



## Acoustic Performance – Case Study 5

### Zero4, Plymouth: Hot-rolled steel frame with *Slimdek* floors



A G J Way

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Zero4 is a large residential and commercial development that forms part of the redevelopment of Plymouth city centre. The 10-storey building comprises bars, restaurants and shops on the ground floor, a basement car park, and 120 apartments on the floors above. The apartments range from one bedroom studios to three bedroom luxury duplex apartments.

The structural solution of a hot-rolled steel frame with *Slimdek* floors was selected because it allows flexibility of layout to accommodate the different size apartments. The *Slimdek* solution also offered a fast construction programme, which was necessary for the city centre site, and minimum floor-to-floor heights.

The site was previously the home of the Ballard Centre and municipal swimming pool, which were demolished in 2005. The plan form of the new building on the site is rectangular, approximately 58 × 28 m. The structural grid is 7.5 m square and is designed to incorporate 12 flats of various sizes per floor. The building is divided into two parts, one nine and the other 10 storeys high, both with pitched roofs.

The acoustic performance of the floors has substantially exceeded requirements of the Building Regulations, by an average of 10 dB for airborne sound and by an average of 19 dB for impact sound. The walls also easily satisfy the acoustic performance standards required by the Building Regulations<sup>[1]</sup> and Approved Document E<sup>[2]</sup>.

#### Acoustic performance summary

Element	Sound reduction	Measured	Required
Floor	Airborne	55 dB	≥ 45 dB
Floor	Impact	43 dB	≤ 62 dB
Wall	Airborne	51 dB	≥ 45 dB



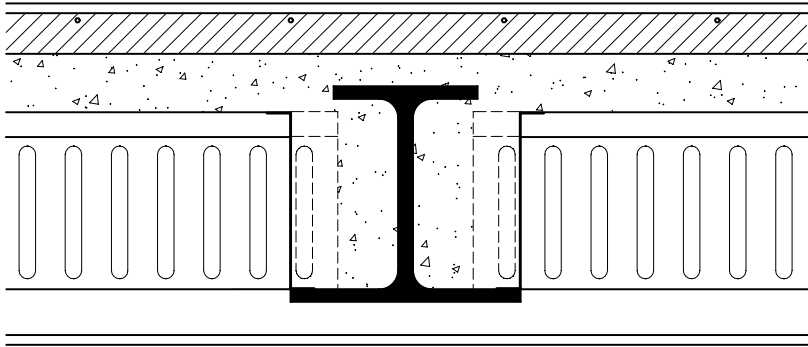
Curved balcony detail

Project sponsored by:

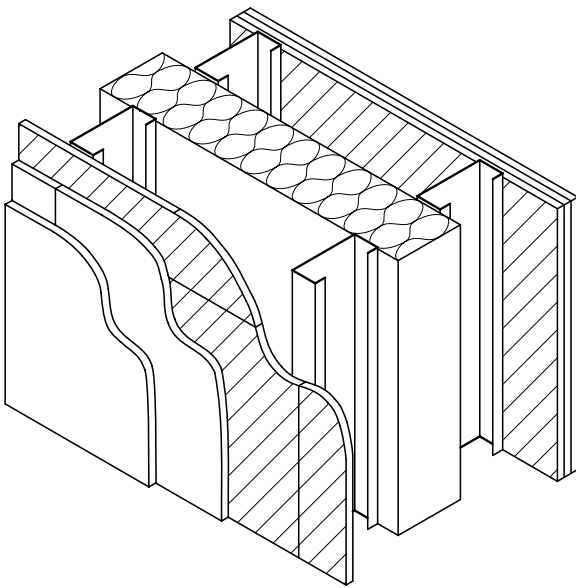


## Floor and wall details

The various layers of the separating floors and walls are illustrated in the diagrams below. The acoustic insulation provided by walls and floors is enhanced by isolation of layers, provision of mass and good detailing of junctions. The Corus *Slimdek* floor system uses a composite slab to provide mass and a floor treatment and ceiling to provide isolated layers.



*Slimdek* separating floor construction



Separating wall construction

### Separating floor:

- 18 mm tongue and groove chipboard
- 75 mm of polystyrene insulation incorporating an under-floor heating system
- 320 mm composite slab formed on SD225 deep decking with steel fibre reinforced concrete (*FibreFlor*)
- The decking is supported on the bottom flange of ASB sections which are incorporated into the depth of the slab
- Void
- 15 mm sound resistant plasterboard supported on a proprietary metal frame system.

### Separating wall:

- Two layers of 15 mm sound resistant plasterboard
- 18 mm of plywood
- 70 mm light steel studs at 600 mm centres
- 50 mm of mineral insulation batts
- The same layer of construction is provided on each side of the mineral wool.

## Floor construction



Floor construction prior to concrete placement

The Zero4 development used fibre reinforced floor slabs. Fibre reinforcement can eliminate the need for steel mesh reinforcement, which saves time and has added health and safety benefits through reduced handling and reduced trip hazards.

The acoustic performance of the floor system is not affected by the type of reinforcement used in the slab.

## Acoustic testing

Table 1: On-site acoustic test results for floors

Floor test results	Measured	Building Regulations	
Airborne ( $D_{nT,w} + C_{tr}$ )	Test 1	56 dB	≥ 45 dB
	Test 2	64 dB	≥ 45 dB
	Test 3	62 dB	≥ 45 dB
	Test 4	61 dB	≥ 45 dB
	Test 5	54 dB	≥ 45 dB
	Test 6	54 dB	≥ 45 dB
	Test 7	58 dB	≥ 45 dB
	Test 8	57 dB	≥ 45 dB
	Test 9	53 dB	≥ 45 dB
	Test 10	54 dB	≥ 45 dB
	Test 11	56 dB	≥ 45 dB
	Test 12	56 dB	≥ 45 dB
	Test 13	48 dB	≥ 45 dB
	Test 14	50 dB	≥ 45 dB
	Test 15	48 dB	≥ 45 dB
	Test 16	47 dB	≥ 45 dB
	Test 17	59 dB	≥ 45 dB
	Test 18	55 dB	≥ 45 dB
<b>Average</b>	<b>55 dB</b>	<b>≥ 45 dB</b>	

Table 2: On-site acoustic test results for walls

Wall test results	Measured	Building Regulations	
Airborne ( $D_{nT,w} + C_{tr}$ )	Test 1	56 dB	≥ 45 dB
	Test 2	54 dB	≥ 45 dB
	Test 3	53 dB	≥ 45 dB
	Test 4	53 dB	≥ 45 dB
	Test 5	50 dB	≥ 45 dB
	Test 6	46 dB	≥ 45 dB
	Test 7	54 dB	≥ 45 dB
	Test 8	55 dB	≥ 45 dB
	Test 9	48 dB	≥ 45 dB
	Test 10	48 dB	≥ 45 dB
	Test 11	48 dB	≥ 45 dB
	Test 12	52 dB	≥ 45 dB
	Test 13	54 dB	≥ 45 dB
	Test 14	49 dB	≥ 45 dB
	Test 15	53 dB	≥ 45 dB
<b>Average</b>	<b>51 dB</b>	<b>≥ 45 dB</b>	

On-site acoustic testing was carried out in accordance with BS EN ISO 140: Part 4<sup>[3]</sup> for the airborne sound and BS EN ISO 140: Part 7<sup>[4]</sup> for the impact sound. The Standard Weighted Level Difference  $D_{nT,w}$ , the Standard Weighted Impact Sound Pressure Level  $L'_{nT,w}$  and the spectrum adaptation term  $C_{tr}$  were calculated in accordance with BS EN ISO 717<sup>[5]</sup>. The measured results for the acoustic performance of the separating floors and walls are shown in Tables 1, 2 and 3.

Table 3: On-site acoustic test results for floors

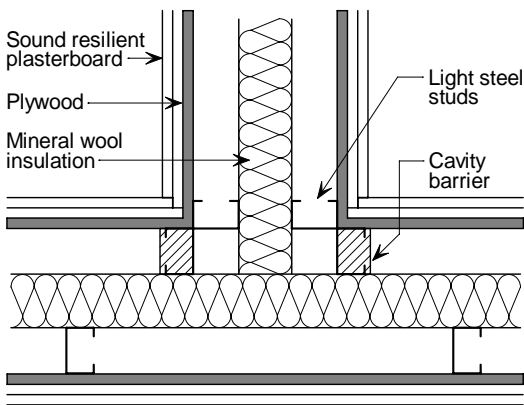
Floor test results	Measured	Building Regulations	
Impact ( $L'_{nT,w}$ )	Test 1	39 dB	≤ 62 dB
	Test 2	39 dB	≤ 62 dB
	Test 3	39 dB	≤ 62 dB
	Test 4	40 dB	≤ 62 dB
	Test 5	41 dB	≤ 62 dB
	Test 6	42 dB	≤ 62 dB
	Test 7	44 dB	≤ 62 dB
	Test 8	44 dB	≤ 62 dB
	Test 9	44 dB	≤ 62 dB
	Test 10	44 dB	≤ 62 dB
	Test 11	49 dB	≤ 62 dB
	Test 12	42 dB	≤ 62 dB
	Test 13	43 dB	≤ 62 dB
	Test 14	44 dB	≤ 62 dB
	Test 15	46 dB	≤ 62 dB
	Test 16	44 dB	≤ 62 dB
	Test 17	47 dB	≤ 62 dB
	Test 18	45 dB	≤ 62 dB
<b>Average</b>	<b>43 dB</b>	<b>≤ 62 dB</b>	

Tests 1 and 2 were conducted by Noise.co.uk in June 2008. The other acoustic tests were performed by SB Consulting Engineering Acoustics Ltd also in June 2008.

The results show that the Building Regulation requirements were exceeded in all cases.

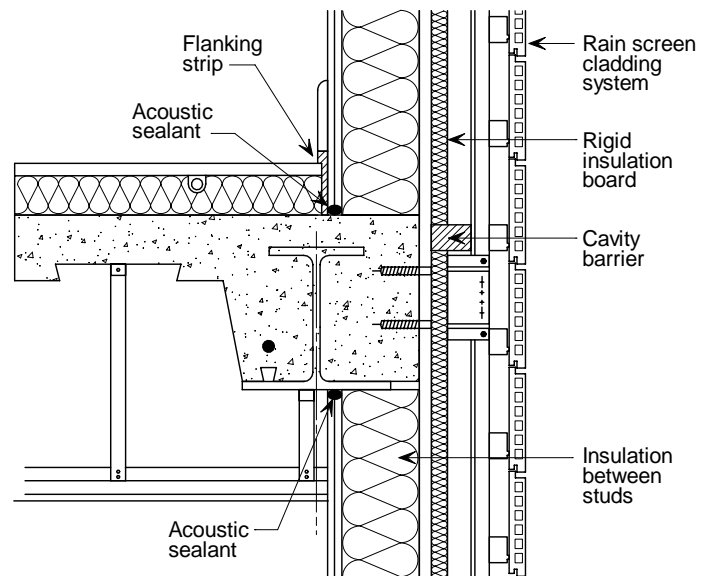
## Junction details

The detailing of junctions between separating walls and floors is important to avoid flanking sound paths which reduce the sound insulation provided between adjacent living spaces. Example details are shown on the next page. Joints between wall and ceiling linings are filled with sealant and the wall boards are not in direct contact with the floor treatment. The plasterboard wall linings are not continuous through the wall junction in any direction. The joints between plasterboard layers are staggered and filled with sealant at the corners.



Junction detail between two separating walls

Junction detail between the floor and external wall



## References and Bibliography

1. The Building Regulations (England and Wales) 2000, Part E - Resistance to the passage of sound. TSO, 2003
2. Approved Document E, 2003 Edition (incorporating 2004 Amendments), TSO, 2004
3. BS EN ISO 140-4: 1998 Acoustics. Measurement of sound insulation in buildings and of building elements. Field measurements of airborne sound insulation between rooms. BSI, 1998
4. BS EN ISO 140-7: 1998 Acoustics. Measurement of sound insulation in buildings and of building elements. Field measurements of impact sound insulation of floors. BSI, 1998
5. BS EN ISO 717: 1997 Acoustics. Rating of sound. BSI, 1997

## SCI Publications

The following SCI publications provide further guidance on acoustic detailing in steel framed buildings.

- P320: Acoustic performance of light steel framed systems. SCI, 2003
- P321: Acoustic performance of *Slimdek*. SCI, 2003
- P322: Acoustic performance of composite floors. SCI, 2003
- P336: Acoustic detailing for multi-storey residential buildings. SCI, 2004
- P371: Acoustic performance – Case Studies:
1. The Waterfront, Grantham: A steel frame with composite floors
  2. St Peters Court, Bristol: A steel frame with precast floors
  3. Paragon Project London: High rise modular construction
  4. Light steel floors with *Gyvlon* screed
  5. Zero4, Plymouth: Hot-rolled steel frame with *Slimdek* floors
  6. Vision, Basingstoke: Modular steel frame
  7. Riverview, Hereford: Hot-rolled steel frame with composite fibre-reinforced slab floors
  8. Brightwell Court and Minerva Lodge, London: Light steel frame, walls and floors
- P372: Acoustic detailing for steel construction. SCI, 2008

## Project team

<b>Client:</b>	Penrose
<b>Main contractor and developer:</b>	Prestige Homes
<b>Architect:</b>	SMC Architects
<b>Structural Engineer:</b>	Airey & Coles
<b>Steelwork contractor:</b>	SIAC Tetbury Steel
<b>Acoustic testing:</b>	Noise.co.uk and SB Consulting Engineering Acoustics



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SCI P371/5 Zero4, Plymouth

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