Office of the Deputy Prime Minister
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# *Building Operational Performance Framework*

# *Development of Acoustic Performance Standards for Robust Details – Final Report*

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# Development of Acoustic Performance Standards for Robust Details – Final Report

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# Contents

# Executive summary

1 This report considers the work necessary to enable test methods to be developed to assess the acoustic performance of components that go to make up separating constructions.

2 Starting from the components and sub-assemblies identified in the interim reports, we have selected those that we consider a priority to be studied further. These are identified in the report, together with the type of test method needed for each one.

3 A programme of testing is proposed to better understand the relationship between overall acoustic performance of constructions and the physical properties, both acoustical and non-acoustic, of components and sub-assemblies of those constructions. The results of this testing would be used to develop test methods and criteria to enable people to decide whether a component can be substituted in a construction without unacceptably reducing its acoustic performance.

4 A cost estimate is given for this work.

# Introduction

5 Under the current Building Regulations 2000 as amended, the normal way of showing compliance with the requirements for sound insulation between dwellings is by a programme of pre-completion testing. This is detailed in Approved Document E (2003 edition)[1].

6 This Approved Document also gives guidance on constructions that may be expected to meet the sound insulation requirements if built well.

7 It has been accepted that the Building Regulations will soon be amended to allow the use of specific constructions without the need for pre-completion testing between newly built dwelling houses and flats. The constructions specified include separating walls and floors, together with alternative sub-assemblies, such as floating floors, and associated junction and flanking construction details. The specified constructions proposed have been termed Robust Details (RDs).

8 For constructions to qualify as RDs they must pass a regime of 30 on-site tests. Constructions have many components that could be varied. It is not practicable to put all possible combinations through the testing regime. In order to encourage innovation through product substitution, methods are needed for the testing of the physical properties of generic products that influence sound insulation of the constructions in which they are incorporated.

9 Similarly, such information would allow the guidance in Approved Document E (2003) to be extended to include new or different construction components.

10 RDs will be introduced together with new acoustic performance tests for three types of product, to enable alternatives to be used. These tests listed below have already been developed by others:

a) Floating floor on timber base floor

b) Floating floor on concrete base floor

c) Resilient bars used in separating floors

It is desirable to extend this to include other generic products and to also consider measuring other physical properties rather than only directly measuring sound insulation.

11 The purpose of this study is to propose and cost a programme of work to develop test methods for testing generic products. The aim is to encourage product substitutions in separating constructions and associated details that are known to give adequate sound insulation.

# Methodology

12 If suitable test methods are to be developed, we need to understand the relationship between the sound insulation of the overall construction and the physical or acoustic properties of its components.

13 If a test method measures an acoustic property, this will usually be done with a component or sub assembly, in a standard base construction. We must understand whether the acoustic property would be significantly different with a different base construction. A straightforward example of this is the performance of a floated floor on a timber joist floor as compared to a concrete floor. This has meant that floating floors for use in RDs are to be tested on both timber joist and concrete standard base floors.

14 Once we have a test method, we need a criterion. In future, when a new component is tested, the result will be compared to this criterion to judge whether the component is an acceptable alternative in an RD or other recognised construction. A criterion could be derived from tests on a 'benchmark' construction, incorporating a similar component that is in common use. For example, a standard independent wall lining, as described in Approved Document E, on a dense block wall, could be taken as a benchmark construction. The amount this lining improved the sound insulation of the dense block wall would be the criterion. If a new type of independent wall lining system were developed, the improvement it achieved would be measured using the same dense block wall and compared to the criterion.

15 However, we must understand what other factors in the overall construction affect the sound insulation. Continuing the example, if the wall lining is to be used with a porous block wall, the improvement in sound insulation would be quite different. This must be taken into account by having test methods and criteria that can cater for lining on walls built of the different types of blockwork in common use.

16 The components or sub-assemblies and their relevant acoustic and physical properties were identified in the two interim reports previously issued in this study. There is a large number of components. For many components the factors materially influencing the sound insulation are straightforward and understood, such as the mass per unit area of a concrete slab or the dynamic stiffness of wall ties. Also three new test methods have been introduced with the RD scheme and another is in development, and there is no need to duplicate this work. Therefore, we have set priorities for the components studied and test methods to be developed.

17 Having decided on the more important components to be studied, it was necessary to decide whether the test method should measure acoustic or non-acoustic (physical) properties. Acoustic properties would include such quantities as reduction in impact sound transmission or absorption coefficient and might well depend on the rest of the overall construction. Physical properties would include dynamic stiffness and airflow resistance and are usually inherent to the component. There are advantages and disadvantages of each approach.

18 Many existing test methods use an acoustic property measured using existing standards. For example, the airborne acoustic performance of a floated floor on a timber joist floor is obtained by measuring the weighted sound reduction index plus adaptation term ($C_{tr}$). A standard timber floor is tested with and without the floated floor installed. The difference between the results is the acoustic property used to describe the performance of the floated floor. Each of the measurements is done to the existing British Standard (BS EN ISO 140-3:1995)[2].

19 A limited number of standards exist for measuring the physical properties of construction components relevant to sound insulation performance. British Standards exist for measuring the dynamic stiffness of materials used under floating floors, such as mineral wool or expanded plastic foam, and for measuring airflow resistance[3,4]. There is a Building Research Establishment method for measuring the dynamic stiffness of wall ties[5].

20 If an acoustic property is chosen:

a) The relationship with the overall sound insulation of a separating construction should be easier to investigate and establish.

b) There will be a British Standard for all the measurements.

c) In practice, there may need to be more than one test, perhaps with different base constructions, to adequately test the component for use in various types of construction on site.

21 If a physical property is chosen:

a) The relationship with the overall sound insulation of a separating construction may be difficult to investigate.

b) There will not be Standards for some of the measurements needed.

c) A supplier would only have to do one test to determine the adequacy of the component.

d) There might have to be different quantitative criteria for the use of the component in different types of construction on site.

22 Taking these factors into consideration we must first decide which types of component and sub-assembly should be studied as a priority. Then we propose a programme of work to develop new test methods, which would fit into the following framework.

23 For the ones chosen, measure the relevant acoustic property when installed with different base constructions. Take similar measurements in each base construction alone. Repeat the measurements while varying the parameters of the component or sub-assembly. For example using different types of resilient bar or varying the cavity depths in a wall lining system. Where existing test methods exist, measure the relevant physical properties of the components that have been varied, including any which may have been changed in the base construction. Measure the acoustic property of a benchmark construction that incorporates the component or sub-assembly being studied.

24 The results of the tests will be analysed to determine the effect of varying physical parameters (e.g. density) of components and base constructions on the acoustic properties. This knowledge will then be used to:

a) Propose an acoustic test method to measure each relevant acoustic property. Variations on a test method may be required where a component or sub-assembly is to be used in different types of construction.

b) Propose quantitative criteria for the acoustic property, which the component or sub-assembly should achieve.

c) Compare those physical properties of components measured with the acoustic properties. Propose further investigation that could be done to enable measurement of only physical properties to be used. Recommend test standards to be developed to assist in this.

# Programme of Investigation

## Priorities in Components to be Studied

25 Many components or sub-assemblies are not being considered further in this study. There are various reasons which include:

a) Physical properties already specified in guidance and can be determined by existing methods. For example, the mass per unit area of brick walls or dynamic stiffness of wall ties.

b) Acoustic performance already specified adequately in Approved Document E (2003) or RD scheme, for example, reduction of impact sound transmission for soft coverings or floating floors.

c) Quantitative specification of the component is not critical or not worth investigation, for example, flexible sealant or flexible perimeter strips for floating floors

d) Component is usually only of significance when used in a proprietary system that is already routinely tested, for example, metal studs in plasterboard partition systems.

26 We propose to test the following components and sub-assemblies:

a) Independent wall linings

b) Non-independent wall lining systems

c) Composite boards as wall lining

d) Sound absorbing infill for cavities or voids

## Testing to be Done

27 For each of the above components and sub-assemblies to be investigated, the salient features of the test samples are listed in the following tables. These features include:

a) A description of the sub-assembly or component(s)

b) The standard overall construction to be used

c) Acoustic property to be measured and test standard followed

d) Parameters of the sub-assembly or component to be varied

e) Any other parameters of the overall construction to be varied

f) Number of acoustic tests proposed

g) Non-acoustic properties to be determined

28 Testing Table for Independent Wall Lining

| | |
|---|---|
| Description of Standard Wall Lining | 2 x 12.5mm dense plasterboard (20 kg/m$^2$),60mm cavity between wall and board, no mineral wool, one side of block wall |
| Standard Base Wall | 100mm dense concrete solid blockwork wall, non-porous with fully filled joints |
| Acoustic Property | Difference in $R_w + C_{tr}$, BS EN ISO 140-3:1995 |
| Parameters of Wall Lining<br>(Standard Base Wall) | 4 cavity depths, 60 to 150mm, no mineral wool<br>3 densities of 50mm mineral wool in 60mm cavity<br>1 density of 50mm mineral wool in 3 cavity depths |
| Variation in Base Wall | 3 additional concrete block types:<br>100mm lightweight aggregate ([ 1200 kg/m$^3$)<br>100mm aircrete (600 – 700 kg/m$^3$)<br>All with/without 50mm of mineral wool (1 density) |
| Porous Wall Only | 100mm dense solid, porous<br>3 cavity depths with/without 50mm of mineral wool (1 density) |
| Benchmark Construction | Standard wall lining on standard base wall |
| Number of tests done | 26 |
| Non-acoustic properties to be determined | Density, airflow resistance and absorption coefficient of mineral wool<br>Airflow resistance of blocks (if practicable) |

29 Testing Table for Non-Independent Wall Lining

| | |
|---|---|
| Description of Standard Wall Lining | 12.5mm standard plasterboard (8 kg/m$^2$), on proprietary metal furring/clip or channel system, one side |
| Standard Base Wall | 100mm dense concrete solid blockwork wall, non-porous with fully filled joints. Note: this is same as for independent wall linings and tests may be combined on same base wall |
| Acoustic Property | Difference in $R_w + C_{tr}$, BS EN ISO 140-3:1995 |
| Parameters of Wall Lining (Standard Base Wall) | 2 additional proprietary systems plus resilient bar/channel all with/without 25mm of mineral wool (1 density) |
| Variation in Base Wall | 3 additional concrete block types (as independent wall lining) standard wall lining system only, with/without mineral wool |
| Benchmark Construction | 215mm dense concrete wall plastered. |
| Number of tests done | 15 (assumes same bare walls used as for independent lining tests) |
| Non-acoustic properties to be determined | Density, airflow resistance and absorption coefficient of mineral wool<br>Airflow resistance of blocks (if practicable)<br>Dynamic stiffness of fixing system (test method not available) |

## 30 Testing Table for Composite Boards

| | |
|---|---|
| Description of Standard Component | Proprietary composite board with 12.5mm layer of plasterboard bonded to mineral fibre, one side of base wall |
| Standard Base Wall | 100mm dense concrete solid blockwork wall, non-porous with fully filled joints |
| Acoustic Property | Difference in $R_w + C_{tr}$, BS EN ISO 140-3:1995 |
| Variations of Composite Board | Board with thicker mineral fibre<br>Proprietary products from 1 or 2 other manufacturers |
| Variation in Base Wall | 3 additional concrete block types:<br>as per independent wall lining<br>each wall type tested with standard board only |
| Benchmark Construction | Standard board on standard wall |
| Number of tests done | 6 to 7 (assume same bare walls used as for independent lining tests) |
| Non-acoustic properties to be determined | Dynamic stiffness of composite board (if practicable)<br>Airflow resistance of blocks (if practicable) |

## 31 Testing Table for Absorbent Infill

| | |
|---|---|
| Description of Standard Infill | 25mm mineral wool quilt (10 – 12 kg/m$^3$) |
| Standard Construction | 2 x 12.5mm standard plasterboard each side of an aperture connected by 70mm metal studs |
| Acoustic Property | Difference in $R_w + C_{tr}$, BS EN ISO 140-3:1995<br>Absorption coefficient of infill BS EN ISO 20354:1993[6] |
| Parameter of Infill | 4 densities (10 – 100 kg/m$^3$)<br>4 thicknesses (25 – 150mm) |
| Variation in Construction | Standard (70mm studs), 25 and 50mm mineral wool, 4 densities<br>Independent 70mm cavity, 25 and 50mm mineral wool, 1 density<br>150mm studs, 25, 50 and 100mm mineral wool, 1 density<br>Independent 150mm cavity, 25, 50 and 100mm mineral wool, 1 density<br>Independent 200mm cavity, 100, 150mm mineral wool, 4 densities<br>Each construction with no mineral wool |
| Benchmark Components | Infill 25mm mineral wool quilt (10 – 12 kg/m$^3$)<br>100mm mineral wool quilt (10 – 12 kg/m$^3$) |
| Absorption Tests | Each thickness and density to be tested laid on solid surface.<br>For two thicknesses and densities test under following conditions:<br>Laid on mesh over plywood supported above solid surface (approx 100mm) with cavity open |
| Acoustic tests | 29 sound insulation<br>32 absorption |
| Non-acoustic properties to be determined | Density and airflow resistance of mineral wool |

# Test Methods Required

## Existing Test Standards and Related Test Methods

32 Existing test standards relevant to this proposed programme of investigation are listed below and are given in full in the References at the end of this report. Most of these are British and European Standards.

| Type of Measurement | Standard or Published Test Method |
|---|---|
| Airborne Sound Insulation | BS EN ISO 140-3:1995 |
| Absorption Coefficients | BS EN 20354:1993 |
| Dynamic Stiffness of Resilient Materials | BS EN 29052-1:1992 |
| Airflow Resistance | BS EN 29053-1:1993 |

33 Some test methods have been developed and published in association with the proposals for Robust Details. These are procedures using measurement methods in existing test standards, but applied in specific ways to test samples incorporated in otherwise standard constructions. These are listed below.

| Type of Measurement | Title of Method and Test Standards Used |
|---|---|
| Airborne and Impact Improvement of Floating Floor on Timber Floor | Determination of the Acoustic Performance Requirements for Floating Floor Treatments used with RSD Timber Core Floor TF2.<br>Uses:<br>BS EN ISO 140-3:1995<br>BS EN ISO 140-6:1998 |
| Impact Improvement of Floating Floor on Concrete Floor | Determination of the Acoustic Performance Requirements for Floating Floor Treatments and with RSD Concrete Core Floors MF1, MF8 and SF2<br>Uses BS EN ISO 140-6:1998 |
| Resilient Bar Performance | Determination of the Acoustic Performance Requirements for Resilient Bars used on Ceilings<br>Uses BS EN ISO 140-3:1995 and BS EN ISO 140-6:1998 |

A similar test is under development for Robust Details to measure the acoustic performance of downlighters.

# New Test Methods

34 The aim of the programme of investigation proposed in this report is to better understand the relationships between overall acoustic performance and properties of components in order to enable new test methods to be developed. These could include:

a) Acoustic test methods on components or sub-assemblies in standard constructions. These would be similar to the methods associated with RDs and use existing British and European Test Standards.

b) Non-acoustic tests on components using existing British and European Test Standards.

c) New British or otherwise recognized Test Standards, i.e. not using existing measurement standards

35 We consider that (c) should be outside the scope of this work. For the components to be studied it does not seem practicable yet to establish the relationship between acoustic performance and most physical properties, such as dynamic stiffness, over an adequate range of values and type of product. Available products are very similar. Also, there are limited test standards available. Therefore, we have concentrated on the first type of test method. However, where non-acoustic test methods are available, we propose to measure the relevant physical properties in conjunction with the acoustic ones.

36 We propose to develop test standards for the following:

a) The airborne sound insulation improvement of independent wall linings on masonry walls.

b) The airborne sound insulation improvement on non-independent wall lining systems, including composite boards, on masonry walls.

c) The airborne sound insulation performance of absorbent material in a cavity or void.

37 Where possible, we will recommend criteria for the results of the test methods related to particular types of construction.

38 We will also recommend other British Standards that should be developed to enable the principles of innovation and substitution to be extended and rely more on non-acoustic properties.

39 We will report any useful information obtained on the relationship between acoustic performance and non-acoustic physical properties. Further work will be recommended to enable test methods to be developed more towards inherent non-acoustic physical properties of components.

# Cost Estimate

40 The great majority of cost in the proposed programme is for the tests, including significant materials and builders work costs. We have proposed building five different blockwork walls and lining systems that must be removed and replaced for each change of infill, cavity or support system. We have also allowed for assessment of results, writing the test methods, and ongoing project management including meetings and briefing notes.

41 Our estimate is £90,000 including all building costs and expenses but excluding VAT.

42 The above costs do not allow for testing non-acoustic properties, dynamic stiffness and airflow resistance. We do not consider it practicable to do all the tests that would be of interest. We are not able to do these non-acoustic tests in-house. We expect the cost for what can readily be tested would not exceed £7,500 (excluding VAT).

# References


1 ODPM Building Regulation Division, Approved Document E – Resistance to the Passage of Sound (2003 Edition), HMSO, 2003.

2 BS EN ISO 140-3:1995 – Measurement of Sound Insulation in Buildings and of Building Elements. Part 3 – Laboratory Measurement of Airborne Sound Insulation of Building Elements.

3 BS EN 29052-1:1992 – Method for the Determination of Dynamic Stiffness. Part 1 – Materials Used Under Floating Floors.

4 BS EN 29053:1:1993 – Materials for Acoustical Applications. Determination of Airflow Resistance.

5 BRE IP3/01 – Dynamic Stiffness of Wall Ties Used in Masonry Cavity Walls: Measurement Procedure. CRC Ltd, 2001.

6 BS EN ISO 20354:1993 – Measurement of Sound Absorption in a Reverberation Room.