Institution: Edinburgh Napier University

Unit of Assessment: Architecture, Built Environment and Planning

Title of case study: Development of acoustic Robust Details enhancing building performance and wellbeing of occupants

1. Summary of the impact (indicative maximum 100 words)

The Building Performance Centre at Edinburgh Napier University led by Professor Sean Smith was the first to research 'robust details' for sound insulation during 2001-2004. This resulted in a government consultation, new regulatory approach, higher quality of life for home occupants, multi-stakeholder engagement and knowledge exchange via a Design Handbook with 4,700 subscribers. Since 2008, over 300,000 robust detail homes have been built, noise complaints have fallen four-fold, site compliance rates have shifted from 35% to 99%, Smith leads a European 32-country robust design group and 16 patented products are manufactured in the UK.

2. Underpinning research (indicative maximum 500 words)

Noise complaints in housing were at a record high as outlined in the government consultation in 2001 for "Part E of the building regulations". Historic poor compliance levels for sound insulation standards (e.g. 40% floors and 25% walls) had been identified by Department of Environment Transport and Regions, BRE previous research and Scottish Executive. In 2001 Smith based at (Edinburgh) Napier University had undertaken a research project to "Review sound insulation in domestic construction" funded by the Scottish Executive [3.1]. The analysis of high sound insulation performing walls and floors, coupled with his previous international research in Italy (1998) and Germany (1999) investigating complex sound transmission in buildings provided a unique research base. In 2002 the Home Builders Federation awarded a £500,000 research project to *Smith et al* at Edinburgh Napier to develop Robust Standard Details (RSD). Key aims were to research and design robust separating wall and floors for attached houses and apartments to address a wide range of living noises, provide enhanced sound insulation, reduce complaints and deliver high level regulatory compliance rates as soon as possible. The RSD project involved 119 industry members, public sector and over 20 industry organisations.

The underpinning research involved using the Edinburgh Napier large-scale database of on-site sound insulation measurements to identify key trends and weaknesses in existing construction designs and their performance. The research team analysed construction techniques which would deliver a safety margin for design, workmanship, technical compatibility with other regulations (e.g. structure) and enhanced performance. Research was also undertaken to review the implications of International Standards, ISO 717 acoustic spectrum adaptation terms for airborne sound transmission. Using a statistical approach to deliver a 95% confidence of achieving enhanced +5 decibel sound insulation better than building regulations, the research team then designed a series of specifications for the house building industry to build and test.

During 2002-03 the industry built 1,400 new homes incorporating new acoustic robust designs by *Smith et al* which were tested on site and the research team undertook computer modelling and empirical data analysis during the on-site period. The research project outcomes led to a public consultation (2003) by the Office of the Deputy Prime Minister [3.2]. During 2003/2004 the industry then funded further £130,000 for *Smith's* team to develop compliance protocols and incorporation of a "no advance warning" robust site inspection scheme [3.3]. As a result of the RSD project, the Scottish Government funded research (2007) into new Building Standards Section 5:Noise, published in May 2009 [3.4] leading to new building standards in October 2010.

The RSD and Building Standards research identified the critical importance of technical compatibility across different building regulations for thermal, acoustic and structural issues resulting in the £1.1 million Low Carbon Building Technologies Gateway for research into future compatible products for low carbon housing. This 11-year research period has led *Smith et al* to

publish 5 patents [example 3.5]. The significant research database led to the 2012 invited paper on ISO 717 proposed changes [3.6].

3. References to the research (indicative maximum of six references)

References to key research outputs

3.1 R.S. Smith, R.G. Mackenzie. R.K. Mackenzie and T. Waters Fuller. A review of sound insulation in Scottish domestic construction. Part 1 - Building Standards Division, Scottish Executive. March, 2001. ***Reviewed by Regulatory Advisory Committee***

3.2 R.S. Smith, J.B. Wood, R.G. Mackenzie and R.K. Mackenzie. *The Building Regulations 2000 – amendment of the building regulations to allow robust standard details to be used as an alternative to pre-completion testing.* Public Consultation Document. Office of the Deputy Prime Minister, UK Government. August, 2003. ***Reviewed by Building Regulations Advisory Committee.***

3.3 R.S. Smith, D. Baker, R.G. Mackenzie, J.B. Wood, P. Dunbavin and D. Panter. *The development of robust details for sound insulation in new build attached dwellings.* Journal of Building Appraisal, 2 (1). pp. 69-85. ISSN 1742-8262, (2006). – ***Peer reviewed journal***

3.4 R.S. Smith, J.B. Wood and R.G. Mackenzie. "Design of separating constructions that are resistant to the transmission of noise." Part 1 Main Report and Part 2 Example Details. Scottish Building Standards Agency (SBSA), Scottish Government, submitted October 2007, published May 2009. ***Reviewed by Regulatory Advisory Committee***

3.5 R.S. Smith and S. McAndrew, Published Patent: GB 2448765. 'A structural connector' (Acoustic Wall Strap), 19 pages, Published 21st March 2012. ***Fully international examined patent application.***

3.6 C. Rodrigues, A. Monteiro, C. Mondaca Marino, M. Machimbarrena, F. Torchia, E. Nannipieri, N. Robertson and R.S. Smith. Comparative analysis of airborne sound insulation field measurements using different ISO 717-1 performance descriptors – Lightweight separating walls and floors. Euronoise 2012, Prague, Czech Republic. 2012. ***Invited paper by EU COST Action steering group***.

Key research grants:

2001 Review of sound insulation in domestic construction. Scottish Executive. (£10,669)
2002-03 RSD Project: Investigation into the development of Robust Standard Details. Home Builders Federation (£500,000)
2003-04 Development of RD protocols and procedures: Home Builders Federation (£130,000)
2003-04 Noise control from laminated floors: Defra (£65,747)
2004-05 Good Practice Design Guide for Sound Insulation: Scottish Executive (£53,045)
2007-08 Review of Building Standards Section 5-Noise: Development of separating walls and floors for Scottish Building Standards, Scottish Executive. (£40,000)
2010-13 LCBT Gateway: Low Carbon Building Technologies Gateway for new housing. (£1,100,000) Scottish Enterprise and European Regional Development Grant

4. Details of the impact (indicative maximum 750 words)

The impact of the research during 2008-13 is multi-dimensional including international outreach to current new ISO standards being drafted and 32 countries developing future robust acoustic solutions. It has been instrumental in developing new regulations, policies and standards for sound insulation leading to innovative knowledge transfer to industry via the robust details handbook. The compliance rates for sound insulation in the UK are now 99% and noise complaints in new dwellings have fallen four fold in 2010 when compared with previous noise complaint statistics in 2004 (NHBC statistics provided in 2011). The quality of life for home occupants has been improved with the average sound insulation performance being 7 decibels above regulatory requirements providing nearly 8 times the sound energy reduction.

A key attribute of the research project was the development of the Robust Detail design Handbook

providing clarity of technical information, guidance and specifications. Over 4,700 handbooks have been sold during the REF impact period. 62% of all new homes use the robust details scheme [5.1] and this is a testament to the transfer of the research findings into a Handbook specification format which is easily incorporated into architectural details. There have been 1,900 site inspections and 6,000 on-site sample acoustic test undertaken (2008-13) which are entered into the UK's (and world leading) most in-depth sound insulation database. Over 600,000 people in the UK now live in 300,000 robust detail homes built during 2008-2013 [5.2]. 30 new innovative robust details using UK manufactured products have been developed during 2008-13, delivering over 300 wall and floor combinations for architects and developers to specify in apartments.

Smith et al research to develop patents for technical compatible solutions for acoustics and structure led to innovative new products such as Icopal-Bridgestop. This was approved as a robust detail (RD ref:E-WM-19) in December 2009 as the highest sound insulation separating wall in the UK. It provides the maximum 4 credits for the Code for Sustainable Homes "Health and Wellbeing" [5.3] delivering enhanced quality of life for occupants versus minimum building standards. Scottish building standards also incorporated the Robust Details approach in 2011. The resultant outputs of 5 published patents from Smith's team have all been declared robust detail compliant since 2008 and form a suite of 16 products manufactured in the UK, with a combined turnover of over £3 million. The "Acoustic Wall Strap" for timber frame party walls [5.4] was designed to deliver high sound insulation performance is licensed in North America (2009) which has a 90% timber frame market and was also granted a full European patent (3rd July 2013). The product uses 30% less steel but has twice the compressive strength which will enhance structural stability for future climate change issues such as high wind loadings on buildings.

In 2009 *Smith's* team were awarded the Queen's Anniversary Prize for "Innovative housing construction for environmental benefit and quality of life" awarded for the outstanding impact to industry, environment and society [5.5, 5.6] from the original Robust Standards Details research project.

In 2010 the RD approach annually saved the industry £14 million and reduces 17,000 car journeys from the UK's roads by not having to undertake large scale testing [5.7]. During 2008-13 *Smith* has given over 20 seminars on sound insulation and product innovation to the UK construction industry and government departments totalling over 900 attendees. In addition he has given invited international presentations to Italian authorities in Rome (October 2009) and Milan (Feb 2011) [5.8], Swedish industry and government organisations (Stockholm October 2010) and Hong Kong/China officials in (January 2013).

Smith was nominated by European countries to lead the EU COST Action TU0901 WG3 (2009-13) to develop new robust solutions involving 29 EU countries and Canada, New Zealand and Australia [5.9]. The significant on-site sound insulation database developed for Robust Details supported by Smith's team allowed the first comparative analysis of the proposed changes to ISO 717 (NP 16717). This invited paper demonstrated how the proposed ISO changes to performance descriptors from Germany would not deal with addressing low frequency sound insulation issues in real attached homes. This led to the UK and Scottish government departments writing to the Chair of the ISO committee and the UK ISO representatives being able to advise the ISO committee on sound insulation performance prescriptors and their influences leading to a refreshed approach to a future ISO 717.

Finally, in 2012 the Government undertook a review of the Effect of Noise Policy Interventions (funded by Defra) which demonstrated the positive impact for compliance rates due to the RD scheme. [5.10]

5. Sources to corroborate the impact (indicative maximum of 10 references)

[5.1] Percentage market share or Robust Details (RD) Scheme - RD Annual Review 2010: Page 5 - http://www.robustdetails.com/Content/PDFs/AnnualReview2010.pdf
[5.2] Number of people living in Robust Detail homes, also technical@robustdetails.com

Page 2 - http://www.robustdetails.com/Content/PDFs/AnnualReview2010.pdf
[5.3] In 2010 Bridgestop © (Smith et al patent) was the first wall structure to receive the maximum four credits under the Code for Sustainable Homes under Health and Wellbeing and is still the highest performing robust detail separating wall structure for sound insulation (E-WM-19).
http://www.robustdetails.com/TheHandbook/CodeForSustainableHomes
[5.4] Acoustic Wall Strap UK patent (Smith et al patent) – key benefits and RD compliant
Page 36 - http://itw-industry.com/lit/Cullen/Timber-Engineering-Connectors/#36/z
[5.5] Recognition by the Royal Anniversary Trust by the award of the Queen's Anniversary Prize 2009 for world-class excellence and achievement for resultant impact of the research:
http://www.royalanniversarytrust.org.uk/the-prizes/previous-prize-winners
[5.6] Feedback from the house building sector relating to the research project's impact:
www.hbf.co.uk/media-centre/news/view/queens-prize-recognises-pioneering-noise-research/
[5.7] Page 14 - http://www.robustdetails.com/Content/PDFs/AnnualReview2010.pdf
[5.8] Invited presentation in Milan, for Lombardia Region Council
http://www.agendadigitale.regione.lombardia.it/shared/ccurl/120/328/Presentazione%20Smith.pdf
[5.9] Confirmation of Prof Smith Chairing and leading Working Group 3 for international EU COST ACTION TU0901 and 32 countries involved in robust construction solutions
http://www.costtu0901.eu/working-groups
[5.10] ANNEX 4, Building Regulations. Table 5.5 and Paragraph 7.4.15, Defra Contract NO0234 "An investigation in the effect of historic noise policy interventions". July 2012.
http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=18090&FromSearch=Y&Publisher=1&SearchText=NO0234