# Structural stability of buildings during refurbishment

# Who we are

CIRIA members lead the industry in raising professional standards through collaboration, sharing knowledge and promoting good practice. Recognised as leaders in industry improvement, CIRIA's members represent all construction stakeholder groups including clients, contractors, consultants, public sector champions, regulators and academia.

CIRIA membership provides organisations with a unique range of business development and improvement services, focused on sharing and embedding research, knowledge and good practice. In addition to the many direct benefits, membership provides a wealth of opportunities for organisations to engage in shaping, informing and delivering industry solutions focused on innovation and improvement.

In addition to representing excellent value for money in terms of direct benefits, CIRIA membership delivers significant returns for organisational investment in business improvement and development, CPD, industry engagement, profile enhancement and collaborative research.

CIRIA membership allows your employees to access the full breadth of CIRIA resources and services, creating valuable networking, performance improvement and leadership opportunities.

In addition to CIRIA membership, there is a range of specialist community of practice memberships available:

- **CIRIA book club**
  The CIRIA book club allows you to buy CIRIA publications at half price – plus free copies of all new guidance for Gold subscribers.
- **Local Authority Contaminated Land (LACL) network**
  LACL helps local authority officers to address responsibilities and duties involving land contamination and redevelopment.
- **Brownfield Risk Management Forum (BRMF)**
  BRMF provides comprehensive support to all construction, environmental, financial and legal professionals working on brownfield projects.
- **European Marine Sand And Gravel Group (EMSAGG)**
  EMSAGG provides a forum for the marine aggregate industry across Europe to discuss sector issues and exchange ideas and learning.

# Where we are

Discover how your organisation can benefit from CIRIA's authoritative and practical guidance – contact us by:


Post Griffin Court, 15 Long Lane, London, EC1A 9PN, UK
Telephone +44 (0)20 7549 3300
Fax +44 (0)20 7549 3349
Email enquiries@ciria.org
Website www.ciria.org


For details of membership, networks, events, collaborative projects and to access CIRIA publications through the bookshop.

CIRIA C740 London, 2017

# Structural stability of buildings during refurbishment

*A Gilbertson, Gilbertson Consultants Ltd*

Griffin Court, 15 Long Lane, London, EC1A 9PN
Tel: 020 7549 3300 Fax: 020 7549 3349
Email: enquiries@ciria.org Website: www.ciria.org

# Summary

HSE inspectors who attend sites have reported that while larger contractors had made strides in improving the health and safety of workers on their sites, smaller contracting companies, often engaged in smaller refurbishment projects, were of more concern. CIRIA has prepared this guidance to provide information to these smaller companies, as well as providing general guidance for clients, designers and contractors. Messages to government are also presented, based on feedback from industry.

The guidance has been prepared following a period of consultation with industry bodies and individuals. It is presented as a series of downloadable toolbox talks (TBTs) that address individual topics. It is expected that following publication, the information provided will be improved by further industry comment and research on particular topics. Feedback to CIRIA will be welcomed and the TBTs will be revised as necessary.

**Structural stability of buildings during refurbishment**

Gilbertson, A

*CIRIA*

C740 RP1020 © CIRIA 2017 ISBN: 978-0-86017-775-3

Updated with errata July 2020

**British Library Cataloguing in Publication Data**

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

| **Keywords** | |
|---|---|
| Health and safety, building and construction technology, building and facilities management, civil and ground engineering, construction and materials products, construction process and management | |
| **Reader interest** | **Classification** |
| Health and safety, structural stability and risk assessment, small-scale and domestic refurbishment, CDM, temporary works | Availability: Unrestricted<br>Content: Advice/guidance<br>Status: Committee-guided<br>Users: Clients, designers, specifiers, contractors, constructors, regulators, structural engineers, temporary works designers |

Published by CIRIA, Griffin Court, 15 Long Lane, London, EC1A 9PN, UK

# Acknowledgements

This guide is a result of Research Project (RP) 1020 and was written by Alan Gilbertson drawing upon information provided from the construction industry.

## Author

### *Alan Gilbertson*

Alan is a chartered structural engineer who worked for Atkins until 2002 and is now an independent consultant. He has worked on a wide variety of projects and has experience of all types of structural work, including both permanent and temporary works and on domestic construction and larger projects. At Atkins, Alan was responsible for the preparation of specifications for structural work, designed to communicate clearly to constructors exactly what was required. Associated guidance notes were also prepared to assist designers. Lessons learned were fed back into their improvement, under his guidance. Alan's recent experience as an independent consultant has enabled him to interact with many other designers and constructors, providing access to much experience and many events that are poorly documented, but of significance to the industry. In preparing this guidance, Alan has drawn upon both his own experience and the experience of others, and he firmly believes that it is through such collaboration the construction industry will learn and improve.

## Project steering group

The project steering group (PSG) comprised the following:

| | |
|---|---|
| Kevin Blunden | Chartered Association of Building Engineers |
| Paul Bussey | Royal Institute of British Architects |
| Howard Button | National Federation of Demolition Contractors |
| Peter Caplehorn | Construction Industry Council |
| Andrew Dixon | Federation of Master Builders |
| Shiraz Dudhia | Temporary Works Forum |
| Paul Everall | Local Authority Building Control |
| Lee Kelly | CIRIA |
| Brian McGinnity | London Underground Limited |
| Andrew Rattray | Health and Safety Executive |
| Ifor Roberts | Association of Specialist Underpinning Contractors |
| Duncan Rudall | Institute of Demolition Engineers |
| Alastair Soane | Structural-Safety |
| David Thomas | Temporary Works Forum |

## Other contributors

Particular thanks are due to Institute of Structural Engineers (IStructE) and the Chartered Association of Building Engineers (CABE) who hosted open industry workshops and to the Federation of Master Builders (FMB), Structural-Safety and the Temporary Works Forum (TWF) whose members also participated in consultation events.

In addition to inputs from the members of the PSG, particular thanks are due to Ray Filip of RKF Consult Ltd who assisted with text, case studies and references.

## CIRIA project team

| | |
|---|---|
| Lee Kelly | Project manager |
| Kieran Tully | Project director |
| Clare Drake | Publishing manager |

# Contents

# Abbreviations

| | |
|---|---|
| **ACM** | Asbestos-containing materials |
| **ASUC** | Association of Specialist Underpinning Contractors |
| **BCO** | Building control officer |
| **BIG** | Basement Insurance Guarantee |
| **BLP** | Building Life Plans |
| **CABE** | Chartered Association of Building Engineers |
| **CAR** | Constructor's 'all-risks' insurance |
| **CCS** | Considerate Constructors Scheme |
| **CDM** | Construction (Design and Management) Regulations 2015 |
| **CIC** | Construction Industry Council |
| **CPA** | Construction Plant Hire Association |
| **CPD** | Continuing professional development |
| **DIG** | Defects Insurance Guarantee |
| **DPM** | Damp proof membrane |
| **EL** | Employers' liability |
| **FMB** | Federation of Master Builders |
| **HSE** | Health and Safety Executive |
| **IDE** | Institute of Demolition Engineers |
| **IStructE** | Institution of Structural Engineers |
| **LABC** | Local Authority Building Control |
| **LUL** | London Underground Limited |
| **NFDC** | National Federation of Demolition Contractors |
| **PC** | Principal contractor |
| **PD** | Principal designer |
| **PII** | Professional indemnity insurance |
| **PL** | Public liability |
| **PM** | Project manager |
| **PSG** | Project steering group |
| **RIBA** | Royal Institute of British Architects |
| **TWF** | Temporary Works Forum |

# Introduction

This introductory note provides an overview of the project and is divided into the following sections:

1 Project background
2 Key issues
3 Toolbox talks
4 Future updates
5 Further information by topic
6 Other relevant websites
7 Issues for government

CIRIA provides a wide range of guidance for the construction industry including some freely available publications. CIRIA members also have access to the catalogue of over 600 guidance documents. For more information go to **www.ciria.org**

# 1 Project background

The project was proposed by the Health and Safety Executive (HSE) based on the experience of HSE inspectors who attended sites following accidents. It was considered that larger contractors had made strides in improving the health and safety (H&S) of workers on their sites but that many smaller companies, often engaged in smaller refurbishment projects, were of more concern.

Following a period of consultation with members, the CIRIA Building and Construction Technology Advisory Panel expressed support for the project and funding was provided by the HSE, London Underground Limited (LUL) and CIRIA members. Work started in late 2014.

The technical writing was carried out by Alan Gilbertson working with a PSG who provided guidance, support and input throughout the process.

As part of the initial evidence-gathering process, workshops were held with a wide range of people including clients, designers and contractors, as well as people working in building control.

# 2 Key issues

The key issues of concern that were identified were:

- lack of appropriate management structure and controls (see BS 5975:2008+A1:2011 and BS 6187:2011)
- failure to address and plan for key activities (see BS 6187:2011)
- failure to carry out appropriate survey and structural assessment
- lack of involvement of people who can recognise what needs to be done to manage the risks
- a perceived lack of funds to procure what is appropriate, risking major financial loss if things go wrong
- time pressures from developers.

Unrealistic expectations from conservation professionals were also suggested as being a problem. The appropriate risk management issues were considered to be:

- responsible parties on a project need to understand the risk issues and take proportionate action
- clients need to appreciate their responsibilities
- an understanding of the existing structure and how the proposed changes can be carried out safely
- studies and physical examination work commissioned where needed, led by a qualified person
- appropriately qualified people should be engaged to plan and manage the work on site.

Other feedback included:

- Anyone can design or construct a building structure – an issue considered 'deplorable' when in other areas of industry (eg gas and electrical systems) it is regulated. While it is understood that government is unlikely to consider more regulation, the general opinion as noted here, was felt to be strongly detrimental for the industry and is the current state of affairs.
- Often clients and small builders are not alerted to the risks involved and shown where to go for assistance, as part of the planning and Building Regulation process. It was considered that steps need to be taken to change the way things are done. It was considered that relevant government and local authority websites, and local authority planning approval process material could all contribute.
- There is a need for accessible guidance about the more common types of failure, which can be referred to by all involved, together with warnings about the need for proper engineering input to design the work. This includes the design of temporary works and the co-ordination of temporary works design (the role of the temporary works co-ordinator). This suite of toolbox talks provides such information.
- The provision of full, authoritative and detailed technical guidance on the topics identified would be a major task requiring input from a range of industry professionals. Further work by industry bodies and experts is required to improve the technical guidance currently available.

Other points noted were:

- Insurance and warranties appears to be a subject where few people have a clear understanding. Guidance has been provided.
- Where planning approval is not required, Building Regulations may apply. Most people do not realise this. They may not even appreciate the difference. There is also an issue around the degree to which people can 'rely' on building control to input technical guidance during the build process and around the need for a 'certificate' confirming that there are no outstanding concerns after completion. Guidance has been provided.

# 3 About the toolbox talks

The project has led to a series of toolbox talks, which are available to download as two combined PDFs. They are listed under two main headings (general and technical guidance). These downloads include hyperlinks between the documents and to external sources for further information to assist the reader. These links are highlighted in **bold-blue** type. Case studies are also included, to demonstrate both good and bad practice.

## GENERAL GUIDANCE

### For clients

**GG1 Before building starts** – alerts people to the risks

**GG2 Legislation, approvals, consents and building control** – outlines what the requirements are.

**GG3 How to get a good builder** – provides advice on finding a reputable builder.

**GG4 Who is the designer?** – information on finding qualified designers, architects, engineers etc.

**GG5 Insurance and warranties** – important considerations.

**GG6 Building a basement** – recognising that basements are technically challenging.

**GG7 Removing a wall** – considering the challenges.

**GG8 Building an extension** – issues to consider.

**GG9 Carrying out a loft conversion** – important considerations.

### For designers

**GG10 The importance of the designer's role** – duties under CDM 2015.

### For builders

**GG11 Planning and managing a project** – includes the need for design input and site work planning and supervision.

### For local authorities and government

**GG12 The importance to clients of CDM 2015: the risks and their duties** – considerations between clients and local government for building works.

## TECHNICAL GUIDANCE

**TG1 Investigating and assessing existing structure.**

**TG2 Where to find information about existing buildings.**

**TG3 Dos and don'ts.**

**TG4 How to avoid undermining existing foundations.**

**TG5 How to plan for partial demolition.**

**TG6 Planning for 'soft-strip' to reduce the risks of unforeseen problems occurring.**

**TG7 How to maintain lateral stability.**

**TG8 How to assess masonry when planning penetrations in walls.**

**TG9 How to safely remove a chimney breast.**

**TG10 Assessing the load-carrying capacity of floors, beams and walls.**

**TG11 How to use props and needling correctly.**

**TG12 How to underpin for basement construction under an existing property.**

**TG13 Provision of hoardings, fencing and large sign-boards.**

# 4 Future updates

Depending on funding and assistance from industry, CIRIA seeks to update its publications and comments are welcomed from anyone reading the guidance provided prepared so far. Contact: **enquiries@ciria.org** with comments and suggestions.

In particular, comments and suggestions are sought where:

- errors are noted
- improvements to the guidance are suggested
- changes in law or industry practice are apparent
- additional or new references to technical guidance are available
- new case study material is available to demonstrate points made.

# 5 Further information by topic

## Access

LLOYD, D and KAY, T (1995) *Temporary access to the workface,* SP121, CIRIA, London, UK (ISBN: 978-0-86017-422-6)
www.ciria.org

## Basements

HSE (2012) *Domestic basement construction projects: what you need to know as a busy builder*, CIS66, Working well together, Health and Safety Executive, London, UK
www.hse.gov.uk/pubns/cis66.pdf

ASUCplus (2013) *Guidelines on safe and efficient basement construction directly below or near to existing structures, second edition*, ASUCplus, Hampshire, UK (ISBN: 978-0-95540-329-3)
www.citb.co.uk/documents/about-us/what%20we%20do/devevlopment%20fund%20info/asuc%20basement%20guidelines%5B1%5D.pdf

## Damage management

BS 12999:2015 *Damage management. Code of practice for the organization and management of the stabilization, mitigation and restoration of properties, contents, facilities and assets following incident damage*

## Demolition

BS 6187:2011 *Code of practice for full and partial demolition*

## Excavations

STIG (2016a) *Management of shoring in excavations. Part 1 Management, Revision 1, Shoring*, STIG 1301, Technology Interest Group. Construction Plant Hire Association, London, UK

STIG (2016b) *Management of Shoring in Excavations. Part 2 Hazard identification for risk assessment*, STIG 1501, Technology Interest Group. Construction Plant Hire Association, London, UK
www.cpa.uk.net/shoring-technology-interest-group-stig-publications

## Façade retention

LAZARUS, D, BUSSELL, M, ROSS, P (2003) *Retention of masonry façades*, C579, CIRIA, London, UK (ISBN: 978-0-86017-579-7)
www.ciria.org

LAZARUS, D, BUSSELL, M, ROSS, P (2003) *Retention of masonry façades – best practice site handbook*, C589, CIRIA, London, UK (ISBN: 978-0-86017-589-6)
www.ciria.org

HSE (1992) *Façades retention*, Guidance Note GS51, Health and Safety Executive, London, UK
http://regulations.completepicture.co.uk/pdf/Health%20and%20Safety/Facade%20retention..pdf

## Fixings

SCOSS (2008) "The selection and installation of construction fixings", *Report 5008, SCOSS Alert*, Structural-Safety, UK
www.structural-safety.org/publications/view-report/?report=1479

## Foundations

ASUC (2000) *ASUC recommended minimum site investigation for typical domestic 1, 2 and 3 storey buildings*, Technical Guidance TGN 01, Association of Specialist Underpinning Contractors, Hampshire, UK

BRE (1980) *Low rise buildings on shrinkable clay soils: Part 3*, BRE Digest 242, Building Research Establishment, Bracknell, UK (withdrawn)

BRE (1990) *Low rise buildings on shrinkable clay soils: Part 2*, BRE Digest 241, Building Research Establishment, Bracknell, UK

BRE (1993) *Low rise buildings on shrinkable clay soils: Part 1*, BRE Digest 240, Building Research Establishment, Bracknell, UK
**www.brebookshop.com**

HSE (2012) *Excavation: what you need to know as a busy builder,* Working Well Together, Health and Safety Executive, London, UK
**www.hse.gov.uk/pubns/cis64.pdf**

### *Standards*

BS 8102:2009 *Code of practice for protection of below ground structures against water from the ground*

## General

HSE (2004) *Health and safety in refurbishment involving demolition and structural stability*, RR204, Health and Safety Executive, London, UK
**www.hse.gov.uk/research/rrpdf/rr204.pdf**

HSE (2006) *Avoiding structural collapses during refurbishment. A decision support system*, RR463, Health and Safety Executive, London, UK
**www.hse.gov.uk/research/rrpdf/rr463.pdf**

## Lintels

BS 5977-1:1981 *Lintels. Methods for assessment for loads*

BS 5977-2:1983 *Lintels. Specification for prefabricated lintels*

## Masonry

BRE (1991) *Repairing brick and block masonry*, BRE Digest 359, Building Research Establishment, Bracknell, UK (ISBN: 0-85125-485-3)

BRE (1999) *Removing internal loadbearing walls in older dwellings*, BRE Good Building Guide GBG 20, Building Research Establishment, Bracknell, UK (ISBN: 978-1-84806-205-4)

BRE (1992) *Repairing or replacing lintels*, Good Building Guide GG1, Building Research Establishment, Bracknell, UK
**www.brebookshop.com**

SADGROVE, R (1991) *Why do buildings crack?* BRE Digest 361, Building Research Establishment, Bracknell, UK (ISBN: 978-1-84806-388-4)

## Propping

BRE (1992) *Temporary support: assessing loads above openings in external walls*, Good Building Guide GG10, Building Research Establishment, Bracknell, UK

BRE (1992) *Providing temporary support during work on openings in external walls*, Good Building Guide GG15, Building Research Establishment, Bracknell, UK

BRE (1999) *Supporting temporary openings*, Good Repair Guide GG25, Building Research Establishment, Bracknell, UK
**www.brebookshop.com**

### *Standards*

BS EN 1065:1999 *Adjustable telescopic steel props. Product specifications, design and assessment by calculation and tests*

## Running a site

HSE (2011) *Running a small construction site? What you need to know as a busy builder*, Working Well Together, Health and Safety Executive, London, UK
**wwww.hse.gov.uk/pubns/cis63.pdf**

## Structural assessment

DRISCOLL, R (1995) *Assessment of damage to low rise buildings, with particular reference to progressive foundation movement*, BRE Digest 251, Building Research Establishment, Bracknell, UK (ISBN: 1-86081-045-4)

www.brebookshop.com/details.jsp?id=287566

ISTRUCTE (2010) *Appraisal of existing structures, third edition*, Institution of Structural Engineers, London, UK (ISBN: 978-1-90633-504-5)
http://shop.istructe.org/appraisal-of-existing-structures-third-edition.html

## Structural renovation

CIRIA (1986) *Structural renovation of traditional buildings*, R111, CIRIA, London, UK (ISBN: 978-0-86017-257-4)
www.ciria.org

## Structural repairs

ASUC (2015) *Guide to safe and efficient structural repairs*, Association of Specialist Underpinning Contractors, Bordon, UK
www.asuc.org.uk/index.html

## Temporary works

DEEBANK, P (2010) "Management of temporary works" *Construction Manager*, July/August
www.constructionmanagermagazine.com/construction-professional/management-temporary-works

GRANT, M and PALLET, P F (2012) *Temporary works – principles of design and construction*, Institution of Civil Engineers, London (ISBN: 978-0-72774-177-6)
www.icevirtuallibrary.com/doi/book/10.1680/twpdc.41776

### *Standards*

BS 5975:2008+A1:2011 *Temporary works procedures and permissible stress design of falsework*

## Raising issues of concern

PAS 8811 (in press) *Temporary works – client procedures – code of practice*

TWF (2015) *Clients guide to temporary works*, Temporary Works Forum, UK
www.twforum.org.uk/media/58911/twf2014.02_client_guide_26_january_2015_final.pdf

## Underpinning

ASUC (2000) *ASUC recommended minimum standards for underpinning typical domestic 1, 2 and 3 storey buildings. Stage 1: Overview of the process – the minimum procedures to follow in carrying out subsidence repair and similar types of construction work*, Technical Guidance TGN 02, Association of Specialist Underpinning Contractors, Hampshire
www.asuc.org.uk/training_publications.html

ASUC (2015) Guidelines on safe and efficient underpinning and mini piling operations, Association of Specialist Underpinning Contractors, Hampshire
www.asuc.org.uk/training_publications.html

**Note that the references provided here will need updating to suit modern practice. In particular, the topics discussed in the following guides need to be addressed:**

BRE (1990) Underpinning, BRE Digest 352, Building Research Establishment, Bracknell (ISBN: 0-85125-446-2)
www.brebookshop.com/details.jsp?id=834

BRE (1992a) *Temporary support: assessing loads above openings in external walls*, Good Building Guide (GG)10, Building Research Establishment, Bracknell, UK

BRE (1992b) *Providing temporary support during work on openings in external walls*, Good Building Guide (GG)15, Building Research Establishment, Bracknell

BRE (1999a) *Supporting temporary openings*, Good Repair Guide (GG) 25, Building Research Establishment, Bracknell, UK (ISBN: 1-86081-307-0)

BRE (1999b) *Removing internal loadbearing walls in older dwellings*, Good Building Guide (GG) 20, Building Research Establishment, Bracknell, UK (ISBN: 1-86081-264-3)
www.brebookshop.com

# 6 Other relevant websites

| Organisation | Information |
|---|---|
| Government | Information about planning in England and Wales<br>**www.planningportal.gov.uk/permission/responsibilities/planningpermission/planning** |
| | Building Regulations, England and Wales<br>**www.legislation.gov.uk/uksi/2010/2214/contents/made** |
| | Building Regulations, England and Wales, approved documents<br>**www.gov.uk/government/collections/approved-documents** |
| | Building Regulations, Scotland<br>**www.legislation.gov.uk/ssi/2004/406/contents/made** |
| | Building Regulations, Scotland, technical handbooks<br>**www.gov.scot/Topics/Built-Environment/Building/Building-standards/techbooks/techhandbooks** |
| BSI Group | British Standards<br>**shop.bsigroup.com** |
| Temporary Works Forum (TWF) | Guidance on a range of temporary works topics<br>**www.twforum.org.uk** |
| Institution of Structural Engineers (IStructE) | Guidance on a range of structural engineering topics<br>**www.istructe.org.uk** |
| Association of Specialist Underpinning Contractors (ASUC) | Guidance on specialist underpinning and repair work<br>**www.asuc.org.uk** |
| National Association of Scaffolding Contractors (NASC) | Guidance on scaffolding work<br>**www.nasc.org.uk** |
| Construction Fixings Association (CFA) | Guidance on fixings<br>**www.fixingscfa.co.uk** |
| Construction Plant Hire Association (CPA) | Guidance on a range of topics<br>**www.cpa.uk.net** |
| Peter Pallett (independent consultant) | Information about temporary works generally<br>**www.temporaryworks.info** |
| Building Research Establishment (BRE) | Industry guidance<br>**www.bre.co.uk** |
| National House Building Council (NHBC) | Standards and technical requirements<br>**www.nhbc.co.uk** |
| Structural-Safety | Incorporating CROSS and SCOSS providing guidance on safety issues in construction<br>**www.structural-safety.org** |

# 7 Issues for government

Regulation of the industry needs to be improved – the strong message throughout this project work was that those undertaking construction involving structural work should be better regulated (see **Case study 8.1**).

**Case study 7.1 Building collapse during refurbishment**

A two-storey corner end of terrace property completely collapsed during refurbishment. The building was situated on a very busy, narrow major route in an area that is normally bustling with pedestrians and traffic. The ground floor was a shop and there was residential accommodation above. Work was in progress, without planning or building regulations approval, to create a basement and loft conversion. A building control inspector visited the property and advised the builder to stop work until permissions had been granted. However, work continued. Internal cross walls had been removed and chimney breasts had been removed from the party wall. The robustness of the structure had been seriously compromised as there was virtually no lateral stability system. The external walls had been underpinned, rather poorly and at the time of failure a mini digger was excavating for the basement. Luckily no-one was passing when the wall collapsed.

Structural failure is most likely to occur due to:

- lack of appreciation of the structure of a building
- loss of stability due to the removal of existing walls
- undermining of foundations either of the building concerned or a neighbouring building
- haphazard partial demolition
- gas explosions due to badly fitted, poorly serviced and faulty gas appliances.

There are many cases every year of buildings partially or completely collapsing as alterations are made by builders (including some DIY home owners) who take on work of a scale or complexity that they are not experienced enough or well-enough organised to manage.

It is vital that buildings are made from heavy materials and components held together as engineered structures. Disrupting supports or connections can result in collapse and the subsequent falling of roofs, floors and walls can kill and injure those underneath. Every plan to dig near or underneath existing foundations, to knock down a wall, to extend a room or to expand a roof space, must be scrutinised by a competent person before work is started.

Many countries have the equivalent of building regulations and some countries require designers and builders to be registered (for example, Singapore). In Holland, recent studies have shown that 10 per cent of the total construction cost in the country is correcting defects during construction and in use. In developing countries much less attention is paid to construction procedures and there are many collapses, often with large loss of life.

In the UK there are:

- building regulations that should (by law) be complied with
- voluntary confidential reporting to Structural-Safety (see **Chapter 6**) of failures and dangerous situations
- voluntary industry schemes such as the Considerate Constructors Scheme (CCS)
- some new construction is built under warranty.

However, there is:

- no mandatory registration of builders or structural designers
- no mandatory provision of warranties backed by insurance
- very slow release of 'lessons learned' information after failures, frequently due to legal pressures on those involved.

## Mandatory registration of designers and/or builders

To an outsider it would seem good practice that work involving gas and electricity is firmly regulated, and yet astonishing that anyone can undertake the design and execution of safety-critical structural work unregulated. However, 'good' clients will apply their own standards and 'good' practitioners will work to high standards.

One of the key issues arising from an HSE research project (Gilbertson and Kappia, 2011, and Gilbertson *et al*, 2011) was that the knowledge, skills and experience of safety risk management should be improved among all managers and supervisors involved in construction projects.

The case studies in the TBTs often demonstrate a failure among all project workers to adequately identify the full extent of hazards and address the risks. Also, other sources demonstrated a considerable degree of uncertainty and a lack of confidence in the industry's knowledge, skills and experience of safety risk management. This suggested that more emphasis needed to be given to:

- education for those who will be entering the industry
- continuing professional development (CPD) and 'on-the-job' training
- development of more effective safety risk management systems.

While the more responsible section of the industry does seek to improve these aspects of performance, it seems that the unregulated 'tail' of the industry has little interest and has not yet recognised the benefit of making such improvements.

## Warranties

The Federation of Master Builders (FMB) believes that the UK Government should introduce a mandatory warranty requirement for all domestic building works that require building regulations approval and structural engineering calculations. This requirement would apply to all internal structural alterations, including such standard works as extensions and loft conversions. The FMB proposal is that all contract work meeting this description should have a minimum 12 month warranty period. As such, when applying for building regulations approval, the approval form should include a 'tick box' section to check that building work is covered by a one-year warranty, similar to the sections requiring confirmation that electrical installations will be carried out by a competent electrical installer. This simple measure would be a cost effective and light-touch means of providing adequate assurance and protection to consumers contracting with domestic builders, while at the same time supporting high standards of workmanship in this crucial industry. As things currently stand, consumer assurance and protection for householders contracting with builders remains ineffective and wholly inadequate.

The commercial case for mandatory warranties is strong. Poor quality workmanship by incompetent companies operating in the domestic building market continues to act as a serious drain on the nation's economic resources. In 2014, a survey of over 2000 homeowners by Trustmark (the quality mark organisation for which the FMB is a scheme operator and founding member) found that, of those that have used builders, plumbers and other tradespeople over the last year, almost one in five (17 per cent) have had to have work re-done. The survey estimated that shoddy builders were costing homeowners £1.9bn per year. The law in the UK currently provides very little protection against substandard work by incompetent builders. Anybody is able to set themselves up as a domestic builder. Building regulations are designed to ensure minimum standards in design and construction, but they do not cover all building works and they cannot guarantee recompense for the householder.

If a service is not carried out with reasonable care and skill, the Consumer Rights Act 2015 mandates that the provider must correct the work or provide some recompense. Yet, for a householder, attempting to enforce this is likely to be an arduous and expensive process, beyond the ability of many, and with only limited chance of success. If the builder in question has ceased to trade, the law can offer the consumer almost nothing at all. By contrast, the proposed warranty would provide cover against any scenario in which the work could not be finished, including the death or bankruptcy of the builder. It would be unthinkable to buy a car for £50 000 without a warranty, yet for building works of a similar value not taking out a warranty remains relatively common.

A mandatory warranty requirement would be a simple and relatively cost effective means of ensuring consumer redress. The vast majority of skilled builders and contractors will already be able offer warranties and will often do so as a matter of course. As opposed to, for example, a licensing system, this requirement would not lead to additional administrative bureaucracy or act as an automatic barrier to market entry. The only companies for whom this requirement would prove a barrier would be those unable to demonstrate the quality of their services sufficiently to gain the backing of insurers.

As such, the FMB suggests that this measure could also have a significant effect in reducing the prevalence of 'cowboy builders', ie rogue companies that plague the industry, inflicting enormous damage on consumers and which successive governments have comprehensively failed to find an answer to. It should be remembered that the requirement for a warranty creates official records of works completed and project values, which would strongly discourage cash-in-hand agreements. While it is difficult to model the extent of this effect, it is thought that this measure will almost certainly lead to a decrease in the number of companies operating in the black economy and a resultant increase in VAT revenue for the Treasury. Considering that an estimated £9.76bn of work is undertaken in the informal construction economy each year, the potential for increasing revenue is significant.

## Release of information after failures

Another of the key strands of output from the HSE research project (Gilbertson and Kappia, 2011, and Gilbertson *et al*, 2011) was that the industry should learn from experience. Learning from experiences was not found to be well-rooted in the industry. There was lack of confidence that:

- learning was shared rapidly
- lessons were incorporated into the education and training process
- information could be easily accessed.

The information presented here has confirmed that current industry forums do not operate effectively. Indeed, accessing key information has not been easy and it has been apparent that the level of resource into what is a safety-critical industry is inadequate. Whereas structural failures are briefly newsworthy, the technical lessons learned are not consistently and speedily understood, recorded, and communicated to the whole industry.

# References

GILBERTSON, A and KAPPIA, J (2011) *Preventing catastrophic events during construction,* RR834, HSE Books, Health and Safety Executive, London, UK
**www.hse.gov.uk/research/rrpdf/rr834.pdf**

GILBERTSON, A, KAPPLA, J, BOSHER, L, GIBB, A (2011) *Guidance on catastrophic events in construction*, C699, CIRIA, London, UK (ISBN: 978-0-86017-699-2)
**www.ciria.org**

HSE (2015) *Managing health and safety in construction*, L153, HSE Books, Health and Safety Executive, London (ISBN: 978-0-71766-626-3)
**www.hse.gov.uk/pUbns/priced/l153.pdf**

## Acts

Consumer Rights Act 2015 (c.15)

Health and Safety at Work etc. Act 1974 (c.37)

## British Standards

BS 5975:2008+A1:2011 *Code of practice for temporary works procedures and the permissible stress design of falsework*

BS 6187:2011 *Code of practice for full and partial demolition*

## Regulations

The Construction (Design and Management) Regulations 2015 (No.51)

The Management of Health and Safety at Work Regulations 1999 (No.3242)

# Toolbox talks

## For clients

# Before building starts

Where building work is being done (new-build or refurbishment) 'the client' in the UK has legal obligations that cannot be passed on to other people, although help from the people and companies that are used in the project can be sought. Ensure that they are suitably experienced to do the work and are organised to do it properly and safely.

If the client gets this wrong, **the work may be done badly or be unsafe, or it may even be illegal**. There have been cases where a house has had to be demolished, or where the builder has gone bankrupt and the work unfinished, or where the designers have walked away, or where the client has been prosecuted because the work was illegal or unsafe. Some problems can even affect neighbours, who may seek compensation. If there is a major problem, clearing up the mess and making things safe can cost far more that the original cost of the work and household property insurance does not cover building works (see **Case study 1**).

**Case study 1**
**Poor building work can be costly**

The owners of this property lost their home, and their neighbours' home was seriously damaged when builders tried to construct a basement below their property causing it to split apart. The builder went into liquidation shortly after and the builder's insurance did not cover the damage caused. This was because exclusions in the policy wording did not cover the basement excavation that the builder was undertaking.

For further guidance about key topics see:

- **Legislation, approvals, consents and building control.**
- **How to get a good builder.**
- **Who is the designer?**
- **Insurance and warranties.**

Remember, in UK law the client has to take reasonable steps to make sure that things are done properly, including planning permission and building regulations approval. However, for most domestic clients duties under health and safety construction legislation will normally pass to other duty holders.

Risk assessment is the modern term for thinking about what could go wrong and taking appropriate reasonable steps to remove risk or by managing it to reduce the level of risk to an acceptable level.

Every client wanting building work done has to comply with UK planning law and Building Regulations. Non-domestic clients also have strict duties under health and safety legislation. There is also the matter of insurance and warranties to be considered. Getting it wrong can spell disaster – **do not take a risk!**

Risks can relate to process (such as getting planning approval) or safety (such as making changes to the way a building stands up or affects a neighbouring properties foundations). See **Case study 2**.

There may also be long-term financial risks such as a property becoming un-saleable if the local authority refuses to confirm that work was been carried out in accordance with Building Regulations.

To meet their responsibilities under CDM 2015, clients should seek professional advice. A professional engineer is often able to provide cost-effective solutions to make the work easier, and without risk of structural movement or collapse.

Do not accept or ignore comments such as:

- "I've done it like this before and it was OK".
- "It will only be like that for a short time".
- "No one is likely to notice".
- "Everyone takes that risk – it should be OK".
- "We know what we're doing and it will cost a lot more to get an engineer involved".

Domestic clients will reasonably rely on appropriately experienced construction professionals for further guidance.

**Case study 2 Structural alterations leading to collapse**

A building used as a mosque was being adapted. The work included major structural alterations that went wrong and the whole structure collapsed one night. Luckily no-one was injured.

## For clients

# Legislation, approvals, consents and building control

In the UK, a property cannot be built or refurbished without considering the law (see **Case study 1**). The main issues to be aware of are:

- Planning approval – this is a highly complex subject and the local authority can provide advice. See the **Government's Planning Portal**.
- **Building Regulations/control** – the UK system for checking that work has been done in compliance with legal requirements.

Note that even if planning approval is not required there may well be a requirement for Building Regulations approval. This is normally required if there is any form of structural alteration to the building (among other changes).

The building control activity may be undertaken by the local authority, but a client can appoint an 'approved inspector' instead.

For further information, see the **Local Authority Building Control (LABC)** website and the **CIC approved inspectors register**.

In Scotland, the process is modified by the certification of structural design, which provides assurance about structural designs to building control inspectors.

See **www.ser-ltd.com/scotland**

Engagement with building control should start well before construction begins, to reduce the risk of conflict and change later on.

Failure to undertake work with building control involvement will mean that a building control completion (or final) certificate is not received and this may make sale of a property difficult. It may also affect a later building insurance claim.

- The Party Wall Act 1996 is a complex piece of legislation that will affect the client if they share a wall with a neighbour or if there is any risk of undermining their foundations.
- CDM 2015 place legal duties about health and safety upon clients and their designers and builders. Note that under CDM 2015, a builder is called a 'contractor'. These regulations are about getting the work done safely and without affecting workers' health.

In addition there are many other restrictions, for example:

- Is work being carried out within a conservation area?
- Is the property listed?
- Will the work affect a neighbour's amenity, such as their 'right to light' (RICS, 2016)?
- Will the statutory authorities have any objections? (roads, railways, water, sewerage, power, surface water runoff etc)
- Will the work affect anything passing under or over the property?

Starting work without the necessary permissions to build is foolish in the extreme and may well be a sign that a client's team are not competent.

**Case study 1 Excavation work leading to a house collapse**

A rear extension to a house collapsed when its foundations were undermined by excavation work in the rear garden. Work had started without any consents in place.

- Will the work affect the environment, including local wildlife?
- Will a tree with a Tree Preservation Order be affected?
- Is there a risk of uncovering hazardous materials such as asbestos?
- Is there a risk of disturbing archaeological remains?

In view of the complexity of these matters, it is generally advisable to engage a professional adviser to ensure that things go smoothly (see **Case study 2**).

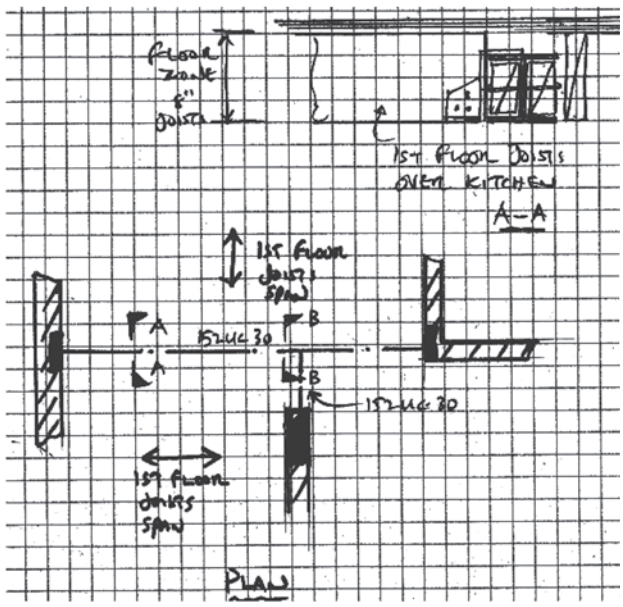
If there will be changes to the structure of a property (foundations, walls, floors, roof etc) it will be necessary for a competent structural engineer to carry out a design. Advice is given in **Find a structural engineer**. **Building Regulations approval** will require that a design has been carried out, but building control activity cannot be relied upon as a check upon the design.

The builder will also need to include a design on how to maintain strength and stability during the work (usually done by the builder's appointed temporary works designer). Temporary works design presents particular risk as it may be carried out in a hurry, without any formal co-ordination with other design work.

For advice on these appointments, see:

- **How to get a good builder**
- **Who is the designer?**
- **Insurance and warranties**

**Case study 2 By failing to advise the local authority, works may have to be re-done**




Work completed had to be opened up and inspected to obtain a certificate of completion from the local authority building control department.

A house refurbishment involved the demolition of walls and the installation of new steel beams. Calculations were made and the work was done.

Unfortunately, the builder failed to advise the local authority and there was no building control oversight. The new ceilings had to be torn down to enable the work to be inspected, so that a certificate of completion could be obtained. Without doing this the local authority would not have been sure that the correct beams had been used.

**Further information**

RICS (2016) *A clear, impartial guide to right to light*, Royal Institution of Chartered Surveyors, London
**www.rics.org/Global/RICS-Right-to-Light.pdf**

### Standards

The Construction (Design and Management) Regulations 2015 (No.51)

The Party Wall etc. Act 1996 (c.40)

## For clients

# How to get a good builder

The key concerns for most clients are that the builder will do a good job, in a reasonable time and at a fair price.

It is important to employ a reputable builder to ensure the client is protected. Rule number one is to never buy from someone offering services at the door. Instead, ask family and friends for recommendations, or check with a trade association (see **Box 1**) and make use of their services and advice in finding a competent builder.

| **Box 1** | **UK recognised qualifications and trade bodies** |
|---|---|
| Federation of Master Builders (FMB): **www.fmb.org.uk** | |
| National Federation of Builders (NFB): **www.builders.org.uk** | |
| Scottish Builders Federation (SBF): **www.scottish-building.co.uk** | |
| Government-backed 'Trustmark' scheme: **www.trustmark.org.uk** | |
| Association of Specialist Underpinning Contractors (ASUC): **www.asuc.org.uk** | |

When selecting a builder arrange for at least three quotes. These should include costs for the whole project, including materials, removal of rubbish and making good after the project has finished. Follow up references in person before making a final decision. Take note of the quality being offered – do not go for the cheapest quote. Ask as many questions as possible to establish goods communication from the start. A good builder should have no problem in answering any questions.

Having building work done by an incompetent builder is inviting disaster. But how can a 'good' one be found?

A builder may seem to have the right answers when asked – but how can this be checked?

- Ask for references for similar work done recently – and follow up by contacting the previous clients, preferably by visiting them for a chat.
- Search on the web for a local builder recommended by independent people.
- Talk to the local building control team.
- Investigate the meaning of any qualifications and membership of trade bodies mentioned by the builder (see **Box 1**).

When a builder has been selected, use a written contract and agree a payment plan as part of the contract (no reputable builder will ask for the full cost of the project upfront). Where appropriate have a suitable warranty in place.

Some of the issues involved are discussed in:

- **Before building starts.**
- **Legislation, approvals, consents and building control.**
- **Who is the designer?**
- **Insurance and warranties.**

**Case study 1 Appointing a reputable builder is vital**

The builder appointed to do the work was not able to manage it effectively and a collapse occurred that virtually demolished the house.

The collapse was initially thought to be connected with the construction of a new basement, but this is now not thought to be the trigger for the collapse.

**Case study 2 Carrying out work on a well-organised site**

This basement project in London shows how good a well-planned site can look – and it was delivered on time too!

## For clients

# Who is the designer?

In the UK, there are many well-qualified, skilled designers (architects and engineers) who can be appointed by a client.

Few clients will be qualified to carry out design themselves (beyond matters of layout etc), but many builders will offer to take on the design. Many builders will appoint an engineer to do the structural design.

Regardless of who is going to do the design, skilled designers must be involved. In particular, if the structure of a building is going to be changed, even in what might appear to be quite a minor way, a competent person must be appointed to avoid problems that can be very expensive for all concerned.

Under CDM 2015, a designer has legal health and safety duties enforceable in the courts and a client has to take reasonable steps to make sure that the designers on the project are up to the job.

In view of the complexity of these matters, it is generally advisable to engage a professional adviser to help make sure that things go smoothly. Advice on finding an architect is given at: **RIBA find an architect**, and for a structural engineer: **Findanengineer**

If there will be changes to the structure of a property (foundations, walls, floors, roof etc) it will be necessary for a competent structural engineer to carry out a design and check everything will be OK.

Appointing a structural engineer simply to provide calculations is not recommended, but it is important to appoint one before and during the works in order to:

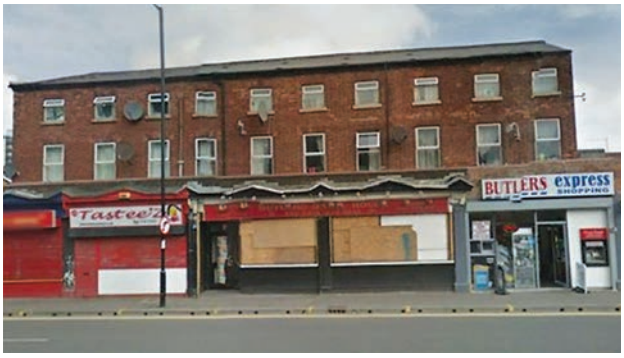
- understand the existing construction to enable the design to take relevant factors into account
- understand and take into account the proposed build process
- inspect during the works to ensure that their design is being correctly understood, their design assumptions are correct and any changes are not detrimental to the design.

The building control officer (BCO) will want to receive design calculations and drawings to make sure that the design complies with the law, as well as visiting site as the work proceeds. The BCO will not normally advise on the construction process and any comments made will be advisory. The builder will need to review their approach and take professional advice as necessary, in response to any comments.

The builder will have to design so that the construction process will be safe – the person who does this is known as the temporary works designer.

**Case study 1 Collapsed building due to builder's incompetence**

Before....




After....


Work to modify this existing building was not designed by competent people. The construction work involved lowering the floor in the basement and removing a number of internal walls. While that was underway, the central wall was undermined, causing it to collapse. In turn, the floors of the flats above and the front wall caved in, injuring three people. The property was so dangerous after the incident that it had to be demolished.

**Case study 2 An office block collapse**

The designer for this work did not fully understand how the loads were taken down to the ground. The office block, which was being refurbished collapsed, crushing a worker's legs.

**Further information**

The Construction (Design and Management) Regulations 2015 (No.51)

## For clients

# Insurance and warranties

Many clients assume that their builder is insured and that they do not need to worry about insurance and warranties – a complex aspect of modern life. But they are wrong.

A client needs to consider:

- Is the builder (or the designer if appointed by the client) properly insured?
- What happens if the builder or designer goes into liquidation or does not renew their insurance?
- How does the work affect a client's normal property and contents insurance?
- What happens if the existing building or a neighbouring property is affected? (Including roads and other infrastructure).

There are various types of insurances and warranties available, which are noted as follows. In addition, clients should be aware that this is a specialist area of expertise where taking advice from a construction industry insurance broker would be advisable.

When checking insurances a builder or designer should possess an 'evidence of insurance' normally in the form of a letter from their broker or insurance company. In addition:

- Contact the broker or insurer for reassurance that the policy is current/valid and when it is due for renewal.
- Read the small print – look out for onerous exclusions or limitations in cover, which could mean the project is not properly insured.
- Make continuation of the policy (at renewal) a condition of any contract and check that it has been renewed, as only work carried out during the insured period will be covered by the insurance.

See **General 1 Case study 1**

## Insurance for construction work

- **Homeowner insurance:** a client must notify their existing insurer to inform them of the work to be undertaken at the property. An extension to the current policy may be offered that provides cover for damage to the property during the works (but note that not all insurers allow this).
- **Contractor's 'all-risks' insurance (CAR):** the normal contractor's insurance policy will cover damage to the 'new' works and all materials on site, including plant and equipment. However, it will not cover damage to the existing property or to a neighbour's property, and will only cover the new works being undertaken.
- **Public liability (PL) insurance:** all contractors should be insured against claims arising from their building works, such as damage to the homeowners' or neighbours' property, and injury to people.
- **Employers' liability (EL) insurance:** all contractors must be insured by law, against injury to their employees that arises out of their trading activities.
- **Non-negligence insurance:** all contractors' PL policies only provide cover where there has been proven negligence by the contractor. However, damage may occasionally occur when the contractor has not been negligent and in such cases the property owner can be held liable. This 'loop-hole' may be closed with non-negligence insurance. Where possible, this cover should be taken out by the contractor, as an extension to PL insurance to avoid any dispute between two or more insurance companies. More information on non-negligent liability is provided by **MPW Brokers**.
- **Designers' professional indemnity insurance (PII):** all designers for the work should have PII, including the contractor, if they also carried out any design of the new works to the property.

Note that in the event of a builder going into liquidation, the costs of stopping work, protection, re-tendering and re-starting may be considerable, so selection of a good contractor is imperative to lessen this risk.

## Post-construction insurance

As well as insurance covering events during the construction, a warranty providing insurance against subsequent defects may also be considered (see **Case study 1**). Building/structural warranties for new-build homes are normal in the UK and are sometimes available for refurbishment work.

Structural warranties normally cover a 10-year period after the work is completed and gives added peace of mind as any structural defects should be rectified. The main UK providers are:

- **NHBC** for housing (new-build only).
- **Local Authority Building Control (LABC)** warranty scheme (normally for new-build only).
- Premier Guarantee (normally for new-build only, but can vary).
- Defects Insurance Guarantee (DIG) and Basement Insurance Guarantee (BIG), which are only available from ASUC member firms (for subsidence repairs and some refurbishment projects), can insure just the new work in isolation.
- Building Life Plans (BLP) also normally for new-build only, but may accommodate some refurbishment projects.

Further guidance about insurance and the DIG/BIG warranties are available from **MPW Brokers** and the **ASUC**. A reputable insurance broker with a construction insurance team can provide more advice.

**Case study 1 Good insurance can ensure all losses are covered**

In 2010, a skip fell through the pavement vaults when the contractor failed to correctly follow the sequential propping of the vaults.

Losses were suffered by the homeowner, neighbouring properties and the pavement/highway, but reinstatement costs are being met by insurance.

## For clients

# Building a basement

Constructing a basement under an existing building is one of the most technically-challenging types of project, yet it may be undertaken (if the client is unfortunate) without the necessary thought, preparation, design and supervision (see **Case study 1**).

The difficulties arise from two main sources:

- The sensitivity of most existing masonry buildings to disturbance of their foundations.
- The difficulty of working under an existing building without disturbing its foundations.

In addition, the work will normally have a potential effect upon neighbouring properties, including subsidence, damage and nuisance, in particular the need to remove large quantities of earth and deliver materials including concrete.

So the design has to recognise and respond to the difficulties and all involved have to work to a high standard of performance (see **Case study 2**). The manner in which existing construction is underpinned is of particular importance.

**Case study 1 Building collapse during refurbishment due to poor underpinning**

Complete collapse of a refurbishment, which included the construction of a new basement.

This building completely collapsed during refurbishment. Work was in progress, without planning or Building Regulations approval, to create a basement and loft conversion. A building control surveyor (also known as a BCI) visited the property and advised the builder to stop work until the permissions had been resolved. However, work continued. Internal cross walls had been removed and chimney breasts had been removed from the party wall. The robustness of the structure had been seriously compromised as there was virtually no lateral stability system. The external walls had been underpinned, rather poorly and at the time of failure a mini digger was excavating for the basement. It is understood that underpinning was not laterally supported during excavation.

For further information see **CROSS Report 123**

**Further information**

CROSS (2009) "Shop/domestic building collapse" *CROSS Newsletter 13, Report 123*, Structural-Safety, UK
**www.structural-safety.org/publications/view-report/?report=3117**

Basements present particularly difficult engineering challenges, especially if they are to be built under or near an existing building. There may well be risks to neighbours' properties too. Be aware and engage people who know what they are doing – do not buy on 'lowest price'.

**Case study 2 The importance of keeping a safe, tidy site**

An expert contractor will keep a safe, tidy site as shown here. The stages of the work for this project were fully planned and documented and the work was closely supervised on a daily basis. Annoyance to neighbours was minimised.

In the UK, the ASUC aim to improve the art of constructing basements under existing buildings, mainly in the London area. They provide notes on various technical subjects, based on experience. They also offer a form of warranty for work undertaken by their members.

Key issues involved in this field are:

- adequate investigation of the ground, groundwater and existing buildings
- overcoming planning hurdles and neighbours objections
- reaching agreement between party wall surveyors
- appointing designers and contractors of adequate experience and competence
- achieving a buildable design solution and ensuring that all parties work closely together to achieve it
- setting up a movement monitoring regime and agreeing the response if limits set are exceeded
- keeping control on site and responding fast to difficulties encountered during the work
- ensuring that all excavations are fully supported in accordance with a design by a competent temporary works designer. It should be inspected to ensure compliance with the design, and inspected at the start of each shift to ensure it remains safe to enter by a temporary works supervisor
- ensuring that all open excavations are fenced-off to prevent anyone falling in.

See **General guidance 1 Case study 1**

## For clients

# Removing a wall

Removal of a wall may appear to be simple, but there are many issues to consider, including:

- planning
- party wall – if the building is not detached or if the work affects the ground under a nearby building
- building control
- support for whatever sits on the wall, eg whether a wall in the room above and/or loads from any floors or roofing that are supported by the wall, these loads will need to be carried on a new beam (or beams) spanning the new gap. This involves understanding loads and load paths and how they will be affected by the removal of the wall (see **Case study 1**)
- strength, stability and stiffness during the building process, to avoid cracking in particular
- increases in loads that will be applied at the edges of the length of wall – the walls at the edges of the length of removed wall may not be strong enough to resist the increased loading applied there (see **Case study 2**)
- changes in:
  - how wind forces are resisted by the building
  - the stability of walls that were stiffened by the wall being removed
  - how loads are applied to foundations – existing foundations at the edges of the length of removed wall may not be strong enough to resist the increased loading applied there
  - fire resistance and means of escape in a fire
  - the insulation of the building against heat loss
- effect upon services fixed to or running within the wall (electrical, water, heating etc).

**Case study 1 Inadequate support to an opening in the wall of a house**

If an opening is made without adequate support during the work, there may be cracking and movement that will need to be investigated and repaired.

**Case study 2 Front wall collapse due to removal of internal load-bearing wall structure**


Four terraced properties were being refurbished when three of the front walls collapsed inwards.

It transpired that a previous contractor had removed much of the internal load-bearing wall structure. The scaffolding shown was erected to arrest the collapse from spreading further along the terrace.

Courtesy RKF Consult Ltd

**Case study 3 Shoring can provide good support**

Substantial shoring provided good support to a wide opening when an opening was made as part of an extension to a house.

## For clients

# Building an extension

Adding an extension may appear to be simple, but there are many issues to consider (see **Case study 1**), including:

- planning
- party walls – if the building is not detached
- building control
- the requirement for new foundations taken down to a depth that can be relied upon to give firm support
- consideration of differential vertical movement of the new extension, relative to the existing structure, because the new structure will settle as it is built and load is applied to the new foundations
- the effect of the extension upon the existing building, including any existing walls that have to be removed
- changes in fire resistance and means of escape in a fire
- changes in the insulation of the building against heat loss
- effect upon services systems (electrical, water, heating etc)
- loft extensions present particular difficulties.

**Case study 1 A house collapse due to inadequate propping**

This house collapsed while an opening was being formed in an existing wall, ready for a new side extension.

The opening was inadequately propped using a proprietary system.

## For clients

# Carrying out a loft conversion

The construction of habitable space within an existing loft may appear to be simple, but there are many issues to consider, including:

- planning
- party walls – if the building is not detached
- building control
- the requirement for existing structure and foundations to take loads from the modified structure, which will usually involve not only new loads, but also a redistribution of existing loading
- consideration of differential vertical movement as the new configuration of loading is applied to the existing structure and foundations
- the effect of the work upon the existing building, including any existing structure that has to be modified
- changes in fire resistance and means of escape in a fire
- changes in the insulation of the building against heat loss
- effect upon services systems (electrical, water, heating etc).

**Case study 1 Roof collapse during refurbishment**

The roof of a terraced house was being refurbished and strengthened. Additional support steelwork had been installed, but the existing roof ties/ceiling joists were cut before providing any temporary support to the existing roof. The weight of the roof pushed the walls out and the roof collapsed onto the new support steelwork. Fortunately, the workers were on their lunch break at the time.

## For designers

# The importance of the designer's role

Each designer involved in a construction project has clear duties under CDM 2015 (see HSE, 2015) that they should be familiar with. **CITB** also provides guidance for designers.

The central duty on the design team is to eliminate foreseeable risks (so far as possible) and then to contribute to the control of remaining risks. This activity will be led by the main or principal designer (PD). This may result in the design team suggesting one of the following:

- a build sequence that aids construction
- adding low-cost features to components that allow safe and easy installation
- providing a design for necessary temporary works
- (as a last resort) comply with their duties under CDM by alerting the contractor to areas where the contractor may need to apply unusual control measures. This means that constructon work can be carried out safely and without affecting the health of workers.

**Case study 1 Collapse due to excessive load on a small beam**

This collapse occurred when a large beam put load onto a small beam that spanned over a window opening.

The small beam was part of an existing structure that had not been properly surveyed and understood by a competent structural engineer.

Often, this information will be incorporated within construction plans/drawings and accompanying instructions. For temporary works, contractors may need to be referred to additional drawings and paperwork.

Each designer should understand the scope of their appointment and plan their work to contribute to the safe delivery of the project. They must provide information to site to explain significant or unusual hazards that will need to be controlled by the contractor. Each designer needs to be clear about what they need to provide and how to deliver to the client/contractor. In many cases the main designer or PD will need to see drawings and other paperwork. The project arrangements should make this clear.

Financial and time pressures should not be used as an excuse for site operatives or others (such as occupants or the public) being put at risk (see **Case study 1**). Some of the issues that can arise are discussed as follows. This guidance may be useful for those making appointments as well as for the designers.

Refurbishment work (even on a domestic scale) can often present great complexity and designers must:

- have a safe sequence of work in mind
- provide information about that sequence
- seek to be involved in the construction phase, to be satisfied that the design intent is taken into account in a safe manner.

Designers working on a refurbishment project need to have relevant experience and take account of particular issues that arise when existing construction is being modified. For example, removal of render and plaster from an existing wall can significantly reduce its strength, both due to the loss of material and the physical 'hacking' work, so removal should be avoided if possible. If it is necessary, the strength and stability of the wall should be carefully considered both in the final state and any temporary conditions, taking account of restraint and exposure to wind and rain.

Designers also need to take account of deterioration, decay etc and the fact that what exists on site may be different from what old drawings suggest.

This means that designers need specialist knowledge and experience and to exercise caution. Review and checking by a competent person with significant experience in this type of work is vital.

**Case study 2 Calculations should be part of the design process**

A structural engineer with a limited role appointment produced 'quick and cheap' calculations.

A building control officer (BCO) received a set of calculations, which had been prepared through a company that specialises in providing calculations at a very low price. They do this by having a number of generic designs that are then adapted to the purpose.

The calculations were done without an engineer visiting the site or clarifying site conditions. Concerns were raised about their accuracy by the local authority. The calculations were done 'on the cheap' and as an afterthought rather than being an integral part of the design process. Luckily, on this occasion, the calculations were deemed acceptable by the BCO.

Three scenarios that have been noted in practice, which may be of concern to designers:

1 A structural engineer is employed to provide calculations, without visiting a site or understanding how the work will be done (see **Case study 2**). The structural engineer taking on work in this manner risks becoming involved if things go wrong because of a failure to co-operate/co-ordinate with others.

2 The structural engineer is employed to design, but with minimal (or zero) site visits to see that the work is being done as intended. A structural engineer taking on work in this manner risks becoming involved if things go wrong, unless their appointment is absolutely clear – and even then there will be a residual risk that those involved on site will say that the information they were provided with was inadequate.

3 There is no co-ordinating PD active on the project. This is illegal unless the works are very minor (just one builder/ contractor involved, no subcontractors appointed). The role of the PD in getting the designers to work as a team should substantially reduce the risk of misunderstandings and provide a route for designers concerned about risks on a project to have them addressed. The statutory duty must be made clear to any commercial client.

## For builders

# Planning and managing a project

In setting out on a new project, the following checklist may help:

| Project roles | |
|---|---|
| Who is undertaking the role of the principal designer (PD) under CDM 2015? | |
| Who is undertaking the role of principal contractor (PC) under CDM 2015? | |
| Who will be the project manager (PM) for the work? | |
| What temporary works design is required and who will be involved? (Excavation support, crane base, demolition, temporary propping, sway stability etc) | |
| Who will co-ordinate the temporary works design? | |
| Who will supervise the overall work on site? | |
| Who will supervise the temporary works on site? | |

Often these roles will be undertaken by the same person, so it is important that they understand the roles they have to play, and that their inputs are co-ordinated.

Before starting the work:

- Has the PM planned the work in detail?
- Is the structural work (permanent works and temporary works) designed and clear? Is it all 'buildable'? (see **Case study 1**).

A typical activities checklist is listed here:

| Typical key activities | |
|---|---|
| Allocate responsibilities clearly. | |
| Make sure the site has been properly investigated before work starts, especially asbestos, existing services, manholes, contamination, any other hazards suspected – then keep an eye out during the work. | |
| Maintain structural lateral stability at all times – keep enough existing walls etc in place on a refurbishment project. | |
| Provide temporary vertical propping where necessary. | |
| Do not overload the structure. | |
| If anything is to be demolished, plan in detail how it will be done safely, instruct workers, supervise closely. | |
| What are the risks in doing the work? Can they be eliminated? Plan the work to manage the residual risks so as to minimise and control them. Prepare safe working procedures to support the plan of work and communicate them on site. Manage the work to ensure those procedures are established and followed. | |
| Keep the site perimeter safe and keep workers away from danger by establishing exclusion zones (eg work overhead). | |
| Environmental issues to be managed. | |

As part of managing health and safety within a business, the risks must be controlled. The risks need to be identified and it should be decided how they will be eliminated or managed to reduce them so far as is reasonably possible (SFAIRP) (eg through a workplace risk assessment). This is a requirement by law and if a company has more than five employees, make a record.

**Case study 1 Beams left unsupported due to errors in planning and managing the work**

During the adaptation of an existing structure, the sequence of work on site involved the installation of new columns before the old columns were removed. The site team did not appreciate exactly what was required and removed the existing columns first, leaving the floor in a dangerous condition, before the building control inspector saw what was happening and the beams were hastily propped.

In this case, the project team were fortunate that the BCO had the knowledge to recognise the concern and advise on temporary works to correct the error. Contractors must seek advice about temporary conditions and temporary works – they cannot expect to rely upon statutory inspections that may be conducted to deal with other matters.

For further information see **CROSS Report 479**

Failing to plan and manage the work can lead to accidents, delays, added costs and even an appearance in court with a potential fine and/or jail sentence (see **Case study 2**).

Further guidance is given by:

- **CITB** (industry guidance for contractors)
- **HSE** (CDM 2015)
- **CIRIA**
- **ASUC** (underpinning, basements, structural repairs)

Relevant British Standards are:

- BS 5975:2008+A1:2011 – procedural controls for temporary works.
- BS 6187:2011 – advice on full and partial demolition.

**Case study 2 Poor design and construction can lead to injury or fatality, and subsequent heavy fines and reputational damage**

A major builder was heavily fined in 2015 after a worker was badly injured when a work platform over a stairwell collapsed. The platform had not been properly designed to support the worker and the blocks stored on it.

Today, it is notable that fines after deaths or injuries are substantial adding to all the other costs and reputational damage incurred when there is an accident.

**Further information**

CROSS (2015) "Dangerous alterations" *CROSS Newsletter 13, Report 479*, Structural-Safety, UK
www.structural-safety.org/media/384703/cross-newsletter-no-40-amended-october-2015-1.pdf

### Standards

BS 5975:2008+A1:2011 *Code of practice for temporary works procedures and the permissible stress design of falsework Code of practice for temporary works procedures and the permissible stress design of falsework*

BS 6187:2011 *Code of practice for full and partial demolition*

## For local authorities and other government agencies

# The importance to clients of CDM 2015: the risks and their duties

In the UK the planning and the building regulations systems are the main interfaces between clients for building and local government. So, it would be reasonable to assume that LAs would seek to ensure that clients for construction work are aware of the issues they need to take into account when carrying out building work (see **Case study 1**).

At the time of writing, the situation is thought to be mixed and that there are opportunities for improvement, including the option of directing clients and others involved in construction work to the information provided by CIRIA in this series.

An overview of the series is provided in the **introduction**.

Suggested links:

- **Central Government** and **local government** websites that provide guidance to clients and others about planning and building.
- **HSE** website provides guidance about construction.
- **Building Regulations** and HSE advice where information in this series may be referred to and signposted.

**Planning application forms**, suggested details are given in **Box 1**.

**Figure 1** is a flow chart showing the transfer of client duties from a domestic client to other duty holders involved.

**Case study 1 Ignoring the advice of the structural engineer can lead to disaster**

A house collapse was caused by a builder carrying out underpinning works. The property, which was a semi-detached house, had previously been part of a larger terrace. It had only recently been bought by a first time buyer who noticed a problem with the gable wall and a structural engineer was commissioned to investigate.

The recommendation was that a new external leaf should be constructed off a new foundation including underpinning of the existing wall in short sections. The structural engineer's report also described works to be carried out before underpinning and these included a requirement to tie the existing wall into the main house. The engineer gave advice to the owner on selection of a suitably-qualified contractor, and also offered to supervise the works. Unfortunately, the owner decided to employ a builder on the recommendation of a friend. The builder ignored the structural engineer's report in respect of preliminary works and sequencing of excavations. Instead a trench was excavated the full length of the gable and left overnight without any temporary support.

During the early hours the wall collapsed, the photograph shows the condition of the wall when the building control officer (BCO) attended. The occupiers, including a baby asleep in the cot in the rear bedroom, were lucky not to be injured and were rescued by the Fire Service. To make matters worse the builder was uninsured and the owner's insurers would not accept liability.

For further information see **CROSS Report 128**

**Case study 1 Clients can be prosecuted following accidents**

In 2012, the owner of a property that was being rented out (and so a commercial client with strong duties under CDM) employed inexperienced workers to carry out repairs on the roof using only ladders for access. One fell off and was killed. The owner was later found guilty of failing to use competent contractors and was sentenced accordingly.

**Further information**

CROSS (2009) "Domestic collapse No 2", *Report 218*, Structural-Safety, UK
**www.structural-safety.org/publications/view-report/?report=3122**

*Box 1* *Planning application details*

## Proposed CDM and structural works declaration

Has sufficient research been carried out and is there sufficient experience to understand the duties under CDM 2015?

**Yes/No**

1 For domestic clients, who has been appointed to provide assistance? (See **Figure 1** flow chart to assist in understanding the situation of a domestic client under CDM)

.....

2 Who is undertaking the role of principal designer (PD)?

.....

3 Who is undertaking the role of principal contractor (PC)?

.....

Note questions 2 and 3 may be answered 'none' only if the work is being undertaken by one builder without any subcontractors (normally only on very small projects).

Does the work include any structural works, such as:

- 'Soft-strip' of render or plaster or of lightweight walls or furniture that might be providing fortuitous support to a floor above.
- Refurbishment (such as complete or partial removal of foundations, floors, walls, foundations, roof etc or the making of penetrations in them) – involving groundworks, masonry, steelwork, timber, concrete or other structural materials, or the provision of scaffolding for access, temporary roofing or lateral support.
- New-build construction.

**Yes/No**

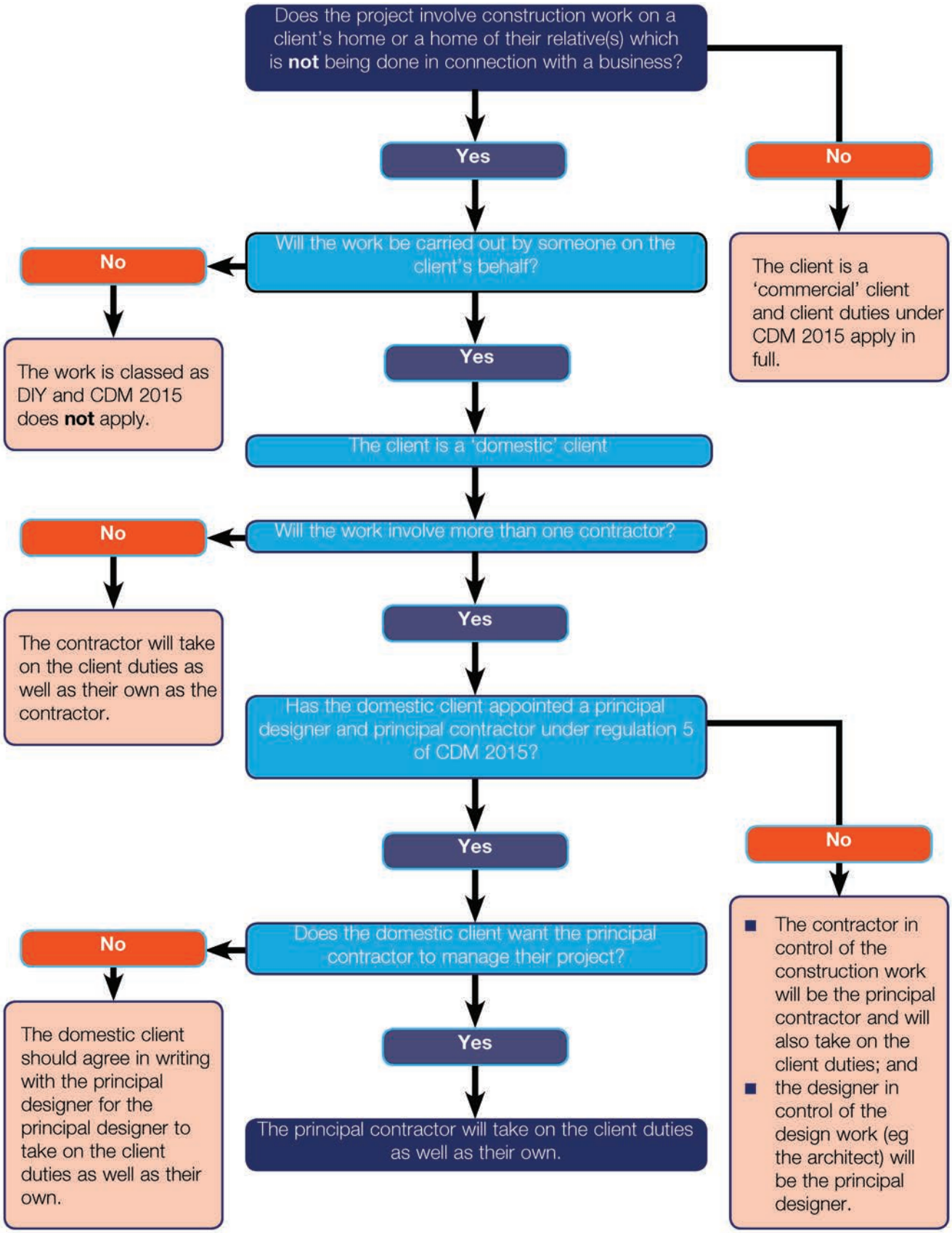
If yes, has a competent structural engineer been appointed to develop the structural design?

Name and company:

.....

If no, please explain why not:

.....




Note: this flow chart shows the transfer of client duties from a domestic client to other duty holders involved.

*Figure 1 How CDM 2015 applies to domestic clients (from HSE, 2015)*

## Refurbishment

# Investigating and assessing existing structures

Unless the work is simple and the builder or architect making the assessment are experienced in the type of construction, it will usually be necessary to appoint a suitably-experienced qualified structural engineer to plan the investigation and carry out the assessment.

The right level of experience in buildings of the age and history involved is important. A builder experienced only in modern methods of construction would struggle to know or identify issues with an old building, especially where construction features are hidden. For example, foundations may be non-existent, inserted joist ends may be rotted out to the point of no contact, nails may appear intact at the surface but have hardly any strength at the timber to timber interface, wallplates, joists, rafters etc may be completely unstrapped, load bearing stud walls may look by modern standards to be non-load bearing partition walls. In other words residual strength may be so low that any disturbance could cause rapid progressive failure (see **Case study 1**).

The investigation and assessment of an existing structure involves more than looking at what can be seen. The work is 'structural investigation and assessment' and not a 'survey'. There are many types of survey and the term is too ambiguous to be useful in this context, although surveys for particular defined aspects (for example for hazardous materials such as asbestos or for environmental issues) will be relevant.

The term 'structural survey' is to be avoided because misunderstandings can arise between clients and professional advisors about what is actually included or excluded and the degree of intrusive investigation to be carried out.

Questions to be answered include:

- What are the structural arrangements?
- What materials and construction techniques have been used?
- What strength of the materials can be relied on?
- What will the new loading be (during the work and on completion/in service)?
- How are loads currently transmitted (the 'loadpath')? (Sometimes load paths are not clear as a structure will come to a state of equilibrium over a period of many years).
- Are any areas unsafe and need immediate demolition or shoring? Areas of distress (such as cracking, bulging, loose masonry) need particular attention.
- Are there any problems, for example corrosion, decay or other degradation due to moisture ingress?
- What strength of the materials can be relied on?
- What will the new loading be (during the work and finally)? And will the new load paths be different from the existing?
- Are there any problems, for example corrosion or other degradation?
- Is the structure weather-tight (roof and flashing)? If not, it is likely to continue to deteriorate quickly (rot). What is the state of any tanking or damp proof membranes (DPMs)? If in poor condition, damp will be a major consideration.
- How plumb and straight are existing walls and how flat are existing floors (or are they sagging excessively)?
- Have repairs or alterations been carried out during the life of the structure?
- How will new materials interface with the existing and what tolerances should be allowed?
- Vibration and construction disturbance including contact with plant, eg risk to brittle cast-iron columns or beams?
- What are the foundations and, if the structure has a basement, what are the retaining walls and what are the ground/groundwater conditions?
- Is there degradation due to, for example, ingress of vegetation into the structural fabric infestation with wood worm, vermin, guano etc?
- Will venting of voids need to be changed?
- Is the structure likely to be affected by external factors (eg vibration from a nearby railway line)?
- Have former industrial buildings been subject to heavy cyclic loads, eg Victorian mills, and should fatigue be considered?
- How does the structure sit in relation to current Building Regulations? Will major upgrading of existing parts be required to meet current codes? Are existing parts capable of supporting the additional loadings likely to be imposed by upgrade works? Will any exemptions to Building Regulations be needed to ensure that either existing parts are not overloaded by works to meet current standards, or that current standards are reduced to prevent existing parts reaching their design limit when assessed against current standards?
- What do records and site investigation reveal about the building's structural history, eg alterations, modification, changes of use, refurbishment. Small changes can have a dramatic effect, eg change of roof covering from corrugated iron to tiles, addition of a fireplace and chimney that was not keyed-in into existing walls, removal of roof members to open up a loft, reduction of masonry load on a pier supporting an arch etc.

Answers will come from some of the following activities:

- existing records such as as-built drawings or the CDM health and safety file for newer structures, although these should not be taken at face value as there may have been changes during construction or later
- a soils investigation
- a groundwater investigation

- assessment of structural elements (foundations, walls, suspended floors, beams, roofs) (see **Case study 2**)
- timber deterioration
- masonry deterioration
- rebar corrosion
- steelwork corrosion (sections/bolts/welds, visible/hidden, general/local)
- confirmation that the structure was built as per records
- note of changes made
- sampling, testing where there are no records
- assessment of existing loads and how they are taken down through the structure
- use of load testing, which to be effective needs to consider both bending load capacity (mid-span) and shear capacity (adjacent to support).

Deterioration may be assessed visually or by probing or testing *in situ*. Testing of samples in a laboratory may be necessary.

Dampness may be assessed using a dampmeter. Rebar may be assessed using a covermeter. In some situations such as cavity walls (where old metal wall-ties might corrode away) a boroscope may be needed.

Past methods of construction and strength of old materials may be assessed using historic records, contemporary codes or expert knowledge.

Modern camera systems for the keyhole examination (of cavities or below ground-bearing slabs or inside foul and surface water drains that might be leaking and causing weakening of ground) are now an affordable option.

Visual records will assist in assessing and communicating issues.

**Case study 1 Listed structures need a cautious approach**

A listed ancient structure to be refurbished required a cautious approach to understand its construction and condition.

It was a planning requirement that existing ancient timbers were retained as far as possible, or be replaced with timbers of similar type and age. This may have entailed dismantling the whole building and then reinstating it, possibly on new foundations, which is a more expensive process than making high quality repairs to the existing structure.

To ascertain the construction and its condition, a protective internal scaffold was progressively erected and the survey work proceeded, observing from within the scaffold. This approach was expensive, but safe and enabled a plan to be agreed and progressed in a manner that was acceptable to conservationists.

Courtesy RKF Consult Ltd

**Case study 2 Building collapse, Tower Bridge Road**

A building collapsed, after construction had started, without an understanding of how the building was founded.

It was decided to construct a shop basement for the storage of stock to increase the sales area at ground level. The designer had been unable to acquire information about the foundations of the adjacent building and noted this on the drawings. Unfortunately when work started on site excavation of the new basement began without any further investigation, undermining the nearby foundations, which caused the collapse.

**Further information**

CIRIA (1986) *Structural renovation of traditional buildings*, R111, CIRIA, London (ISBN: 978-0-86017-257-4)
**www.ciria.org**

ISTRUCTE (2008) *Guide to surveys and inspections of buildings and associated structures*, Institution of Structural Engineers, London, UK (ISBN: 978-1-90633-505-2)
**www.istructe.org/journal/volumes/volume-86-(published-in-2008)/issues/issue-18/articles/guide-to-surveys-and-inspections-of-buildings-and**

**Standards**

BS 6187:2011 *Code of practice for full and partial demolition* (Clause 7 knowledge of the site)

## Refurbishment

# Where to find information about existing buildings

Information about an existing building should ideally come from the structural investigation and assessment, which will be primarily based upon information about the particular structure involved.

The following sources of information about existing buildings may be useful:

- client records, including the CDM health and safety file where this exists
- records and knowledge of previous work, including the records of contractors and designers and the knowledge of the people involved
- local authority records, where these exist
- historic records, for example catalogues of proprietary systems and products (see **Case study 1**)
- contemporary codes, including local building regulations
- expert knowledge (publications or personal contact).

IStructE (2010) gives comprehensive guidance for the use of professional engineers, but it starts with a warning: *"Appraising is not for the faint-hearted nor for the inexperienced"* (see **Case study 2**).

Other sources of guidance and access to expert knowledge are available via web searches, through publications and journals published by **IStructE** and the **ICE**, and from the **Conservation Register for Engineers (CARE panel)**. Also, librarians can provide access to information.

**Case study 1 Chapel collapses during underpinning**

The underpinning work failed to take account of the poor state of the walls. This information existed in historic records, but had not been accessed by the design team.

**Case study 2 Shop collapsed into new foundation work behind the shop**

This scene of devastation shows the back wall of the shop and some of the shop stock having collapsed into a hole behind the shop. This happened because new excavation behind the shop proceeded without an understanding of the shop's foundations and the forces upon them. The existing foundations were disturbed by the new work and overturned backwards into the new excavation.

**Further information**

ISTRUCTE (2010) *Appraisal of existing structures, third edition*, Institution of Structural Engineers, London (ISBN: 978-1-90633-504-5)
http://shop.istructe.org/appraisal-of-existing-structures-third-edition.html

# Refurbishment
# Dos and don'ts

✓ Do gain an understanding of how an existing structure works

See **Investigating and assessing existing structure**
**Where to go for information about existing buildings**

✓ Do provide reliable temporary vertical propping

See **How to use props correctly**

✓ Do plan 'soft-strip' to reduce the risks of unforeseen problems occurring

See **Planning 'soft-strip' to reduce the risks of unforeseen problems occurring**

✓ Do get expert input if you build a basement (see **Case study 1**)

See **Building a basement**

**Case study 1 Double basement installation in London**

A double basement under a large listed London property was successfully installed.

Despite the major challenges, after extensive surveys and design work a scheme was prepared and executed by a competent team. The temporary works were substantial.

Courtesy RKF Consult Ltd

× Don't undertake partial demolition without serious consideration

See **How to plan for partial demolition**

× Don't lose lateral stability as structure is removed

See **How to maintain lateral stability**

× Don't overload existing structure (see **Case study 2**)

See **Assessing the load-carrying capacity of floors, beams, walls**

× Don't undermine existing foundations

See **How to avoid undermining existing foundations**

× Don't make holes or openings in walls without a structural assessment of the loads to be carried and the vertical support required

See **How to assess masonry when planning penetrations**

× Don't remove part or all of a chimney breast without serious thought

See **How to remove chimney breasts safely**

**Case study 2 Front wall collapse due to removal of internal load-bearing wall structure**

Four terraced properties were being refurbished when three of the front walls collapsed inwards.

It transpired that a previous contractor had removed much of the internal load-bearing wall structure. The scaffolding shown was erected to arrest the collapse from spreading further along the terrace.

Courtesy RKF Consult Ltd

## Refurbishment

# How to avoid undermining existing foundations

Foundations of the structure being refurbished and adjacent structures should not be 'undermined' except temporarily and in sequence over a small proportion of their length, typically less than one metre at a time – by following a sequence prepared by a temporary works designer.

As the load from the ground-bearing foundation is transferred to the soil, it spreads downwards outside the footprint of the foundation. The load-spread is typically taken to be 45 degrees (see **Figure 1**)

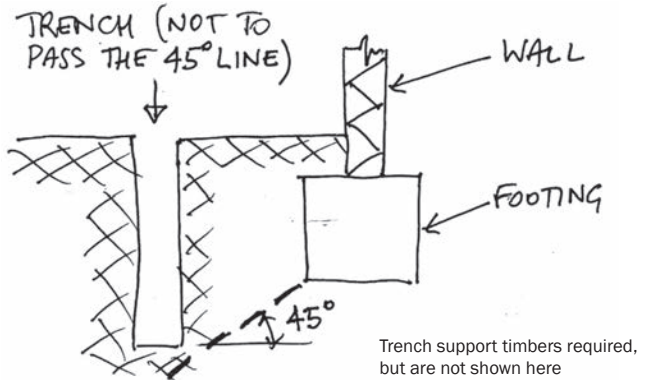



*Figure 1 Showing 45 degree load spread*

The 45 degree principle is an important concept that anyone undertaking excavation work needs to understand. It can assist in assessing whether a trench can be used, or whether alternative means of placing foundations or services may be needed. It should not (as a rule) be followed where the:

- foundation level is below the water-table
- foundations are on fill or made ground
- soils are of an organic nature
- soils under the founding level are very soft cohesive materials (for example peat, or wet/running sand or chalk with solution features)
- existing foundations are already under high lateral load, eg due to pressure from retained soils or to the influence of thrust beams or thrust arches or influential foundations at lower depths.

Where nearby foundations are to be affected, the ground below the foundation should be fully supported at all times by a temporary ground support system and designed by a temporary works designer.

Even shallow foundations usually need full support to prevent them collapsing onto workers who may need to enter the trench (see **Case study 1**).

**Further information**

HSE (2012) *Excavation: What you need to know as a busy builder*, CIS64, Health and Safety Executive, London, UK
**www.hse.gov.uk/pubns/cis64.pdf**

**Case study 1 Undermining foundations can lead to collapse**

A trench was dug alongside a house wall, undermining the wall, which collapsed.

Undermining of foundations is a common cause of failure. In this case, a trench was dug alongside a house, below the level of the footings, and the footings slipped sideways into the trench, collapsing the wall.

Note that additional measures may be necessary to take account of heave in clays under the founding level, as overburden is removed.

When excavation has to be carried out that could undermine an existing foundation, the permanent works designer should communicate a safe sequence of work documented and discussed before work starts on site. See HSE (2012).

The following precautions should normally be taken:

- The sequence of excavation should be undertaken such that no more than 20 per cent of any section of the wall will be undermined at any time.
- The exact sequence should be developed by the temporary works designer when the existing ground conditions and the quality of the existing foundations and the condition of the structure above are known. These factors and the chosen sequence should be kept under review as the work progresses.
- Conservative acceptance values for movement and cracking should be agreed and documented.
- To minimise movement of the remaining soil, support the open sides of the excavation with fully designed timbering and prop the timbers so that they can resist the soil pressure. This will also protect workers from risk of a cave-in of the soil.
- Monitor the structure above for signs of movement or cracking and have an agreed plan in place (including additional temporary works) in the event that conservative acceptance values for movement and cracking are reached.
- Make sure that the work is designed by an experienced temporary works designer and supervised by an experienced competent person.

The opinions and requirements of any party wall surveyors advising neighbours need to be taken into account.

## Refurbishment

# How to plan for partial demolition

The dangers inherent in demolition work and the result this can have unless suitable control measures are used should be obvious. However experience among investigators suggests that short cuts are often taken in the misplaced hope that the work will be completed before gravity can catch up.

During many refurbishment projects there is usually a need for partial demolition – the removal and adaptation of an existing structure to make it safe to work on before a new structure is added, starting with making the existing structure safe to work on (see **Case study 1**).

This work should be given the same degree of care and attention as complete demolition and the following special features recognised:

- Workers and others are likely to be exposed to the risks for long periods of time.
- Traditionally, workers were required to be within the structure, whereas nowadays much demolition is carried out using machinery outside the debris zone or using remotely-controlled machinery so that the operator is not at risk of being struck by debris.
- The structural adaptations are often complex and require careful thought and planning and carefully specified sequencing by suitably-qualified and experienced experts.

The key people involved will be the:

- designer and checker for the permanent works, normally a qualified structural engineer
- contractor's project manager
- contractor's temporary works designer and checker, normally a qualified structural engineer
- principal designer (PD) who must ensure that all parties co-operate to co-ordinate their work.

In the UK, BS 6187:2011 *Code of practice for full and partial demolition* is the main code of practice for demolition. The reference to 'partial' demolition was added in 2011 in recognition of the risks inherent in the refurbishment of existing structures (see **Case study 2**). The main points from BS 6187:2011 are:

- management of the demolition process
- structural assessment of the whole building to ensure correct understanding of the parts that need to be removed and the effect that step-by-step removal will have on the remainder
- maintaining structural stability
- managing any deliberate structural collapse
- identifying and establishing responsibilities

**Case study 1 Supporting façades and cross-walls before reconstruction**

The façade of a housing mews in London was carefully supported to an engineered design before reconstruction of the interior started. The internal structure was then carefully removed, leaving supported façades and some cross-walls.

The existing structure was fully investigated and surveyed, enabling a façade retention scheme to be designed by the temporary works designer and installed by a competent contractor. There was extensive crack and movement monitoring during the work.

Courtesy RKF Consult Ltd

**Case study 2 Partial demolition can be hazardous**

A worker was badly injured during the partial demolition of a building in London.

The existing structure was weakened and became unstable, leading to what is known as 'unplanned demolition' of a large area of the upper floors.

- acquiring a knowledge of the site
- managing environmental issues
- managing health and safety hazards
- carrying out risk assessments and planning accordingly
- establishing and managing procedures
- determining and managing safe exclusion zones.

Façade retention is an extreme example of partial demolition with little, if any, internal construction retained, and requires substantial temporary works. Guidance on façade retention is given in Lazarus *et al* (2003).

**Further information**

LAZARUS, D, BUSSELL, M and ROSS, P (2003) *Retention of masonry façade. Best practice guide,* C579, CIRIA, London, UK (ISBN: 978-0-86017-579-7) **www.ciria.org**

**Standards**

BS 6187:2011 *Code of practice for full and partial demolition*

## Refurbishment

# Planning ‘soft-strip’ to reduce the risks of unforeseen problems occurring

‘Soft strip’ involves the removal of non-structural materials before any actual structure is demolished or adjusted. For example, wall linings or panelling, insulation, fitted cupboards or kitchens etc. It may appear relatively innocuous, but there are dangers.

When considering removal, check that what is being removed is non-structural. Be aware of:

- the presence of asbestos
- walling (initially thought to be non-structural, but on detailed investigation may be supporting a floor above)
- walling thought to be solid may be rubble-filled
- panelling, floor-boards, ceilings that are thought to be non-structural, but actually provide stability back to lines of lateral stability (ie walls)
- where there is severe (but hidden) deterioration of the structure, removal of material may trigger collapse. Even the removal of a window-frame where the fortuitous support it provided to a weak lintel above has triggered a large, fatal collapse (see **Case study 1**)
- removal of fire compartmentation or fire protection, which together with disturbance of gas and electrical services, makes a building less safe for remaining occupants, or workers at the site
- the methods used to carry out soft strip must also be considered – aggressive removal may disturb the main structure and cause collapse. Storage of removed materials on upper levels, or piling up material against a weak wall may cause overload failure (see **Case study 2**).

Actions to take:

- A survey for the presence of asbestos should always be carried out and form part of the pre-construction information. Be aware of hidden danger as even a good intrusive survey may fail to find asbestos that is in poor enough condition to fill the work area with airborne fibres when it is disturbed.
- Carry out an intrusive/refurbishment survey, ie it is not acceptable to rely on an existing landlord’s survey that is only suitable for users of the building.
- The work to be undertaken must be clearly and comprehensively documented, noting areas of the structure that must not be damaged and indicating where exploratory work is required before proceeding.
- Areas that must not be touched and areas that must not be entered should be marked by signs or painted to make clear the concern. This may cross reference to the documents, but as well as providing a physical barrier, the required action and the reason should be clearly marked to all, eg providing a sign with ‘Keep out – weak floor’.

**Case study 1 Removal of non-structural elements can prove fatal**

A building in Liverpool collapsed and a worker was found dead under the rubble.

The scope of ‘soft strip’ has to be carefully controlled. In this case, the removal of apparently non-structural elements led to a situation where a wall was left with inadequate stability, leading to the failure.

- If there is any doubt about the strength or stability of a structure, stop work and report to the designers.
- Have props handy and if in doubt, use them.

If a building remains partially occupied, the designers must ensure that fire protection is not compromised and the builder must ensure that gas and electrical services are maintained in a safe condition. The safety of workers must also be considered, especially in multi-storey buildings where escape will be more difficult.

**Case study 2 Fatal incident following the refurbishment of a retail unit**

The need for a full investigation of a structure before making changes was demonstrated when a fatal incident occurred when a retail unit was being refurbished.

Above the entrance to the retail unit was a long fascia panel carrying the shop name. This was to be retained. Beneath this the shop front superstructure incorporated a series of timber display units with glazing.

Steel hanger brackets extended from the concrete floor soffit above the retail unit. The overhead fascia panel was partially fixed to these brackets. However, the fascia panel was also partly supported by the floor level display units. The steel hangers and the fixing points both to the concrete ceiling above and into the fascia were visible above a false ceiling.

At the time of the incident the false ceiling had been removed and the shop front including the display units below the fascia panel had been dismantled. Without warning a 10 m long section of the overhead fascia panel weighing over 500 kg detached at one end and fell to the ground. A worker who was underneath as it fell suffered fatal injuries.

This incident shows the importance of exposing and correctly assessing the condition of large, heavy items and how they are supported and fixed. Where there is any doubt additional fixings should be designed and installed, or alternative means of supporting a vulnerable item should be designed and installed. Structural inspections, assessments and design work needs to be carried out by a competent person to take account of all foreseeable loadings and existing support systems. A structural engineer should be available to help with the structural assessment and design of new or temporary supports and to advise on the sequencing of work.

It is also important that planning for intrusive works – including those necessary to carry out structural assessment – should take into account the possible presence of asbestos-containing materials (ACM). Asbestos should not be disturbed unless proper control measures are in place. This may require assistance from a trained asbestos surveyor. Removal of ACM may require the services of a contractor holding a licence to work with asbestos.

## Refurbishment

# How to maintain lateral stability

It is not enough to provide vertical support, lateral stability should also be provided to be safe and to resist wind-loading and anything else that could knock the structure over sideways.

This means that throughout the work, there has to be lateral stability in all directions. This is generally achieved by having enough walls in both directions at right-angles, or adequate designed structural framing instead. In addition, floors have to be able to act as a diaphragm to carry loads back to the walls or framing and where there are arch structures lateral support at the springings must be maintained.

**Anything that looks or feels unsafe probably is unsafe.**

If there is any doubt, or if the guidance given here is unclear, appoint a competent structural engineer to provide advice.

At all times, the strength of the structure against lateral movement should be adequate to deal with:

- wind loads
- eccentric loads that cause sideways lurching
- out-of-vertical walls that need to be laterally supported
- accidental impact forces, particularly where there are known risks
- unreliable foundation systems, for example where there are known areas of weakness.

**Case study 1 Dangerous temporary works during conversion of an existing building**

This shows the inside of a building with little residual internal structure to provide stability to the external walls.

The internal structure of a two-storey building had been completely removed. This building was previously a row of three or four shops in a longer terrace and all cross walls and the first floor had been removed. The front wall was about 18 metres long with no returns. The roof trusses, six metres above the ground floor, had been left supported on props made by nailing floor joists together, one at each party wall position.

For further information see **CROSS Report 46**.

In addition to any known or assessed forces, there should be adequate lateral strength in any direction to resist a disturbing lateral force equal to 2.5 per cent of the weight supported (plus safety factor). This check is in addition to normal 'code' design checks. The value of 2.5 per cent suggested for temporary works is to take account of the risks of events such as accidental impact on temporary works, which may occur during construction – a higher value may be appropriate in some circumstances.

Relying on adjacent properties to provide stability may not be safe in the long term as they may be demolished or the entire row of properties may sway over together. For example, where a row of shops have all had their internal walls removed to increase the areas of an open shop floor. The frontage is likely to be entirely glazed, so the resistance to sway-collapse will be poor (see **Case study 1**). Also, end-properties may pull away from the rest of the block.

Masonry may be damaged by excessive impact and vibration during demolition. Pieces may become detached and fall, endangering those beneath. The strength and stability of whole elements of a structure may be compromised in extreme cases, for example if frictional restraint is lost.

**Case study 2 Unbraced props can lead to collapse**

One corner of a building had been removed, and it was supported along one edge by slender props.

Assessing the stability of complex domestic structures is difficult and temporary works designers will be cautious. But not in this case.

Note that the props are loaded eccentrically, causing them to bow outwards. Also, most of the props are supported by a beam-and-block floor, which may be overloaded.

Even if the supported structure above does not collapse, very little movement will be needed to cause cracking that cannot be repaired without dismantling and rebuilding. This job is not only dangerous, but the total costs and timescale will grow if damage occurs. To a sensible client and experienced contractor risks like this are simply not worth taking.

For further information see **CROSS Report 482**.

**Further information**

CROSS (2006) "Removal of internal structure", *Report 46, Newsletter 3,* Structural-Safety, UK
**www.structural-safety.org/publications/view-report/?report=3009**

CROSS (2015) "Unbraced temporary propping", *CROSS Newsletter 37, Report 482*, Structural-Safety, UK
**www.structural-safety.org/publications/view-report/?report=4659**

## Refurbishment

# How to assess masonry when planning penetrations in walls

The removal of existing walls, either completely or partially, must not be undertaken lightly, the structure may become unstable or it may be too weak to support the loads involved.

The questions to be asked are:

- Will lateral stability be compromised?

See **How to use props and needling correctly**

- What loads does the wall have to resist? (Vertical loads, wind-loading)
- What is the wall made of and how does it act structurally?
- What condition is it in?
- Is there evidence of previous repairs and alteration?
- How will it act after modification and how will the loads be resisted then?
- Will the foundations need to be extended or reinforced for the new vertical loading system?
- How will any new lintels be installed?
- Does the existing wall next to the penetrations need to be reinforced for strength and stability?

There may also be temporary works issues:

- How can vertical loads be resisted during the work? Is there a need for underpinning, needling or other specialist techniques?
- Are temporary footings (eg to support props or for temporary stabilising structures) required?
- Is back-propping required to support suspended floors?
- Is there adequate working space and access?
- Can heavy beams etc be safely handled/introduced?

See **How to use props and needling correctly**

Except for the simplest of structures, this will require in-depth knowledge and experience and will mean that a qualified structural engineer has to be engaged.

For further advice on removing internal walls, see BRE (1992a, 1992b, 1999).

Some points to note:

- Is the existing wall really understood or are assumptions being made?
- Are there any signs of deterioration? (Rotting timber, frost damage, rusting ties etc).
- Do not drill holes directly under bearings for beams and lintels.
- Use stiff lintel beams or the wall above may crack as the beam deflects. Span/750 may be taken as a maximum allowable calculated deflection (although the precise value taken is a matter of opinion). Deflection due to dead-load may be taken out using folding wedges, to reduce the risk of cracking.
- Some walls will be rubble-filled and particular care is required with any alterations.
- Many external walls are cavity walls – each skin acts separately and each skin needs to be supported. Loads from floors (and generally roofs) will normally be applied to the inner skin and if joist-hangers are used the load will be applied at the inside face of that skin. Exactly how loads from lintels will be applied to the supporting walls needs to be carefully considered – the load bearing on the inner skin will normally be greater. Pad-stones will often be required to provide a firm support to lintels, reduce bearing stresses and improve reliability.
- Load transfer to foundations will change and existing foundations may need to be modified or re-made. Note that this work should normally precede work on the structure above.
- Removal of walls in a row of terraced properties that have already been similarly weakened could cause the entire terrace to become unstable.

**Case study 1 inadequate support can lead to injury**

A worker was badly injured when a hole was made with inadequate support and the wall collapsed.

The original scheme had been to create an opening in the gable wall, but a late change required the opening to extend over the entire length of the gable.

The existing gable wall above the opening was to be supported on a system of short precast planks inserted into the wall and propped from one side using a proprietary propping system.

Unfortunately the insertion of the planks in short lengths and the poor support provided by the props caused the brickwork above to come crashing down as the wall beneath was removed.

Folding (hardwood) wedges (**Figure 1**) may be used to take up load so that the supported masonry does not have to crack to gain support from a new beam inserted below. They may be inserted as soon as the beam is in place, reducing the risk of cracking of the masonry above.

Detailing and dimensions will need to take account of the use of wedges. They may be left in place or removed once the wall is fully supported (and the gap filled).

Final filling of gaps under walls will normally be achieved using dry-pack non-shrink grout, but steel shims or slate may be used.

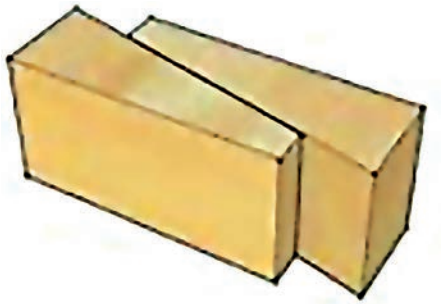


*Figure 1 Folding (hardwood) wedges*

**Case study 2 Removal of old window frames can lead to brickwork collapse**

When an existing window frame was removed, the brickwork above fell and injured a worker.

It was for many years common practice for window frames to be incorporated in the structure as it progressed. So, when they are removed for the installation of modern window systems, there may be sagging or even collapse. In this case, the brickwork panel above was not even keyed into the adjacent walling and it fell as the frame beneath was removed.

**Further information**


BRE (1999) *Removing internal loadbearing walls in older dwellings*, Good Building Guide GG20, Building Research Establishment, Bracknell, UK

BRE (1992a) *Temporary support: assessing loads above openings in external walls*, Good Building Guide GG10, Building Research Establishment, Bracknell, UK

BRE (1992b) *Providing temporary support during work on openings in external walls,* Good Building Guide GG15, Building Research Establishment, Bracknell, UK

www.brebookshop.com

## Refurbishment

# How to safely remove a chimney breast

Removal of an existing chimney breast may appear a low risk, but there are significant structural ramifications:

- The chimney breast may provide stability to the building as a whole and its removal may have wide implications.
- Fireplaces and chimney breasts may have been installed after the initial build, so some are not keyed into the wall – they are abut and can slide down if a lower portion is removed.
- Remaining chimney breast masonry above has to be supported. How this is done can depend on what the neighbour has done – or may do – in the future. Reliance upon the strength of masonry alone (however good it appears) by corbel action is not reliable (see **Case study 1**).
- It will normally be built as part of a wall – is the wall stable and strong enough without it?
- If a 'gallows bracket' is proposed, is it an acceptable solution? CROSS (2015) suggests the current consensus is generally 'no'.
- The sequence of work must be part of the temporary works design and must be documented for use on site.

CROSS (2015) advises that:

*"Gallows brackets may be acceptable, but only where the bracket and supporting wall have been designed by a suitably qualified engineer to cater for the load and eccentricity. The preferred option is an arrangement of horizontal beams in the roof space to provide support to the chimney breast and cheeks. There are a number of items sold to the public which can lead to safety concerns due to inadequate instruction or technical knowledge."*

**Case-study 1 Steel frames can provide good support for a chimney breast**

The remaining chimney breast is supported on new steel framing.

Steel beams taking the weight of the remaining chimney breast above the removed masonry are the best way to provide support.

Work on flues must not be allowed to affect any remaining 'live' flues. Seek advice from an expert as flues are often 'shared' and there are particular requirements and design solutions for different types of heating (solid fuel, gas, oil, mixed systems).

After the work is complete, old flues may need to be blocked up to avoid smoke or gases from remaining 'live' chimneys entering occupied spaces.

Note that mantelpiece assemblies may not be securely fixed back and should be treated with care. For example, in 2012 a heavy mantelpiece toppled over and crushed a child (CROSS, 2012). Decorative stone fireplace surrounds should be securely fixed to the wall. They are not suitable for installation on lightweight partition walls. Stone components should be mechanically fixed to each other. It is not acceptable to rely on glued or mortar connections.

Gallows brackets act as support for brickwork when chimney breasts are removed (see **Figure 1**).

Although gallows brackets have been used many times, collapses have been reported and they are now frequently not accepted by building control. The problems are:

- The fixing of the bracket to the wall may be inadequate, in particular, the tension force at the upper connection.
- The forces from the gallows onto the wall may fail the wall.

Balancing load above from a neighbour's chimney breast may appear to reduce the loads and strengthen the wall, but if the neighbour has removed (or may remove in the future) the chimney breast this beneficial effect will be lost and the loads on the gallows bracket will be increased.

ciria

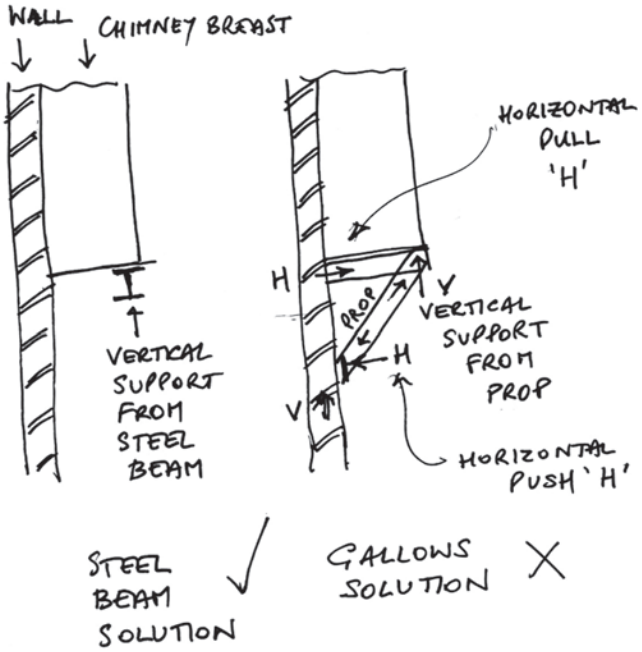



*Figure 1 Gallows brackets*

**Figure 1** shows:

- Steel beam support – beams may span in either direction, back to padstones in masonry walls.
- A gallows under remaining chimneybreast, taking load from above, applying load to wall, including horizontal kicks that apply substantial lateral forces 'H' to the remaining masonry. Note that this masonry may not be reliably able to take forces back to adjacent walls due to the length it has to span, its slenderness and discontinuities in the area of the chimney breast.

**Further information**

CROSS (2012) "Child killed by falling mantlepiece", *Report 145*, Structural-Safety, UK
**www.structural-safety.org/publications/view-report/?report=1458**

CROSS (2015) "Gallows brackets for supporting chimney breasts", *CROSS Newsletter 40, Report 481,* Structural-Safety, UK
**www.structural-safety.org/media/384703/cross-newsletter-no-40-amended-october-2015-1.pdf**

## Refurbishment

# Assessing the load-carrying capacity of floors, beams and walls

The loading has to be assessed (dead-loads and live-loads) at each stage of the work and the way the loads are supported by the structure has to be understood. This will require:

- knowledge about the loads
- knowledge about how the structure 'works'
- assessment of the condition of the existing structure and the strength and stability of the structural elements
- calculation of the loads taken by the various parts of the structure (see **Case study 1**).

Except for simple structures, an experienced structural engineer should be employed.

Things to look out for:

- Reduction in strength of existing structure due to degradation.
- Existing structure not acting as assumed, for example, beams not framing as expected or floors actually being propped by what was thought to be non-structural lightweight infill panelling.
- Existing structure compromised by elements being removed or partially cut out.

Floor removal increases slenderness of walls and can lead to bowing/buckling without an increase (and in some cases a decrease) in vertical loading.

**Case study 1 Do not make assumptions about an existing structure**

Unusually, when the building was originally built there was no corner column in this steel-framed structure.

During later construction for refurbishment the alterations made incorrectly relied upon the corner being supported and the second floor collapsed, seriously injuring an operative.

The lesson for designers is not to make assumptions about the way an existing structure works. Issues like this should normally be caught during a review and check by an experienced structural engineer.

Although in this case it is not known what transpired on site, when there are concerns they should be pursued vigorously. Contractors should not rely upon the designer always having made the right assumptions.

## Refurbishment

# How to use props and needling correctly

During refurbishment work, the propping of existing loads (walls, floor etc) is normal and the UK-wide use of 'acrow' props have a long and successful pedigree.

Props need to be used correctly, the main issues are:

- Is the prop strong enough for the load? (But note loads may be unevenly distributed).
- Is the prop adequately fixed in place at its top and bottom? (It might fall or be knocked out of position).
- Is the prop vertical (not more than 1.5 degrees out of plumb)
- Is the prop too long and slender? (It may buckle without warning) (see **Case study 1**).
- Is the load applied properly at the top? (Ideally applying load centrally, but never more than 20 mm from the centre).
- Is the bearing at the bottom safe? (Good stable detail? Structure strong enough where bearing on a floor? Soil not overloaded where bearing on the ground?).
- Do the operatives know how to install the props and take up the load in the props in a controlled manner?
- Is pre-loading required by the designers?

Props may be used as part of a 'needling' system in which loads from a wall above are supported on temporary beams (or 'needles') passing through the wall to support it while the wall is broken out and a beam introduced.

Experienced temporary works designers and construction supervisors should be aware of these issues and know how to use props safely. Guidance on propping and needling may be found in BRE (1992b) and Filip (2017).

Well-designed needling should provide strong, firm support using stiff beams through the wall and props tightened up to take the load before the opening is made ('pre-loading').

As an alternative to traditional needling supported by props, beams may be placed on each side of a wall, with designed needles to the wall and with designed supports at their ends.

There are many associated products on the market, whose advantages need to be considered with a cautious approach. Their main selling-point is that walls which are to have openings made in them can be supported without the need for needling, ie the traditional method. Advice on the use of these devices should be sought from a competent structural engineer.

CROSS (2006) provides advice on the use of proprietary devices:

*"The use of a steel bracket on top of a prop, giving an eccentricity of about 200 mm would not seem to be such a good idea."*

While it is noted that the recommended allowable load is less than for a normal, vertically-installed prop, the report notes that safety information at hire shops and builders merchants may be minimal.

**Case study 1 Dangerous propping – bowing and unbraced props**

The propping shown here looks dangerous. One wall is supported (externally only) with acrow props fitted with 'strongboy' heads. They are bowing and they are unbraced.

For further information see **CROSS Report 482**.

CROSS (2015) advises that:

*"Clearly any disturbance of these un-braced props could result in collapse.... If these props were erected by a householder, the individual was putting his own family's lives at risk. If they were erected by a builder, the individual was at risk of a manslaughter charge and custodial sentence, should they have failed and caused death."*

Proprietary devices:

- informed industry opinion is that these devices should:
  - only be used for small openings (doors and similar openings up to about two metres wide) in thin walls
  - where the masonry is likely to arch over the opening when it is formed, ie is not near the end of a panel or a movement joint or other discontinuity
  - on the basis that incoming floor or roof joists will be separately propped.
- manufacturer's recommendations must be obtained and followed
- the systems should never be used if there is any pre-existing weakness or instability
- systems that may work with single-skin wall are unlikely to be suitable for a cavity wall
- if there is any doubt, a competent structural engineer must be consulted.

There are many systems available, eg Strongboy, Propmate, Spartan etc (Acrow-prop-head devices). These devices fit to the head of an acrow-prop

and support walling from the side, allowing the installation of a lintel without the need for needling.

These points need to be considered:

- The prop will be subjected to considerable moment as well as the axial load. This will need to be taken into account when calculating its strength – if reliable information is available. The degree of eccentricity will be affected by the extent to which the support plate penetrates into the wall – the manufacturer's recommendations must be followed exactly.
- There will be a lateral 'kick' at the top and bottom of the prop as the support to the masonry is essentially sloping. This may have an effect on the masonry and the stability of the support.
- The plate extending under the masonry will tend to support the masonry at its outer edge. This may have an effect upon the stability of the masonry.
- Supporting two separate skins of brickwork from one side is not possible.

Note that:

- Loads on the supports need to be carefully assessed, including loads from incoming floor and roof joists.
- For cavity walls, supports will be required on each side of the wall unless one skin is well-supported by floor construction which is also propped.

**Note**

Masonry alterations during refurbishment are usually not standard. They should be planned carefully and carried out safely using the most suitable temporary masonry support equipment. Masonry strength may be unknown or variable. The equipment used should suit the fitting access available. This is important to avoid the misuse of equipment which is supporting the structure. This can sometimes be seen in the case of poorly fitted, over extended or eccentrically loaded structural props*.

*Please refer to the manufacturer's website for instructions, guidance and testing information.

If proprietary products or systems are used, the manufacturers' technical information and advice must be acquired and applied using sound engineering principles. Load capacities and other limitations should be respected and potential failure modes understood and designed for.

For further information about needling, see BRE (1992b).

**Figures 1 and 2** show needling schemes that have stable, well-braced supports founded on a solid base.

**'No More Props' by Diversity Products**

This system does not use props, but provides a stiff external beam-type system to support the masonry over an opening. It is offered for creating small openings (doors and similar openings up to 2 m wide). As the device supports the brickwork on one side only, there are eccentricity effects in play and for a cavity wall the system should be applied both externally and internally.

Go to: **https://www.diversityproducts.co.uk/no-more-props/about-us/**

**Brick Brace Safety Tool and Safety System**

Designed to transfer load laterally without the use of props and as such can provide benefits over other systems when used for structural renovations, alterations and masonry repairs. The Brick Brace Safety Tool* (**Figure 3**) works by bracing the existing brickwork without the need for support from the existing brickwork below.

*Please refer to the manufacturer's website for instructions, guidance and testing information: **www.brickbrace.com**

*Figure 1 Good needling*

*Figure 2 A strong, reliable system of needling*

*Figure 3 Brick Brace Safety Tool and Safety System*

**Further information**

BRE (1992b) *Providing temporary support during work on openings in external walls*, Good Building Guide GG15, Building Research Establishment, Bracknell, UK
**www.brebookshop.com**

CROSS (2006) "Existing buildings", *CROSS Newsletter 3*, Structural-Safety, UK
**www.structural-safety.org/media/35847/Cross_Newsletter_No_03__July_2006_.pdf**

CROSS (2015) "Unbraced temporary propping", *CROSS Newsletter 37, Report 482*, Structural-Safety, UK
**www.structural-safety.org/media/376905/cross-newsletter-no-37-final.pdf**

FILIP, R K (2017) "Propping and needling", *Temporary works toolkit*, Part 10, vol 95, 4, The Institution of Structural Engineers, London, UK
**www.istructe.org/journal/volumes/volume-95-(2017)/issue-4**

**Standards**

BS EN 1065:1999 *Adjustable telescopic steel props. Product specifications, design and assessment by calculation and tests*

## Refurbishment

# How to underpin for basement construction under an existing property

Underpinning is the term given to the creation of new, deeper supports to existing structure. When creating a basement under existing construction, underpins are often formed that then become part of the basement construction.

Creation of underpins and the subsequent excavation of ground to create a basement requires a good understanding of the ground and of any existing structures that may be affected by the changing stress state in the ground and in structures above and adjacent to the work (see **Case study 1**).

There are many factors to be remembered including:

- safety of the workers
- stability of the existing structure above as the way it is supported changes
- limitation of movements so that any cracking of existing structures is acceptable
- maintenance of lateral support of underpins as soil is excavated for the basement, otherwise the underpin may be forced into the excavation as soil is removed
- allowance for soil movements as soil is excavated, changing the stress state in the ground
- allowance for water, both during construction and in the longer-term
- any other job-specific considerations identified in expert studies.

Consideration of the many factors involved requires experience of this type of work, and (usually) the ability to develop working methods that are acceptable to all the parties involved. This often includes the party wall surveyors and technical advisers appointed by neighbours.

In the UK, specialists from the ASUC have worked together to advance the art of underpinning, mainly in the London area (see **Case study 2**).

**ASUC** provides freely available guidance on various technical subjects, based on experience. They also offer a warranty form for work undertaken by their members.

**Case study 1 Dangerous underpinning can lead to accidents**

The underpinning shown here looks dangerous. The sides of this excavation were unsupported and could have caved in at any time. Any workers in the excavation would be buried and existing construction bearing on the ground around the excavation would lose support as the ground settled.

**Case study 2 Well-supported underpinning**

The sides of the excavation are laterally propped, supporting the earth creating a safe working environment and a less risky temporary state for the structure above.

This underpinning is well-supported, but note that a screw-jack head-plate on the top prop has not yet been fully tightened against the sheet-piling.

## Refurbishment

# Provision of hoardings, fencing and large sign-boards

Hoardings, fencing and large signboards need to be designed by a competent structural engineer so that wind forces that may be experienced do not cause failure or over-turning. Note that:

- Hoardings need to be supported on designed foundations so that they are firmly founded, allowing for subsequent excavation nearby.
- Fencing needs to be similarly designed and if it is a system, the supplier's recommendations must be complied with.
- Large signboards need to be fixed back securely.
- Hoardings in apparently sheltered areas are also subject to wind loadings. Collapse has even occurred inside buildings due to pressure changes when large doors or roller shutters are opened.
- Signs and hoardings that will remain in place for a long time need to be inspected for deterioration. Where water can be trapped between sheet materials decay can progress rapidly and cause a reduction in strength.

Poorly designed and inadequately constructed hoardings that blew over in windy conditions have caused fatalities (see **Case study 1**).

There are a number of failures of hoardings each year. Generally there is no design, calculations or drawings. Often they were not erected to suppliers' instructions and sometimes are altered during the works, eg ties removed.

Guidance about the design of hoardings is given in TWF (2012).

**Case study 1 Hoardings need to withstand extreme weather conditions**

A hoarding blew over. Failure was not surprising as the stanchions relied upon inadequate counterweights. Even when fixed down into the ground, a design is needed.

**Further information**

TWF (2012) *Hoardings – a guide to good practice*, TWf2012:01, Temporary Works Forum, UK
www.crawley.gov.uk/pub_livx/groups/operational/documents/plappother/pub208452.pdf

# CIRIA members

ABG Geosynthetics Ltd
Active Building Centre
AECOM Ltd
AMC Environmental Ltd
Arcadis Consulting (UK) Ltd
ARL Training Services Ltd
Arup Group Ltd
Atkins Consultants Ltd
Autodesk Ltd
Balfour Beatty Civil Group
BAM Nuttall Ltd
Barratt Developments Plc
Black & Veatch Ltd
BSG Ecology
BWB Consulting Ltd
City of Glasgow College
City University of London
Costain Ltd
COWI UK Ltd
Curtins Consulting
Darcy Products Ltd
Durham University
E3P
Environment Agency
Esri UK & Ireland
Galliford Try Plc
Gatwick Airport Ltd
Gavin & Doherty Geosolutions Ltd
Geobrugg AG (UK office)
Geofem Ltd
Geotechnical Consulting Group
Golder Associates (UK) Ltd
Grosvenor Britain and Ireland
Heathrow Airport Ltd
Henderson Thomas Associates Ltd
Highways England
High Speed Two (HS2) Ltd
HR Wallingford Ltd
Hydro Water Management Solutions Ltd
Imperial College London
Institution of Civil Engineers
Ischebeck Titan Ltd (Ground Engineering Department)
J Murphy & Sons Ltd
James Fisher Testing Ltd
Kier Group plc
Laing O'Rourke Civil Engineering Ltd
London Underground Ltd
Loughborough University
Maccaferri Ltd
Marshalls Plc
Ministry of Justice
Mistras Group Ltd
Morgan Sindall Construction and Infrastructure Ltd
Mott MacDonald Group Ltd
Network Rail
Northumbrian Water Ltd
OES Consulting Ltd
Pinssar (Australia) Pty Ltd
Polypipe
Rail Safety and Standards Board
Royal HaskoningDHV Ltd
SafeLane Global Ltd
Sir Robert McAlpine Ltd
SLR Consulting Ltd
Smith and Williamson LLP
Southern Water Services Ltd
Stantec
Stuart Michael Associates
T&S Environmental Ltd
Temple Group Ltd
Thames Water Utilities Ltd
TOPCON (Great Britain) Ltd
Transport Scotland
UK Green Building Council
United Utilities Plc
University College London
University of Birmingham
University of Bristol
University of Cardiff
University of Edinburgh
University of Liverpool
University of Reading
University of Southampton
WSP
Zero Waste Scotland

**May 2020**

HSE inspectors who attend sites have reported that while larger contractors had made strides in improving the health and safety of workers on their sites, smaller contracting companies, often engaged in smaller refurbishment projects, were of more concern. CIRIA has prepared this guidance to provide information to these smaller companies, as well as providing general guidance for clients, designers and contractors. Messages to government are also presented, based on industry feedback.

The guidance has been prepared following a period of consultation with industry bodies and individual experts. An introductory note provides details of the topics covered, which are presented as a series of toolbox talks (TBTs). These are available to download as individual PDFs and as a combined guide.

It is expected that following publication, the information provided will be improved by further industry comment and research on particular topics.

ciria
C740
9 780860 177753