

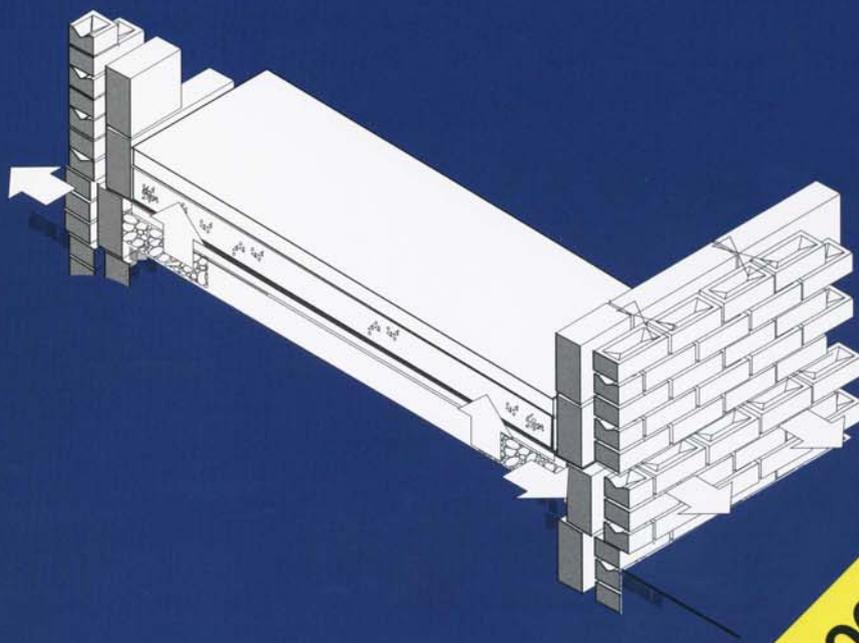
BRE Building Elements

Floors and flooring



P W Pye
and
H W Harrison

Performance,
diagnosis,
maintenance,
repair and
the avoidance
of defects



BRE

New edition 2003

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Floors and flooring

**Performance, diagnosis, maintenance,
repair and the avoidance of defects**

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Preface

First edition

It has been said that most problems with floors occur because people insist on walking on them, pushing trolleys over them, placing large objects on them and dropping things on them – if only they were ceilings they would never wear out! A small witticism that reflects the way some people, including professionals in the construction industry, see floors. Or, rather, don't see them! After all, what is there to a floor: floorboards nailed to joists. What can go wrong with that? And if it happens to form a ceiling, even better. But the facts belie this perception.

BRE's figures on faults in buildings of all types (given in greater detail in the introductory chapter which follows) show that a substantial number concern floors. Despite the advice that has been available to the industry from the 1920s, faults in flooring, such as cracking, detachment and entrapped water, recur frequently. If some of the errors appear elementary, this only reflects what happens in the design office and on site. All that we can do is show to those who work in the flooring industry what is being done incorrectly and how to take corrective action – preferably before faults or defects lead to costly damage.

This book describes the materials and products, methods and criteria which are used in the construction of floors and flooring. It draws the reader's attention to those elements and practices which ensure good performance or lead to faults and failure. There is sufficient discussion

of the underlying structure to enable an understanding of the behaviour of the whole floor without going very far into engineering design principles. It does not purport, though, to be a book of construction practice; nor does it provide the reader with the information necessary to design a floor, but, mainly through lists and comprehensive illustration, shows him or her what to look for as good and bad features of floors and flooring. It also offers sources of further information and advice.

Readership

Floors and flooring is addressed primarily to building surveyors and other professionals performing similar functions, such as architects and builders, who maintain, repair, extend and renew the national building stock. Lecturers and other educators in the building field will also find it to be a useful adjunct to their course material.

Scope of the book

Although books on flooring are few, there is no shortage of industry guidance on floors and flooring. The problem is that people do not use the guidance that exists.

To try to remedy that situation, the contents of this book are configured so that the principles, features and functions of floors and flooring are described first (Chapter 1). There needs to be sufficient discussion of principles to impart understanding of the reason for certain practices; without that understanding, practitioners will have difficulty following correct

procedures – or until they make the mistakes, or overlook precautions, as previous generations have done. The criteria presented in Chapter 1 are then related to the different types of floors and their finishes (Chapters 2–8).

The text concentrates on those aspects of construction which, in the experience of BRE, lead to the greatest number of problems or greatest potential expense if carried out unsatisfactorily. It follows that these problems will be picked up most frequently by maintenance surveyors and others carrying out remedial work on floors. Although most of the information relates to older buildings, surveyors may be called upon to inspect buildings built in relatively recent years. It is therefore appropriate also to include much material concerning observations by BRE of new buildings under construction in the period 1985–95.

Many of the difficulties which are referred to BRE for advice stem from too hasty assumptions about the causes of particular defects. Very often the symptoms are treated, not the causes, and the defects recur. It is to be hoped that this book will encourage a systematic approach to the diagnosis of floor and flooring defects.

The case studies provided in some of the chapters are selected from the files of BRE Advisory Service and the former Housing Defects Prevention Unit, and represent the most frequent kinds of problems on which BRE is consulted. They are not meant to be comprehensive in scope since the factors affecting

individual sites are many and varied.

As has already been said, this book is not a textbook on building construction. Hence, the drawings are not working drawings but merely show either those aspects to which the particular attention of readers needs to be drawn or simply provide typical details to support text.

Other more specific aspects of the subject not deemed to be relevant to this book are mentioned briefly in appropriate chapters – usually in the introductory paragraphs.

Passive fire protection measures are those features of the fabric, such as structural frames, walls and floors, that are incorporated into building design to ensure an acceptable level of safety. These measures, so far as they affect floors, are dealt with in outline in this book. Measures which are brought into action on the occurrence of a fire, such as fire detectors, sprinklers and smoke exhaust systems are referred to as active fire protection, and are not dealt with in this book.

The standard headings within the chapters are repeated only where there is a need to refer the reader back to earlier statements or where there is something relevant to add to what has gone before. We have assumed that readers will know many of the more common abbreviations used in the industry – DPC, PVC etc – and we have declined to spell them out.

This book deals with all kinds of floorings (ie floor coverings), including both in situ and manufactured products, and these are covered in detail in Chapters 5–8. A classification of floorings for use internationally has been published by the European Union of Agrément, and this is examined in more detail later in the book.

Ceilings, whether suspended or applied directly to soffits, are treated as integral parts of the element of floors since many aspects of performance, such as fire and sound, affect all parts of both floors and ceilings. Ceilings are mainly dealt with in Chapter 2.

Ramps, landings and stair treads are included as elements of floors, but not staircase enclosures. There is an argument for dealing with staircases in conjunction with walls since, in most cases, it is necessary to consider the enclosures for stairs in conjunction with stair flights; enclosures for staircases, and such matters as protected shafts, are therefore considered as elements of walls.

Much that is relevant to ordinary floor finishes applies also to stair tread finishes.

The weatherproofing aspects of balconies, insofar as they are similar to those of roofs, are dealt with in the book on roofs. Thresholds are handled as parts of external walls.

In many places through the book we have quoted British Standards and codes of practice which have been withdrawn; however they would have been current at the time a particular floor or flooring was laid. We have done this deliberately since they often gave better specifications than those now current. Indeed, in some cases, standards and codes have been withdrawn and not replaced. Copies of old standards and codes are often retained by BRE for use in disputes; they can also be seen in the British Library.

In the United Kingdom, there are three different sets of building regulations: the Building Regulations 1991 which apply to England and Wales; the Building Standards (Scotland) Regulations 1990; and the Building Regulations (Northern Ireland) 1994. There are many common provisions between the three sets, but there are also major differences. Although the book has been written against the background of the building regulations for England and Wales, this is simply because it is in England and Wales that most BRE site inspections have been carried out. The fact that the majority of references to building regulations are to those for England and Wales should not make the book inapplicable to Scotland and Northern Ireland.

We have deliberately not provided more than an outline of the major points which specifiers will need to take into account in the cleaning and maintenance of floorings since this is not a topic which has been studied in depth by BRE or its predecessor, the Building Research Station; in any case there is suitable literature available from industry sources and other publishers.

Some important definitions

Some of the more general terms used in floors and ceilings will be found in Section 1.3, Subsection 1.3.3 of BS 6100-1 (Glossary of building and civil engineering terms: General and miscellaneous).

Since the book is mainly about the problems that can arise in floors, two words, 'fault' and 'defect', need precise definition. Fault describes a departure from good practice in design or execution of design; it is used for any departure from requirements specified in building regulations, British Standards and codes of practice, and the published recommendations of authoritative organisations. A defect – a shortfall in performance – is the product of a fault, but while such a consequence cannot always be predicted with certainty, all faults should be seen as having the potential for leading to defects. The word 'failure' has occasionally been used to signify the more serious defects.

By 'floor' we mean the whole of the horizontal elements of a building (excluding roofs but including ceilings); 'flooring' refers simply to the finish of the upper surface of the floor.

Where the term 'investigator' has been used, it covers a variety of roles including a member of BRE's Advisory Service, a BRE researcher or a consultant working under contract to BRE.

'Topping' has been used to describe an in situ material laid to provide good abrasion resistance and to provide the wearing surface. It has also been used to refer to a cementitious mix used to lock together components of a structural concrete floor, such as hollow pots, where it is called a structural topping.

'Underlay' is a layer used between the structural deck or slab and the flooring, either prefabricated (eg plywood or hardboard) or a thick in situ layer (eg mastic asphalt or aggregate filled latex cement). 'Underlayment' is in situ material used to smooth or level the base prior to laying the flooring. (The term underlay seems to have become restricted to preformed substrates and the term underlayment to those formed in situ, and we have adopted this distinction. However, in other industry publications and documents the former term will be found to apply to both applications.)

'Wear' is the progressive loss from the surface of a material or component brought about by mechanical action.

Acknowledgements

Photographs which do not bear an attribution have been provided from our own collections or from the BRE Photographic Archive, a unique collection dating from the early 1920s.

To the following colleagues – many from the BRE Scottish Laboratory and the Fire Research Station – and former colleagues who have suggested material for this book or commented on drafts or both, we offer our thanks:

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We have also drawn upon some notes prepared by the late Dr Frank Harper and the late Wilfred Warlow. In addition, we acknowledge the contributions of the original, though anonymous, authors of *Principles of modern building*, Volume 2, from which several passages have been adapted and updated.

PWP
HWH
August 1997

Second edition

This revised edition of *Floors and flooring* embodies a considerable number of changes from the first edition, particularly with respect to changes to standards and codes, and to building regulations.

Major changes will be found to the section concerned with revised guidance for identifying radon affected areas (Chapter 1.5); to the section on tests for sound insulation which has been amended by the introduction of pre-completion testing (PCT) by Approved Document E (2003) of the Building Regulations (Chapter 1.8); and to the chapter on panel products (Chapter 8.5) following the preparation of performance specifications and confirmation of former draft International Standards.

The opportunity has also been taken to update references to the hundred or so British Standards mentioned in the first edition.

PWP
HWH
July 2003

Chapter 1.9

Durability

This is a general chapter which includes information relevant to all kinds of flooring – information relevant to a particular kind of flooring, such as typical wear rates on a particular surface, will be given in the appropriate later chapter.

Floor finishes may be considered to provide for the following main functions:

- protection of the structural floor
- better appearance
- increased comfort and safety

The relative importance of these functions varies according to circumstances and budgets.

However, one of the most important attributes is the maintenance of the functions over time; in other words, the finishes must be durable. Because of its importance, durability has often been regarded as a basic property of a floor finish, but it represents only the length of time that the chosen properties persist and depends as much on the conditions of use as on the properties of the finish⁽⁹⁸⁾.

Many factors influence the life of a floor finish:

- wear
- water and other liquids
- indenting loads and impacts (Figure 1.61)
- sunlight
- insects
- moulds and fungi
- high temperature

as well as the fundamental properties of the materials and adhesives used, and the compatibility of these with other parts of the structure and its behaviour in use.



Figure 1.60

The durability of any flooring is governed ultimately by the kind of use it gets, particularly by heavy wheeled vehicles



Figure 1.61

This industrial floor has suffered very heavy wear in spite of the robust finish. It has been subjected to piecemeal replacement. The wheel tracks of mechanical handling equipment can be seen

The European Union of Agrément (UEAtc) have given priority, in their Method of Assessment and Test covering innovative floorings, to assessing the conditions of service for floorings using what has been called the UPEC system. UPEC is the French acronym for wear (usure) index 1–4, indentation (poinçonnement) index 1–3, water (eau) index 0–3, and chemicals (chimiques) index 0–3 (UEAtc Method of Assessment and Test No 2⁽²⁵⁾). Given the existence of an Agrément certificate for a particular product, therefore, a surveyor should be able to make a judgement on its performance. UEAtc and the British Board of Agrément (BBA) have also issued further guidance on the assessment



Figure 1.62

This paint finish is breaking up. There is little substance to resist further wear

of plastics floorings (UEAtc Methods of Assessment and Test No 23⁽⁹⁹⁾ and No 36⁽¹⁰⁰⁾, and BBA Information Sheet No 2⁽¹⁰¹⁾). These are referred to in greater detail in the appropriate later chapters. Experience has shown that there is a relationship between wear and indentation of PVC floorings; these floorings, invariably, have a C index of 2. For PVC floorings, it has therefore been found possible to omit the C rating, and to combine the U and P ratings into a single G classification (1–5).

Of all the performance factors described above, wear is perhaps the most influential because:

- it is unavoidable in normal use
- it applies to all kinds of flooring
- in many cases, it can be very obvious to users when it occurs

Expected life of floorings

There is a British Standard on durability, BS 7543⁽¹⁰²⁾, which applies to floors and flooring. It gives general guidance on required and predicted service life, and how to present these requirements when preparing a design brief.

The service life of a floor covering depends as much on the conditions in the building and the degree of use as on the inherent properties of the material and the techniques adopted in laying it. However, even bearing in mind the comparative ease of replacement of many thin floorings, building users should have a reasonable expectation of a minimum service life for a properly

selected flooring, taking all circumstances into account. What that minimum might be is a matter for debate, but UEAtc have decided on 10 years, and BRE would not dispute that figure⁽²⁵⁾.

Durability is affected by the care and skill with which the floor is laid, and the behaviour of the subfloor, as well as by the choice of material itself. Failure to provide adequate dampproofing and ventilation, and a sound screed, can lead to serious deterioration in finish; for example as buckling of wood block floors or loss of adhesion in tiled or painted finishes (Figure 1.62).

Resistance to wear

All floor surfaces wear to some degree when subjected to foot or wheeled traffic. There may also be other factors including the movement of furniture, which may scrape or cut the surface, and the movement of heavy loads such as in warehouses. However, using the definition of wear as the progressive loss from the surface of a body brought about by mechanical action, it is not just the quantitative loss of material which is important but also the qualitative assessment of the condition of the worn surface.

Where changes in appearance are

involved, the assessment becomes more and more subjective.

Wear and damage can be considered to arise from a number of causes:

- mechanical action (leading to progressive loss of substance)
- abrasion caused by fine solid particles
- cutting by the action of vehicles (eg trolleys) and furniture
- corrosion from spillages
- degradation from soluble salts rising from the subsoil or entrapped moisture in concrete
- fatigue in the surface material
- movement or rocking from uneven or friable bedding causing chipping of arrises of slabs or tiles

There has been considerable concern since the 1960s with the degree of wear of floors in heritage buildings. This is dealt with in detail in Chapters 5.2 and 5.5. In some cases, depending of course on the material involved, it is evident that wear of around one millimetre in ten years is occurring⁽¹⁰³⁾.

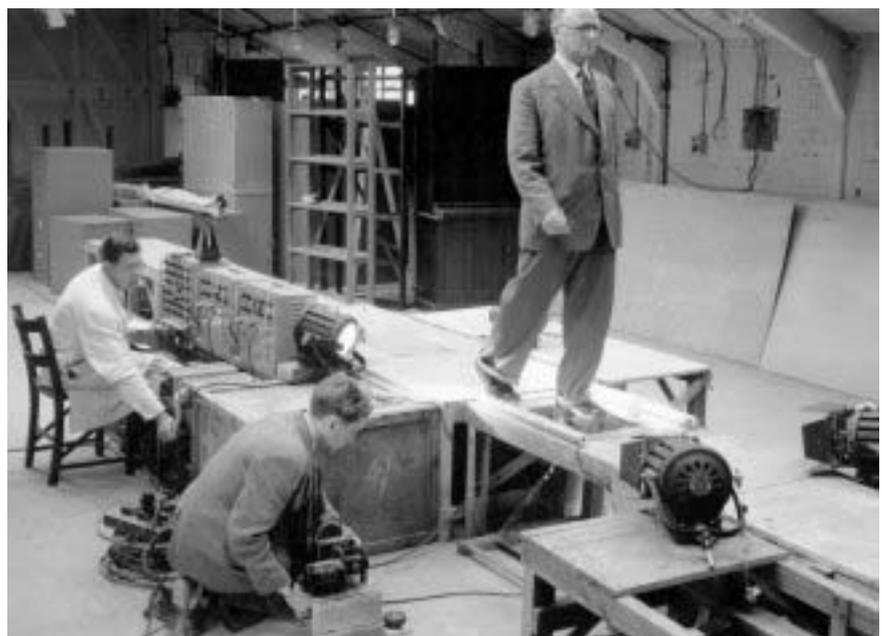


Figure 1.63

Measuring the forces applied by foot traffic to flooring. Although these tests were conducted in the late 1950s, the results still apply