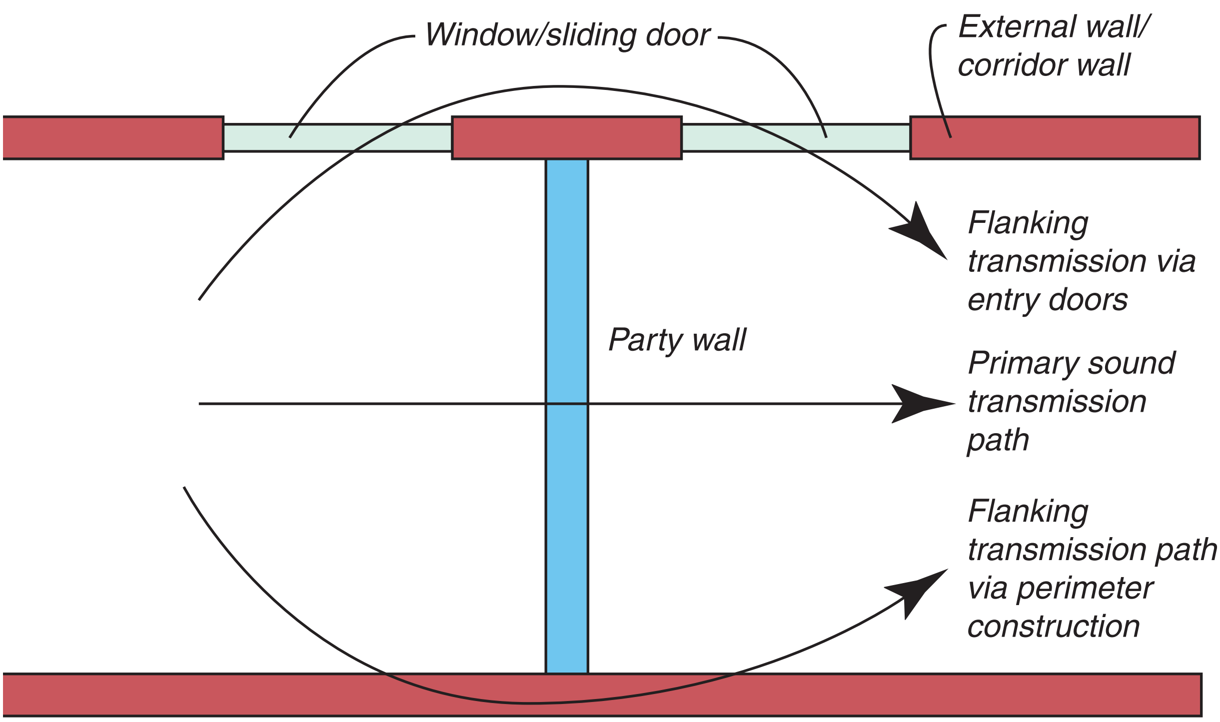


4.5 Field Tests of Partitions and Design Considerations

Field tests of acoustic performance of the partition can be conducted using the same procedure described for laboratory testing and expressed as the Apparent Weighted Sound Reduction Index, R_W. In a real life situation sound transmission can occur between two rooms by a number of transmission paths, of which the dividing partition is the principle path, but by no means the only one. As a result there is now universal preference to use $D_{ntw} + C_{tr}$, which is the method of rating the effective sound insulation between two spaces in a completed building. It represents the total performance of the dividing wall or floor and all the sound *flanking paths*. The measured results are normalised to relate to a typical furnished receiving room. This is considered the preferred option for all site testing. The other sound transmission paths are referred to as flanking paths, because the sound energy flanks around (or over or above) the dividing partition.

When high-performance partitions, R_W of 55 or higher, are installed in an apartment building, then the limiting factor is often the concrete floor *(flanking path)* on which the partition is installed. If the floor slab is continuous then it will transfer some sound energy to the other rooms and the energy will be re-radiated as sound in those rooms. If the slab is too thin, then the acoustic performance of the system will be limited. Similar flanking paths include common walls, such as corridor and continuous external walls, penetrations (air conditioning ducts), doors and windows (see Figure 4.2). To achieve a high-performance acoustic system, the designer will have to consider factors, such as, the floor type, thicknesses, coverings, ceiling systems, etc. It is recommended that an acoustic consultant be engaged to assess the acoustic performance of the system.

Figure 4.2: Plan of Flanking Paths for Sound Transmission



4.6 What Acoustic Performance Do We Need?

The effective sound insulation (privacy) is dependent on three factors. Firstly how loud the sound, secondly the acoustic performance of the barrier and thirdly how quiet it is in the receiving room. All these factors are interdependent. On the basis of a typical suburban background noise level 30dB(A), Chart 4.1 suggests how much sound insulation is needed between apartments.

Chart 4.1: Comparative Performance of Sound Insulation Systems Based on an Ambient Noise Level of 30dB(A)

Type of Noise Source	D_{ntw} Value (Hz)				
	40	45	50	55	60
Normal Speech	Audible	Just Audible	Not Audible		
Raised Speech	Clearly Audible	Audible	Just Audible	Not Audible	
Dinner Party/Laughter	Clearly Audible	Audible	Just Audible	Not Audible	Not Audible
Shouting	Clearly Audible	Clearly Audible	Audible	Just Audible	Not Audible
Small Television/Small Entertainment System	Clearly Audible	Clearly Audible	Audible	Just Audible	Not Audible
Large Television/Large HiFi Music System	Clearly Audible	Clearly Audible	Clearly Audible	Audible	Just Audible
DVD with Surround Sound	Clearly Audible	Clearly Audible	Clearly Audible	Audible	Audible
Digital Television with Surround Sound	Clearly Audible	Clearly Audible	Clearly Audible	Audible	Audible

Building Designer to consider possible *Flanking* Issues

4.7 Impact Sound Transfer

Impact sound transfer can occur across a wall separating two apartments when a kitchen cupboard, or the like, is attached directly to one side of the wall. Opening and closing the cupboard doors will transfer impact sound energy directly to the wall, which will be re-radiated as sound into the other apartment. Ideally, to minimise this sound transfer, the dividing wall should incorporate a cavity in the middle, with no direct or rigid connections between the two sides of the wall. This can be achieved by constructing a double-leaf Hebel wall, a wall with a separate steel stud wall.

For walls to be impact rated they must be of discontinuous construction. In general, "discontinuous construction" is described as a wall having a minimum of 20mm cavity between 2 separate wall leaves and no mechanical linkage except at the periphery. For detailed description of impact, sound insulation ratings requirements refer to the Sound Insulation sections of the BCA.

The new BCA requirements have quantified the Impact Sound Insulation Ratings for floors by including weighted normalised impact sound pressure level ($L'_{n,w}$) and spectrum adaptation term (C_I). The two terms are added together ($L'_{n,w} + C_I$) to obtain a single rating value of the floor systems. For required performance ratings of floors see section 4.9.

At present there is no agreed method of impact testing of walls amongst the acoustics fraternity, particularly for field testing."

4.8 Recesses for Services and Chasing in CSR Hebel Walls

CSR Hebel has a set of informative provisions with regards to recesses for services and/or chasing, which are not detrimental to the already established fire/acoustic levels. The designer should refer to chasing guidance in CSR Hebel building systems literature.

These provisions include:

- Recesses and chasings for all services must comply with BCA 2004, Volumes 1 and 2 requirements.
- Water services should not be chased whatsoever into CSR Hebel blockwork or panels. For locating water services within walls, refer to the BCA volumes 1 and 2. In non-acoustic rated walls such as internal unit walls, chasing may be permissible but check with the BCA for your State or Territory.
- Electrical services may be chased within the wall section for party dividing walls (R_W rated) but check with BCA requirements for your State or Territory. If chasing is allowed, certain guidelines must be enforced:
  - ★ Offset all GPO's by 600mm to ensure that a full stud cavity or furring channel exists between outlets. All GPO's on the stud and plasterboard side of the wall system should be acoustic and fire rated.
  - ★ Electrical service chasings should not be installed exactly opposite each other, on either side of the wall, with at least a vertical offset of 300mm enforced.
  - ★ The chase is backfilled after the installation of the services with suitable material, which would adhere to the wall (e.g., Hebel Patch).
  - ★ The depth of the chasings should not exceed 25mm for vertical chases and 15mm for horizontal chases. Maximum width of the chasings shall not be greater then 25mm.
  - ★ Maximum number of chases allowed is 2 chases per 1m length of wall.

The guidelines above provide methods to minimise R_W loss due to chasing in CSR Hebel block or panel walls.

4.9 Requirements of the BCA for Dividing Walls and Floors

On the 1st of May, 2004, the Building Code of Australia (BCA) was released with new regulatory *Performance Requirements* for insulation design of airborne and impact sound generation through *Building Solutions* (i.e., walls, floors, etc.) for various classes of buildings. The acoustic requirements for party walls have been in place for over 30 years, but in 2004 were significantly upgraded for most of the Australian states and the ACT. In 2005 some of the remaining states adopted the upgrades. This only leaves the state of Queensland and the Northern Territory using the old acoustic regulations.

For the States of

New South Wales
Victoria
South Australia
Western Australia
Tasmania
Australian Capital Territory

The sound insulation rating of a wall in Class 2 or 3 building must :

(i) have an $R_w + C_{tr}$ (airborne) not less than 50, if it separates sole-occupancy units; and

(ii) have an R_w (airborne) not less than 50, if it separates a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification; and

(iii)comply with F5.3(b) if it separates:

(A) a bathroom, sanitary compartment, laundry or kitchen in one sole-occupancy unit from a habitable room (other than a kitchen) in an adjoining unit; or

(B) a sole-occupancy unit from a plant room or lift shaft.

The BCA 2005 allows for on site verification.

This is covered by Section FV5.2. Compliance with FP5.2(a) and FP5.3 to avoid the transmission of airborne sound through walls is verified when it is measured in-situ that:

(a) a wall separating sole-occupancy units has a weighted standardised level difference with spectrum adaptation term ($D_{nT,w} + C_{tr}$) not less than 45 when determined under AS/NZS 1276.1 or ISO 717.1; or

(b) a wall separating a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby, or the like, or parts of a different classification, has a weighted standardised level difference ($D_{nT,w}$) not less than 45 when determined under AS/NZS 1276.1 or ISO 717.1.

BCA 2004 also allows for A0.8 Alternative Solutions, together with A0.9 Assessment Methods, providing these are determined in accordance with A0.10.Relevant Performance Requirements. This is covered in A2.2 Evidence of Suitability (a) (iii) (A) and (B)."

To comply with the measures outlined in the BCA or by other appropriate authorities, the *Building Solution* for a project will satisfy the *Performance Requirements* presented in the BCA or other authority. The BCA is structured so that compliance of the *Building Solution* can be achieved by several methods, these being:

- Complying with *Deemed-to-Satisfy Provisions* presented in the BCA; or
- Formulating an *Alternative Solution*; or
- A combination of the above.

For a building solution that is an Alternative Solution, Assessment Methods are presented in the BCA for compliance assessment. These methods include:

- Documentary evidence; or
- *Verifications Methods* in the BCA or those accepted by the appropriate authority; or
- Comparison to *Deemed-to-Satisfy Provisions*; or
- Expert Judgement.

4.10 AAAC Star Rating System

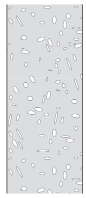
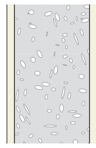
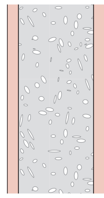
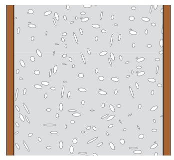
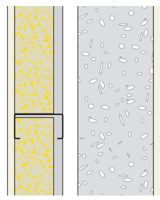
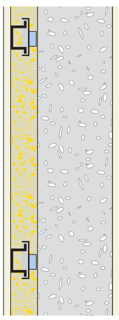
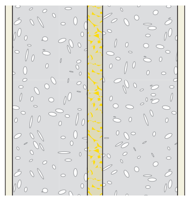
The Association of Australia Acoustical Consultants (AAAC) has developed a star rating system, from 1 to 6 stars, which addresses all aspects of acoustic amenity in apartments. This will create greater awareness of acoustic issues and better informed purchasers of residential apartments. The AAAC Star Rating System is designed to promote better acoustic quality in buildings where as the BCA is a minimum acceptable community standard.

Some aspects of the AAAC system have been adopted by some councils in Sydney.

Experience, to date, has clearly shown that the minimum becomes "The Standard" irrespective of the cost of the apartment. The AAAC Star Rating System intends to correct this situation.

The AAAC System is totally field orientated and relates to the actual performance of the completed apartment. It is a direct measure of what an occupant can anticipate. The measurement of sound insulation will be as $D_{nT,w}$ and it is most likely that the relevant C_{tr} correction will be applied.

Table 4.1: Acceptable Forms of CSR Hebel AAC Construction for Walls

Description	$R_w + C_{tr}$	R_w	Construction
CSR Hebel Thermoblok AAC Masonry			
Nil lining CSR Hebel Thermoblok masonry Nil lining • 100mm thick • 125mm thick • 150mm thick • 175mm thick • 200mm thick • 250mm thick	 35 37 40 39 39 42	 38 40 43 42 42 45	
10mm Gyprock plasterboard CD CSR Hebel Thermoblok masonry 10mm Gyprock plasterboard CD • 200mm thick • 250mm thick	 39 41	 42 44	
16mm Gyprock Fyrchek plasterboard CSR Hebel Thermoblok masonry 16mm Gyprock Fyrchek plasterboard • 150mm thick • 175mm thick • 200mm thick • 250mm thick	 42 42 43 45	 45 45 46 48	
10mm Render CSR Hebel Thermoblok masonry 10mm Render • 200mm thick • 250mm thick	 42 44	 46 48	
10mm Gyprock plasterboard CD (screw fixed) CSR Hebel Thermoblok masonry 20mm offset 64mm steel stud S4 Bradford polyester insulation 10mm Gyprock plasterboard CD • 100mm thick • 125mm thick • 150mm thick	 42 44 47	 52 54 56	
10mm Gyprock plasterboard CD (screw fixed) CSR Hebel Thermoblok masonry 28mm furring channel + resilient mounts S4 Bradford polyester insulation 10mm Gyprock plasterboard CD • 100mm thick • 125mm thick • 150mm thick • 175mm thick • 200mm thick • 250mm thick	 39 41 43 44 46 49	 50 52 54 55 56 59	
10mm Gyprock plasterboard CD (screw fixed) CSR Hebel Thermoblok masonry 20mm gap S4 Bradford polyester insulation CSR Hebel Thermoblok masonry 10mm Gyprock plasterboard CD (screw fixed) • 100mm thick • 125mm thick • 150mm thick • 175mm thick • 200mm thick • 250mm thick	 43 45 48 49 50 54	 50 52 54 55 56 59	

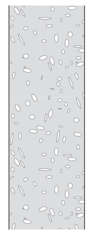
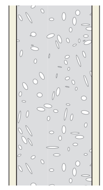
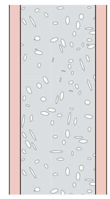
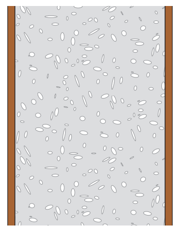
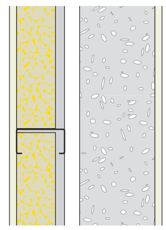
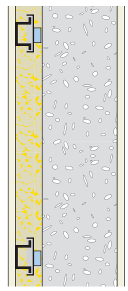
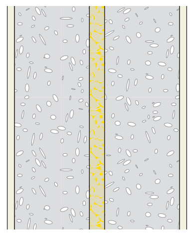
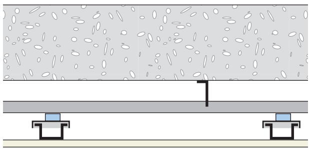
CSR Hebel Sonoblok AAC Masonry			
Nil lining CSR Hebel Sonoblok masonry Nil lining • 100mm thick • 125mm thick • 150mm thick • 175mm thick • 200mm thick • 250mm thick	34 36 48 40 41 43	39 41 43 45 46 48	
10mm Gyprock plasterboard CD CSR Hebel Sonoblok masonry 10mm Gyprock plasterboard CD • 150mm thick • 175mm thick • 200mm thick • 250mm thick	37 39 41 43	42 44 46 48	
16mm Gyprock Fyrchek plasterboard CSR Hebel Sonoblok masonry 16mm Gyprock Fyrchek plasterboard • 125mm thick • 150mm thick • 175mm thick • 200mm thick • 250mm thick	39 40 41 42 44	44 45 46 47 49	
10mm Render CSR Hebel Sonoblok masonry 10mm Render • 100mm thick • 125mm thick • 150mm thick • 175mm thick • 200mm thick • 250mm thick	39 40 41 42 43 45	42 45 46 47 48 50	
10mm Gyprock plasterboard CD (screw fixed) CSR Hebel Sonoblok masonry 20mm offset 64mm steel stud S4 Bradford polyester insulation 10mm Gyprock plasterboard CD • 100mm thick • 125mm thick • 150mm thick	44 46 49	54 56 58	
10mm Gyprock plasterboard CD (screw fixed) CSR Hebel Sonoblok masonry 28mm furring channel + resilient mounts S4 Bradford polyester insulation 10mm Gyprock plasterboard CD • 100mm thick • 125mm thick • 150mm thick • 175mm thick • 200mm thick • 250mm thick	41 43 45 47 49 51	52 54 56 58 59 61	
10mm Gyprock plasterboard CD (screw fixed) CSR Hebel Sonoblok masonry 20mm gap S4 Bradford polyester insulation CSR Hebel Sonoblok masonry 10mm Gyprock plasterboard CD (screw fixed) • 100mm thick • 125mm thick	45 47	52 54	

Table 4.2: Acceptable Forms of CSR Hebel AAC Construction for Floors

Description	R_w	$R_w + C_{tr}$	IIC	$L_{n,w} + C_I$	Construction
Nil floor covering CSR Hebel floor panel system 64mm minimum cavity gap Nil insulation Resiliently suspended ceiling system 10mm Gyprock Plasterboard CD • 150mm thick • 200mm thick	 50 52	 42 43			
Nil floor covering CSR Hebel floor panel system Nil ceiling system • 150mm thick • 200mm thick	 42 45	 37 40