Recommendations for the Inspection, Maintenance and Management of Car Park Structures

Recommendations for the Inspection, Maintenance and Management of Car Park Structures

Second edition

**Edited by
Chris Whapples and Leo McKibbins**

Published by ICE Publishing, One Great George Street, Westminster, London SW1P 3AA.

Full details of ICE Publishing representatives and distributors can be found at:
www.icebookshop.com/bookshop_contact.asp

Other titles by ICE Publishing:

Car Park Designers' Handbook, Second edition.

J.D. Hill *et al.* ISBN 978-0-7277-5814-9

Earthquake Design Practice for Buildings, Third edition.

E. Booth. ISBN 978-0-7277-5794-4

Designers' Guide to Eurocode 4: Design of composite steel and concrete structures, Second edition (EN 1994-1-1).

R.P. Johnson. ISBN 978-0-7277-4173-8

www.icebookshop.com

A catalogue record for this book is available from the British Library

ISBN 978-0-7277-5839-2

© Thomas Telford Limited 2018

ICE Publishing is a division of Thomas Telford Ltd, a wholly owned subsidiary of the Institution of Civil Engineers (ICE).

All rights, including translation, reserved. Except as permitted by the Copyright, Designs and Patents Act 1988, no part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying or otherwise, without the prior written permission of the Publisher, ICE Publishing, One Great George Street, Westminster, London SW1P 3AA.

This book is published on the understanding that the authors are solely responsible for the statements made and opinions expressed in it and that its publication does not necessarily imply that such statements and/or opinions are or reflect the views or opinions of the publishers. While every effort has been made to ensure that the statements made and the opinions expressed in this publication provide a safe and accurate guide, no liability or responsibility can be accepted in this respect by the authors or publishers.

While every reasonable effort has been undertaken by the authors and the publisher to acknowledge copyright on material reproduced, if there has been an oversight please contact the publisher and we will endeavour to correct this upon a reprint.

Commissioning Editor: Rachel Gerlis

Development Editor: Maria Inês Pinheiro

Production Editor: Madhubanti Bhattacharyya

Market Development Executive: Elizabeth Hobson

Typeset by The Manila Typesetting Company

Index created by Nigel d'Auvergne

Printed and bound in Great Britain by Latimer Trend, Plymouth

Contents

	Foreword to the second edition	vii
	About the editors	ix
	About the contributors	xi
	Acknowledgements	xiv
	Glossary	xv
	PART I: Recommendations for owners and operators: car park structures, responsibilities and management	
01	Introduction and scope	3
02	Car park structures	5
03	Responsibilities of owners and operators	11
04	Legal overview	15
05	Action for owners and operators	19
06	Life-care plan	23
	6.1. Background	23
	6.2. The benefits	23
	6.3. Obligations for owners and operators	24
	6.4. Getting started	24
	6.5. Preparation	24
	6.6. Records	25
07	Main recommendations of Part I	27
	PART II: Recommendations for engineers and other professional advisors: the development and implementation of life-care plans	
08	Structural defects and deterioration	31
	8.1. Introduction	31
	8.2. Reinforced concrete	31
	8.3. Prestressed concrete structures (pre- and post-tensioned concrete)	33
	8.4. Steel structures	35
	8.5. Composite slabs with steel decking	36
	8.6. Vehicle containment systems (including edge protection, cladding, fencing)	36
09	Non-structural defects and deterioration	39
	9.1. Decoration (above deck level)	39
	9.2. Lighting, trunking and conduits	39
	9.3. Signage, deck-based parking bay and traffic management markings	41
	9.4. Fire safety	41
	9.5. Deck coatings	41
	9.6. Joints	43
	9.7. Drainage	43
10	Daily surveillance and routine inspection	47
	10.1. Preparation	47
	10.2. Daily surveillance	47
	10.3. Routine inspection	48

11	Condition surveys and special investigations	51
	11.1. Overview	51
	11.2. Baseline condition survey	51
	11.3. Subsequent condition surveys	53
	11.4. Detailed inspection	53
	11.5. Structural investigation	56
	11.6. Actions following the condition survey	61
	11.7. Special investigation	62
12	Structural appraisal	65
	12.1. Overview	65
	12.2. The baseline structural appraisal	65
	12.3. Subsequent structural appraisals	66
	12.4. When to undertake a structural appraisal	66
	12.5. The structural appraisal	66
	12.6. Summary of principal actions for a structural appraisal	69
	12.7. Detailed considerations for structural adequacy checks	70
13	Options for maintenance, repair, rehabilitation and replacement	75
	13.1. Objectives	75
	13.2. Assessing options for concrete structures	77
	13.3. Assessing options for steel and composite structures	83
	13.4. Routine maintenance	83
	13.5. Protection, repair and rehabilitation or replacement	85
	13.6. Residual life assessment	91
14	Health and safety of personnel on site	95
	14.1. General	95
	14.2. Common hazards	95
	14.3. Personal protective equipment	96
15	Risk-based evaluation activities	99
	15.1. Introduction	99
	15.2. Risk-based process	101
	15.3. Use of risk-based approaches	101
	15.4. Inspections, surveys and appraisals	104
	15.5. Category A structures	105
	15.6. Category B structures	108
16	Development of the life-care plan	115
	16.1. Background	115
	16.2. Preparation of the life-care plan	115
	16.3. Retention	116
17	Main recommendations of Part II	117
Appendix A	Useful web sources	119
Appendix B	Background of design, construction and structural performance	121
Appendix C	Defects, cracking and deterioration processes in structural concrete	129
Appendix D	Testing and monitoring concrete and steel materials and components	133
Appendix E	Typical life-care plan	137
	Index	151

Foreword to the second edition

I am delighted to introduce the Institution of Civil Engineers' *Recommendations for the Inspection, Maintenance and Management of Car Park Structures*, Second edition. It's long overdue. Some would say that's also true for proper and effective life-care planning for many of Britain's ageing car parks.

People don't park to park. They park on their journey to do something else – to work, to shop, to play – and the quality of the parking is the first and last impression of that experience. Making sure your customers and clients have a good experience in your parking facility says a lot about you and what you think of them.

There's no such thing as a free parking place – somebody is paying for it. So-called free parking is subsidised in some way, whether by council tax payers, business rate payers or a commercial operator. Regardless of whether motorists pay directly for their parking or not, they deserve good quality, well-maintained and properly serviced parking facilities.

In the first edition, published in 2002, Adrian Long, then president of the Institution of Civil Engineers, commented: 'There are well over 4000 multi-storey car parks in the UK and many have a history of early deterioration, structural defects and safety shortcomings due to poor design and construction and low standards of maintenance and repair.' Is it any better today? Of course, it is. But there is much more to do!

Good-quality, well-designed and properly maintained car parks can contribute significantly to the prosperity of Britain's towns and cities. At the British Parking Association (BPA), we work diligently towards this by sharing best practice and the promotion of safer parking through Park Mark. We have also used Park Mark as a vehicle (excuse pun) to raise awareness of the importance of proper and effective life-care planning. Complimentary literature is entitled *Safe...and Sound?*, emphasising the importance of parking facilities not only being crime-free but safe to use, both by operators' employees and their customers.

I've seen examples of some fantastic car parks. I've also seen a car park or two where I almost dare not go in without a safety helmet – hardly the experience you would want to deliver to a discerning motorist. Seriously, I once went into a car park, in London, which was open to the public, and where the crumbling and spalling ceiling was held in place by wire mesh, and with adjustable steel props alongside columns in so many places it looked like a Meccano set. Scary! Needless to say, it didn't achieve Park Mark, which was my purpose for being there. I'm pleased to say it's no longer standing, having been closed and subsequently redeveloped.

As a civil engineer myself, I fully appreciate the importance of life-care planning for the assets which make up the built environment: and as a parking professional I admire the 'art of parking' created by my fellow colleagues; as a consumer I want to be able to park my car as quickly and as effectively as I can and get on with the business in hand, be it work or play; this is especially true if I have children with me.

Equally important is my need to feel intuitively safe and welcome wherever I choose to park. Complex layouts, frustration with queues and conflict with others who are manoeuvring in or out of parking spaces, or sometimes in what seems like a never-ending set of twists and turns to get in or out of the car park in the first place, only serve to increase my sense of being 'uncared for' by the owner or operator. Likewise, if I get the impression it is not properly serviced and maintained.

I have known Chris Whapples for many years and admire his tenacity and ambition to ensure that Britain's car parks are properly serviced and maintained. He brings his own style of humour and intelligence to bear; he certainly convinced me all those years ago when we were setting up the BPA's Structures and Asset Management Group. Ever since then I have shared his ambition, if not his tenacity. Chris and Leo complement each other well and, together with the other specialist chapter authors, we have a formidable team of experts. Collectively they

have produced a world-class set of recommendations on how you can efficiently and effectively take care of a parking structure, be it a fully fledged multi-storey car park, an underground or basement car park or, indeed, any car park which has structural elements.

Importantly, this second edition recognises that there is no such thing as a ‘one size fits all’ regime for every car park in the country. Indeed, instead of recommending regular inspections of increasing invasiveness, we are now recommended to adopt a risk management approach right from the outset at the design and build stage, if needs be. This means that designers, owners and operators can tailor their life-care planning to suit the environment where the parking structure is situated; the nature of its design and materials used for construction and its expected performance in service. Levels of use, the kinds of vehicle and the demographics of users can all be considered when designing and implementing the most appropriate life-care plan too. No more excuses: it’s not too difficult, too invasive, too expensive or too anything. Other than too late if you don’t do it, and the unthinkable occurs and your car park is closed for safety reasons, or worse, it suffers a structural failure of some kind.

If I were still a practising car park designer, owner or operator, this publication would be close to hand. Always!

Kelvin Reynolds IEng FIHE FBPA DipHTE(Middx)
Director of Corporate and Public Affairs
British Parking Association

About the editors

Chris Whapples BSc (Hons) CEng FStructE FICE

Chris is a consultant to Stripe Consulting and has over 35 years' experience as a civil and structural engineer. He became interested in the design and construction of multi-storey car parks and the betterment thereof, and is the joint owner of a patent for a vehicle circulation system known as the VCM system. He has worked on many structured car parks both at home and overseas and became a member of the Institution of Structural Engineers task group to update the design recommendations for multi-storey and underground car parks. He has been a member of a number of European technical committees relating to durability, repair, inspection and maintenance of concrete structures.

Chris has worked in association with the Transport Research Laboratory in developing new standards for testing vehicular impact barrier systems, and his specialist knowledge has enabled him to present several technical papers. For several years Chris has been a judge for the British Parking Awards. In 2006 he was awarded the Ernest Davies Award for advancing parking knowledge, and in 2015 a lifetime achievement award for his outstanding contribution to the sector.

Leo McKibbins BSc (Hons) MSc CEng MIMMM MIAM

Leo is a technical director in the metros and civils division of the employee-owned global management and engineering consultancy Mott MacDonald, where he has worked for nearly 20 years, and he currently leads their civils asset management (CAM) team based in Croydon, UK. He previously worked for Sandberg Consulting Engineers. A specialist in asset management and construction materials technology, he supports asset owners by understanding the current and future performance of their structures and developing strategies to evaluate and manage risk. His experience has been gained through the technical leadership of a diverse portfolio of projects involving the durable design and specification of new structures and the assessment, protection, repair and rehabilitation of existing structures across a range of sectors, including not only car parks but also tunnels, bridges, buildings, reservoirs and power and water utility structures, operating in a variety of service environments in the UK and overseas. He is an active member of several technical and working groups and the author of industry guidance on the management of a range of civil engineering assets.

About the contributors

Barry Ayres BSc CEng DMS FStructE MRICS

Barry is currently senior structural engineer with the London borough of Bromley, after spending 6 years with consultants, and being responsible for a wide range of engineering projects. He was until recently the chairman of the Association for Structural Engineers of London Boroughs (ASELB) and chaired the National Steering Committee/Monitoring Group for the first edition of *Recommendations for the Inspection, Maintenance and Management of Car Park Structures*.

EurIng Dr Richard Barnes BSc MPhil PhD CEng MICE MICT FHEA ILTM

Richard joined The Concrete Society in 2006. A chartered civil engineer and formerly a lecturer at Cranfield University (Royal Military College of Science) and senior research officer, he has an extensive and up-to-date knowledge of concrete technology. He currently acts as a senior advisory engineer and has contributed to society publications on permeability, foamed concrete, formwork, visual concrete, water-resisting admixtures, cementitious materials and the analysis of hardened concrete.

Simon Bladon MSc

Simon is the survey manager for CRL Surveys. As an industrial petrologist, he specialises in the assessment of buildings and structures for alteration, strengthening, repair and refurbishment. He has over 30 years' experience both within the UK and the overseas construction business community, having worked with consultants, contractors and owners.

John Carpenter CEng FICE CFIOSH

John Carpenter is an independent consultant and past secretary to the Standing Committee on Structural Safety and of the Temporary Works Forum, specialising in safety risk management. He is the author of several Health and Safety Executive research reports related to education, health, competence and building safety and is the co-author of the Construction Industry Research and Information Association guide *Safe Access for Maintenance and Repair*, and *Safer Surfaces to Walk On*. John is also an established training provider and author of numerous papers on the management of safety risk.

Richard Day BSc FICT

Richard Day joined the Concrete Society in 1997. His previous employment for 9 years involved R & D projects and consulting to the construction companies under the Kvaerner (now Skanska) banner, a short period with Travers Morgan as a materials engineer and some 7 years with Sir Robert McAlpine. He is responsible for the management of the society's technical activities, including advisory service, standing committees, publication development and information provision.

Peter Guest BSc MSc DipTE MCIT

Peter Guest has been involved in parking for over 45 years. Starting in local government as a researcher in 1972, he moved to consultancy in 1987, working in Europe, the USA, the Middle East, India and South-East Asia. Peter is a past president of the British Parking Association and an honorary member of the Croatian Parking Association. He contributed to the Institution of Structural Engineers' *Design Recommendations for Multi-Storey and Underground Car Parks* (2011) and The Chartered Institution of Highways and Transportation's *Parking Strategies and Management* (2005). He was a member of the European Parking Association Panel of Experts and secretary of the EPA group responsible for the EPA Standard Parking Award and a judge for the British Parking awards. He is co-author of the book *Traffic Engineering Design* (Butterworth-Heinemann, 2005) and writes a regular column for the US publication *Parking Today*.

EurlIng Dr Davies M. Mulenga BEng MSc Eng PhD CEng MICE MVDI

Zambian-born, Davies is managing director of Huebl Gruppe (Huebl Group) and a chartered civil structural engineer. He was formerly a technical expert and asset management specialist in CH2M HILL, with over 23 years of experience in civil structural engineering and management, including materials, research, design, construction, assessment and maintenance of structures. Also principal structures consultant, Davies has worked on several high-profile projects in Europe and overseas, most recently as the lead specialist reviewer and DN structures asset manager for the £6.2 billion M25 design–build–finance–operate project in London.

Mark Pundsack BEng(Hons) CEng MStructE MRICS

Mark is both a Chartered Surveyor and Chartered Structural Engineer. Working as a Building Control Officer he is involved in all aspects of building structures and has particular knowledge of Building Regulations, Accessibility and Fire Engineering. Through his working life, he has been involved in assessing some of the largest buildings in the country, all of which incorporate car parking in some form.

Andrew Rattray BSc CEng MICE

Andrew is a chartered civil engineer with over 35 years' experience of the construction industry. He started work as a civil and structural design engineer before joining the Health and Safety Executive as a specialist inspector providing professional and technical advice on the health and safety aspects of civil engineering and building-related topics; the role also includes the investigation of a range of construction accidents and incidents.

Ian Raybould BSc CBuildE MCABE MCIQB MBIFM

Ian is presently responsible for delivering all aspects of statutory compliance, construction, maintenance and refurbishment works across a £1.6 billion estate comprising over 700 sites spread throughout the UK for one of the UK's largest private car park operator, National Car Parks (NCP). Ian joined the NCP in 1997 to restructure the technical services department and to ensure that a robust and diligent approach to inspecting and managing its aged estate was implemented along with the development of detailed life care plans to highlight any sensitivities and mitigate future risks.

Peter Robery BSc PhD CEng FEng FICE FCS MICT MIAM

Peter is director of Robery Forensic Engineering and Royal Academy of Engineering visiting professor in forensic engineering at the University of Birmingham. Formerly, he was lead technical expert for concrete durability, maintenance and repair in CH2M and internationally recognised through fellowship of the Royal Academy of Engineering and the Institution of Civil Engineers (ICE). In his 35 years of experience, Peter has served as president of the Concrete Society and teaches concrete testing, maintenance and repair at the University of Leeds, where he is also a visiting professor. Peter served on the steering committee for the first edition of the *ICE Recommendations for the Inspection, Maintenance and Management of Car Park Structures* and is co-chair for this second edition of the publication. He has also served on the Institution of Structural Engineers committee responsible for the latest edition of its car park design guidance.

Russell Simmons BSc (Hons) MCIQB CBuildE MCABE MCIHT MBPA AMICE

Russell is director and founder of Stripe Consulting, a multi-disciplinary practice specialising in car park structures. He has been project lead on many high-profile car park rejuvenation and refurbishment projects and is trusted by local authorities and private sector clients alike to deliver specialist services relating to car park structures. Russell is also currently chair of the Structures and Asset Management Special Interest Group at the British Parking Association and has won several industry awards, including Parking Person of the Year and Young Parking Professional of the Year. Reportal (a **life-care plan** system) was developed by Russell at Stripe in 2013.

Alastair Soane BSc PhD CEng FICE FStructE

Alastair is the director of Structural-Safety, the UK group encompassing Confidential Reporting on Structural Safety (CROSS) and the Standing Committee on Structural Safety (SCOSS). He has extensive experience on UK and international construction projects and is a former member of the Building Regulations Advisory Committee for England and chair of the advisory panel on part A structures. Alastair is a member of the Ethics Committee of the Royal Academy of Engineering, the Advisory Group on Temporary Structures, IStructE committees, and a visiting professor of civil engineering at Liverpool University.

Acknowledgements

The authors would like to thank Mr Shy Jackson of Pinsent Masons LLP for providing the legal review of Chapter 4 and Michael Grantham for his contributions to Chapter 11.

Note to readers:

There was a fire in a multi storey car park in Liverpool on 31 December 2017 which totally destroyed 1390 cars.

The ICE Recommendations are aimed at promoting inspecting and maintaining car parks together with preparing and implementing life-care plans to ensure that car park structures and edge protection remain safe. To incorporate fire considerations would require the scope of the Recommendations to be broadened.

While Structural-Safety published a SCOSS Alert in February 2018 (Fire in Multi-Storey Car Parks – February 2018 <<http://www.structural-safety.org/media/426735/scoss-alert-fire-in-multi-storey-car-parks.pdf>>) with interim advice, it is considered that fire considerations are a subject in their own right and separate guidance appertaining to car parks will be issued in due course.

Glossary

Note: terms used in the glossary are denoted in bold in the text.

Asset management database A system (paper-based or electronic) that stores and makes available documents and other information used in the course of operating, managing and maintaining a car park asset throughout its entire life.

Assistant A person with knowledge of car park structures and the deterioration processes likely to be present who, through training, is competent to carry out **routine inspections** using a checklist under the supervision of the **engineer** or the **inspector**.

Baseline condition survey The first **condition survey** carried out on a car park, which should provide a detailed and comprehensive baseline against which future change is measured.

Car park A place for parking or storage of motor vehicles up to 2500 kg in weight, including motorcycles and cycles, that may comprise a surface site, a structured car park, be it standalone or part of a mixed-use development, a basement or rooftop car park or any bridging element that is a functional requirement of the car park.

Car park structure Primary framework essential to the support and stability of a multi-storey car park, including cladding and protection at changes in level, key and secondary elements, elevated access ramps/ bridges and retaining walls.

Category A or B car park Categories assigned to individual car park structures for the purpose of determining the maximum intervals between **evaluation activities** in accordance with Chapter 15 of this guidance.

Cladding External components fixed to the car park structure.

Condition survey An evaluation of the condition of a car park structure, its cladding and edge protection, comprising a **detailed inspection** and, where appropriate, a **structural investigation**. Undertaken at intervals in accordance with the **life-care plan**, the first on any structure being referred to as the **baseline condition survey**, against which future change is assessed.

Daily surveillance Visual observation and reporting of equipment breakdown, drainage failure and obvious deterioration and damage to the car park structure or waterproofing, cladding and edge protection, and of untoward incidents while in service. Usually carried out by the **owner/operator's** own staff, who should have received from the **engineer** some basic training and direction in terms of identifying and recording potentially significant issues and changes.

Detailed inspection A close visual and tactile inspection of the structure, including its cladding, edge protection and any other defined elements of the car park, undertaken at touching distance. Will usually be carried out by the **inspector** or the **engineer** and requires special access provisions and removal of any items obscuring structural elements, such as non-structural cladding/panelling. Undertaken at intervals in accordance with the **life-care plan**.

Edge protection A barrier or restraint at changes in level to contain errant vehicles (vehicle impact barrier) and/or to protect pedestrians (pedestrian guarding).

Engineer A chartered civil or structural engineer with appropriate experience of car park structures and competency to take the lead in advising an **owner/operator** on structural safety and on the management, inspection, maintenance and repair of a car park structure, cladding, edge protection, drainage and waterproofing.

Evaluation activities A collective term referring to the inspection, survey and appraisal/assessment activities that are carried out in the course of managing and maintaining a car park structure, specifically, as defined in this guidance: **daily surveillance**, **routine inspections**, **condition surveys** (including **detailed inspections** and **structural investigations**), **structural appraisals** and **special investigations**.

Inspection and maintenance strategy A strategy involving inspections and maintenance of a car park structure meeting the requirements of the design and the **life-care plan**.

Inspector A competent person by virtue of qualifications and experience to work under the guidance of the **engineer**.

Issue of concern An actual or potential deficiency in the structure of the car park (including its cladding and edge protection) or a feature, state or situation that might reasonably be expected to give rise to such a deficiency.

Key element A component of a structure, as defined in the Building Regulations Approved Document A – Structure (2004 edition incorporating 2010 and 2013 amendments), where the notional removal would result in an extent of damage in excess of acceptable limits.

Life-care plan A documented managed approach to the inspection, maintenance and management of a car park structure, cladding, edge protection, drainage and waterproofing which is derived by the **engineer**, agreed with the **owner/operator** and implemented throughout the entire life of the facility, including demolition.

Maintenance Action taken to reinstate the functionality of a car park structure or its components to an acceptable level of safety or serviceability, typically involving routine and relatively minor activities such as like-for-like replacement or limited repairs.

Owner/operator A term used in this guidance to refer to either party. The owner is the freehold or leasehold owner of the multi-storey car park. The operator may be the owner or a third party acting on behalf of the owner and is responsible for the operation and use of the car park.

Rehabilitation The repair and refurbishment of a part or the whole of a car park structure.

Repair Action taken to reinstate or mitigate the effects of damage or deterioration that has resulted, or could result, in a loss of function of the structure (including for cosmetic purposes where this is a function of the structure).

Retention of records The **life-care plan** and health and safety file, including all other records relating to the structure of the car park, cladding and edge protection should be retained for the life of the facility by the person responsible for the safety and upkeep of the car park. The record keeper is normally the owner or the operator or an appointed representative, whose contact details should be regularly updated and accessible to those persons requiring access.

Risk-based assessment An assessment that is based on an evaluation of risk, used here as a basis for specifying the maximum intervals between **evaluation activities** for a car park structure based on a qualitative consideration of factors, including its original form, its current condition and its potential for loss of serviceability or structural integrity, as described in Chapter 15.

Robustness The ability of a structure subject to accidental or exceptional loading to sustain damage to some structural components without experiencing a disproportionate degree of overall distress or collapse.

Routine inspection A visual inspection of the structure, cladding, edge protection and any other defined aspects of the car park undertaken from normal vantage points with no special access provisions. Carried out by an **assistant** working under the supervision of the **inspector** or the **engineer** using a pre-prepared checklist to ensure comprehensive observation and recording of condition. Undertaken at intervals in accordance with the **life-care plan**.

Special investigation Additional non-scheduled inspection and/or investigation that is carried out when the need arises to find out more about a particular feature, element or defect, or in response to an event or action on the car park structure. Usually undertaken by the **engineer** and targeted at a particular structural detail, element or location.

Structural adequacy check An assessment of the structural adequacy of the car park to sustain safely the loads/actions for which it was originally designed, and/or that are anticipated to arise in the course of its service life, with an adequate factor of safety. The check should reflect the current condition of the structure based on information from a **condition survey**, and take account of any damage or deterioration that might affect its capacity. Usually carried out by the **engineer** as part of an overall **structural appraisal**, but may also be in response to concerns over the structural adequacy of a particular element or area of the structure following an observed change in condition.

Structural appraisal A comprehensive evaluation of the current and potential future structural adequacy and safety of a car park, including cladding, edge protection and fixings using information from a **condition survey** (including both a **detailed inspection** and a **structural investigation**) and a **structural adequacy check**, supplemented by a review of historic records, and taking into account its environment, likely usage, the likely implications of current and potential future deterioration and anticipated service life. The first such appraisal of a structure is known as the **baseline structural appraisal** and provides a benchmark against which change will be measured through time. Subsequent structural appraisals either full or partial may be required from time to time or in response to an event or action on the structure as determined by the **engineer** and recommended in the **life-care plan**.

Structural integrity The ability of structural components to act together as a single entity.

Structural investigation An investigation of a car park structure that involves methods other than visual and tactile inspection, for example, materials sampling and testing and measurement by intrusive or non-intrusive means in order to determine or verify construction details, characterise current condition and evaluate performance. Carried out by the **inspector** or the **engineer** (typically with the assistance of a specialist investigation contractor) as part of a **condition survey**, **structural appraisal** or a **special investigation**, as required.