ICE Specification for piling and embedded retaining walls
2nd edition
Welcome to the latest edition of the ICE Specification for Piling and Embedded Retaining Walls – the third in a highly successful series, some eleven years after the first edition of the complete ICE Specification for Piling and Embedded Retaining Walls (SPERW) and almost twenty years after the original ICE Specification for Piling. This specification has been one of the most popular of the ICE’s standard specifications and has been influential in raising piling standards in the UK and in other places where it has been used. The vast majority of UK piling contracts now refer to it (or to derivatives via the National Building Specification or the Highways Agency’s Specification for Highway Works), and its requirements are well known to most specialist consultants and contractors. The existence of a standard agreed way of executing piling works helps to reduce conflict on site and enables consultants to design more economically by having confidence in how site works will be carried out.

For those interested in the history of the evolution of the document, it is based on the following documents:

- ICE Specification for Piling (1988)
- Draft Specification for Embedded Retaining Walls – unpublished
- ICE Specification for Piling and Embedded Retaining Walls (1996)

The document has a new look to make it more usable. Part A is an introduction to the essential concepts necessary to procure a piling contract. Part B is the specification and is the only part of this document intended for incorporation in contracts. Part C provides guidance for use of the specification and essential background information for specifiers and contractors alike. This is an advance on the previous first edition of SPERW where the guidance was dispersed. This new edition also incorporates the helpful commentary produced by the Federation of Piling Specialists (‘the essential guide’ from 1999) so contained in one authoritative document are all the guidance documents needed to prepare and work to this piling specification.

In terms of national standards, much has happened since the publication of the previous edition. The Eurocodes have been written and are now in widespread usage. Many European standards have now been issued as British Standards. This new edition has striven to keep pace with these fast-moving changes. Likewise, safety standards continue to improve and the piling industry has responded positively to each new initiative.

This specification has been written by practising engineers for practising engineers. It is the product of wide consultation and rigorous review to ensure that it takes account of latest developments and updates to standards. The review panel has been drawn from consultants, specialist foundation contractors and client organisations.
Comments have been widely sought and the penultimate draft was reviewed by specialists to ensure consistency and clarity. Accordingly, this edition represents a major advance and should facilitate even more rapid development of the piling and embedded walling industry. It is therefore commended to the UK construction industry.

Finally, the ICE would like to gratefully acknowledge those individuals who have contributed so much to the development of the specification. Consultants and contractors have collaborated to produce a compromise between a desire for exacting standards and an economical approach that balances risk and cost. It is this long collaboration between many highly-skilled people that makes this specification so valuable. I would like to add my thanks to the contributors for this excellent new edition of the specification.

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*Chairman, British Geotechnical Association*
Acknowledgements

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J. Bickerdike; A. Fawcett; K. Fleming; J. May; I. McFarlane; D. Palmer; S. Thorburn; D. Wake; J. Woodhouse.

ICE Working Group for draft Specification for embedded retaining walls
F. Chartres; J. Findlay (Chairman); E. Haws; D. Sherwood; V. Troughton.

Highways Agency Specification for piling and embedded retaining walls, 1994
D. Bush; T. Chapman; K. Cole; B. Simpson; V. Troughton (Chairman); D. Twine. This specification benefited from earlier contributions by J. Mitchell and A. Turner.

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A. Fawcett; J. Findlay; K. Fleming (Chairman); L. Stansfield.

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D. Evans; K. Fleming; D. Illingworth; P. McIvor; N. Mure; Q. Spear; L. Stansfield; V. Troughton (Chairman); S. Wade; C. Whalley.

ICE Specification for piling and embedded retaining walls, 2007
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Financial support from Network Rail, the Highways Agency and Thomas Telford is gratefully acknowledged. The authors and their organizations have also supported the production of this document by generous donation of their time.
## General requirements

A1 Introduction 3  
A2 Specification roles 3  
A3 Responsibilities for safety, quality and the environment 3  
A4 Enquiry documents 7  
A5 Tender Documents 10  
A6 Tender evaluation 10  
A7 Contract documents 11  

Appendix 1 Example Project Specification 13  
Appendix 2 Recommended electronic tendering protocol 16  
Appendix 3 Example Bill of Quantities 17  
Appendix 4 Typical Schedule of Attendances and Facilities to be provided by the Client to a Piling or Embedded Walling Specialist, including Working Platform Certificate 18

## Specification requirements for piling and embedded retaining walls

B1 Specification requirements for piling and embedded retaining walls 25  
B2 Driven pre-cast concrete piles 47  
B3 Bored cast-in-place piles 49  
B4 Piles constructed using continuous flight augers or displacement augers 57  
B5 Driven cast-in-place piles 63  
B6 Steel bearing piles 65  
B7 Timber piles 71  
B8 Diaphragm walls and barrettes 75  
B9 Secant pile walls 79  
B10 Contiguous pile walls 83  
B11 King post walls 85  
B12 Steel sheet piles 87  
B13 Integrity testing 93  
B14 Dynamic and rapid load testing of piles 95  
B15 Static load testing of piles 99  
B16 Piles with sleeves and/or coatings 111  
B17 Instrumentation for piles and embedded retaining walls 113  
B18 Support fluid 121  
B19 General requirements for concrete and steel reinforcement 123

## Guidance notes on specification requirements for piling and embedded retaining walls

C1 Specification Requirements for piling and embedded retaining walls 133  
C2 Driven pre-cast concrete piles 155  
C3 Bored cast-in-place piles 157  
C4 Piles constructed using continuous flight augers or displacement augers 163  
C5 Driven cast-in-place piles 171  
C6 Steel bearing piles 173  
C7 Timber Piles 175  
C8 Diaphragm walls and barrettes 179
C9  Secant pile walls  189
C10 Contiguous pile walls  193
C11 King post walls  195
C12 Steel sheet piles  197
C13 Integrity testing  203
C14 Dynamic and rapid load testing of piles  205
C15 Static load testing of piles  209
C16 Piles with sleeves and/or with coatings  217
C17 Instrumentation for piles and embedded retaining walls  219
C18 Support fluid  223
C19 General requirements for concrete and steel reinforcement  229

References  237
The Institution of Civil Engineers (ICE) *Specification for piling and embedded retaining walls 2007 (SPERW)* is the latest version of this successful document for piling and embedded walling works. Earlier versions were published in 1988 and in 1996.

*SPERW* has been updated to reflect the latest piling techniques and procurement methods used in the United Kingdom (UK) foundations market, and the introduction of European Standards. *SPERW* is intended for use as a technical specification for piling and embedded walling works either on land or near to shore. It is not applicable for offshore works. Piles or shafts constructed using hand-dug methods are specifically excluded from *SPERW*.

*SPERW* comprises three parts as follows:

- Part A – General requirements
- Part B – Specification requirements
- Part C – Guidance notes

Part A is general guidance describing the requirements typically necessary for the successful construction of piling and embedded retaining walls. Information is given on the tendering process, design and on issues such as safety, quality and the environment.

Part B is the main technical Specification advocated for use on piling and embedded walling works in the UK. Part B comprises 19 sections covering the main piling and embedded walling methods, and the most common testing methods and materials used in these types of foundations works. Definitions are given in Section B1.18.

Part C provides specific guidance on the use of each of the 19 sections within the Specification Part B. This guidance collates the experiences of contractors and consultants involved for many years with piling and embedded retaining walls.

It is intended that this document continues to be used as the UK national standard Specification for piling and embedded retaining walls and that specifiers will continue to refer only to *SPERW* so that its standard clauses need not be reproduced for every contract. Specifiers can make special amendments to *SPERW* with the use of a Project Specification containing the details described within each of the sections in Part B.

Specifiers should refer only to the relevant sections within Part B that are applicable for the foundation type, as indicated by the asterixes in Table 1. In this document the walling Sections 8 to 12 should be specified in conjunction with the appropriate piling method sections; for example to specify a contiguous concrete pile wall Sections B1, B3 and/or B4, B10 and B19 should be referred to.

Parts A and C of *SPERW* are not intended to form part of any contractual Specification, but the guidance contained in Parts A and C would normally be reflected within the contract documentation. It is intended that only Part B of *SPERW* should form part of the contractual Specification.

Part B of *SPERW* is the technical Specification and is intended to be used with any form of contract. Accordingly it does not contain detailed guidance on contract documentation and measurement.
This is because of the plethora of different contract forms now regularly in use in the UK foundations market. For further guidance on contract documentation and measurement relevant for piling and embedded retaining walls, see www.fps.org.uk.

Part B of SPERW relates to materials and workmanship and is not a design document. Every effort has been made to avoid conflict between this Specification, the ICE conditions, the JCT conditions and other forms of contract. However, certain clauses in the ICE conditions do not have parallel clauses in other conditions. Therefore, clauses in this Specification, which the Engineer considers are covered by the contract conditions, should be amended or deleted.

There are many European Standards currently being introduced which will work in parallel with BS EN 1997 Geotechnical design; see Table 2 for some Standards relevant for piling and embedded retaining walls.

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<th>Section no. in Part B</th>
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<td>Dynamic testing of piles</td>
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retaining walls. Some of these have been published and some are still being prepared.

The Eurocode Standards provide common structural design rules for everyday use in the design of whole structures and component products of both a traditional and an innovative nature. The Eurocode programme comprises ten Standards which generally consist of a number of parts. In addition to the Eurocodes, there are several European Standards that cover the execution procedures for geotechnical works which have been prepared to stand alongside BS EN 1997-1 as well as a range of CEN Standards which address testing procedures. Also some British Standards have been harmonized with the European Standards so that they now comply with them.

Monitoring of the development of all Standards independent of SPERW should be undertaken by the Engineer before writing any Project Specification.

This document has been designed for use with common practices, but is not intended to inhibit innovation. Novel solutions, such as the use of ribbed piles, piles with shaft enlargements or enlarged heads to piles, can be used with this Specification provided that additional clauses are included in the Project Specification which will ensure that the final product is constructed in accordance with the design requirements.
Part A

General requirements
General requirements

A1 Introduction

This part of the document is general guidance describing the requirements typically necessary for successful piling or embedded retaining wall works and is not intended to form part of any contractual specification. Information is given on the tendering process and on issues such as safety, quality and the environment.

A2 Specification roles

Within the Specification reference is made to the roles of the ‘Engineer’ and the ‘Contractor’. As this Specification is published by the ICE, the ‘Engineer’ is assumed to have full delegated powers to control the contract and is acting on behalf of the ‘Employer’. The two parties to the contract are the ‘Employer’ and the ‘Contractor’.

Where piling or embedded walling works are executed under a contract which is not governed by ICE conditions, the Project Specification should state which bodies are to be nominated in their place. Where the Contractor has design responsibility under the terms of the contract, the Project Specification should state the role of the Engineer. An example Project Specification is given in Appendix 1.

The term ‘Contractor’ is always deemed to mean the principal or main contractor appointed by the Employer to undertake the contract works. This could be a specialist piling or walling contractor where they are appointed directly by the Employer. This document specifies only the direct contractual responsibilities between the Employer and their Contractor.

It is recognized that under different contract philosophies the ‘Contractor’ may opt to delegate some or all of their responsibilities to other organizations such as subcontractors. Responsibilities between the Contractor and their subcontractors and suppliers should be specified in the subcontract documentation and, in the absence of any provisions to the contrary, the ‘Contractor’ will always be taken to mean the party that is in contract with the Employer.

In Part C of this document the role of ‘Designer’ is introduced alongside the ‘Engineer’ and the ‘Contractor’. This is to help clarify responsibilities as, for the design of piling or embedded walling works, either the ‘Engineer’ or the ‘Contractor’ can be responsible for the design of all, or part of, the foundation scheme, the choice of method, and the piles or wall elements.

A3 Responsibilities for safety, quality and the environment

A3.1 Safety

A3.1.1 Design and construction

Piling is potentially a dangerous activity and, as a minimum, the Contractor must carry out the works in compliance with the requirements of UK law, and pay particular regard to the Health and Safety at Work Act and other safety legislation that is in force and is applicable to the health and safety of persons involved with or affected by the execution of the contract.

The design and construction of the works shall be carried out in accordance with the latest safety legislation including the Construction (Design & Management) Regulations (CDM). All construction plant must be maintained and operated in a safe manner.

A3.1.2 Health and Safety Plan

The Contractor should submit a Health and Safety Plan with the tender, which should include the following:
(a) The Contractor’s Health and Safety Policy Statement.
(b) A general indication of the number and types of employees intended to undertake the contract.
(c) Brief details of the experience and relevant technical qualifications of the Contractor’s Manager/Supervisor responsible for undertaking the contract.
(d) A method statement detailing how the work will be carried out safely. This shall take account of any hazard information supplied by the Employer.
(e) An assessment of any safety systems and general induction training that would be required before work can start on site and how this will be provided.
(f) Accident reporting arrangements.
(g) A summary of details of any major injuries and accidents reportable as required by The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 that have occurred to the Contractor’s personnel within the past two years.
(h) A broad description of the types of work carried out in the past two years by the Contractor.
(i) Additional requirements specifically mentioned in the invitation to tender.

Immediately prior to starting work for the first time the Contractor should make any necessary amendments to the tender Health and Safety Plan which should be agreed with the Engineer. After starting work on site the Contractor should formally review the Health and Safety Plan at suitable intervals to ensure the Health and Safety Plan is kept up to date and relevant to the work in hand.

It is the responsibility of the Contractor to bring all the relevant safety clauses to the attention of all the Contractor’s personnel, including subcontractors and suppliers, as applicable to their work, and to ensure compliance with the contract safety clauses.

It is also the responsibility of the Contractor to ensure that any subcontractor or supplier employed by them on the project ensures that their personnel are aware of, and comply with, all relevant clauses. In particular, copies of relevant extracts of the Health and Safety Plan and method statements should be made readily available at the site for display by the subcontractor to their personnel.

_A3.1.3 Risk management_ Risk management is the identification, measurement and economic control of risks. A qualitative assessment of risk is essential in order to gain an appreciation of the relative importance of the various issues and to determine a risk management strategy.

Both the Engineer and the Contractor should undertake risk assessments for the piling or embedded walling works. The risk assessment process needs to be practical and take account of the views of their own staff and, where applicable, subcontractors and suppliers, who will all have practical knowledge to contribute.

For piling and embedded walling works it is essential that the risk management process continues after tendering throughout the construction process until the works are complete.

_A3.1.4 Working platforms_ Working platforms should be designed, constructed, maintained and repaired in accordance with BRE Report BR470. Further guidance on the use of hydraulically bound material (HBM) for working platforms has also been produced by BRE.
The Contractor should provide the platform designer with plant bearing pressures for all loading cases. The design of the working platform should take account of these plant bearing pressures and the ground conditions upon which the platform will be constructed. This design must be undertaken by a competent person with appropriate geotechnical expertise.

A Working Platform Certificate (see www.fps.org.uk), or similar, should be used to identify responsibilities and confirm that the working platform has been properly designed, constructed in accordance with this design, and will be adequately maintained and repaired to ensure the integrity of the platform throughout its working life.

It is recognized that preliminary working platform design is often undertaken for cost and design purposes prior to the appointment of the Contractor. In this instance all assumptions must be verified and, if necessary, the design revised prior to the construction of the working platform and the issue of the Working Platform Certificate.

A3.1.5 Pile trimming

Traditionally, concrete piles have been broken down by hand operated tools to limit the damage induced in the pile. In recent years the hazards of vibration-induced conditions such as hand-arm and whole-body vibration syndrome caused by these tools have come to the fore as a health issue for the construction industry. The Control of Vibration at Work Regulations are now in place and apply in combination with the CDM regulations. Hence both the Engineer and Contractor must comply with these requirements to reduce the risk to workers of vibration-induced conditions.

The Engineer is encouraged to design the structure so that pile trimming is minimized. The Engineer should then facilitate the use of improved technologies to ensure that risk from the exposure of site workers to vibration is either eliminated at source or, where this is not reasonably practicable, is reduced to a level which is as low as is reasonably practicable.

There are several methods that can be specified to help reduce this risk (see www.fps.org.uk). These systems may require the reinforcement above cut-off level to be debonded from the concrete. The applicability of these methods and any impact on tolerances should be agreed with the Contractor at tender stage. Alternatively, consideration should be given to the use of steel piling methods. Whilst trimming of steel piles will not provide a vibration induced risk to operatives, there will be other safety risks which will need to be taken into account.

A3.2 Quality
A3.2.1 Essential design requirements

Foundation design needs to fulfil three essential criteria in all cases:

- To have an adequate safety margin against failure.
- To have acceptable displacements over the likely range of applied loads.
- To be durable for the stated design life.

A3.2.2 Design and construction

It is essential that the method of construction is compatible with the design. This applies to both practicality aspects as well as to selected design parameters. Clear communication of the design to the Contractor will help to identify the appropriate methods of construction and will enable inappropriate methods to be discounted at an early stage.

It is essential that the type of pile to be specified is carefully considered to ensure its suitability in relation to the ground and environmental conditions. Ground conditions must be properly defined by means of adequate site investigation works to permit the appropriate selection of pile type and the proper design of the pile.
Criteria governing the length of piles and testing requirements should be agreed before entering into a contract.

A3.2.3 Ground conditions

A Site Investigation (SI) is a desk study combined with the Ground Investigation (GI).

A GI for geotechnical works should comprise appropriate geotechnical and geo-environmental fieldwork and laboratory testing.

BS EN 1997-1 states that a Ground Investigation Report should comprise all available geotechnical information with a geotechnical evaluation of this information, stating assumptions.

BS EN 1997-1 also states that the Ground Investigation Report shall form a part of the Geotechnical Design Report. The Geotechnical Design Report shall include assumptions, data, calculation methods and results, including a description of the ground conditions, design values of soil and rock properties, statement on risks, and foundation design recommendations.

A planned and well-executed GI, which addresses both design and construction phases, is essential to the successful outcome of any geotechnical project. The Engineer is responsible for advising the Employer on the appropriate scope of the SI for the foundation works, including the adequacy of any provided information. The Employer is responsible for implementing all the Engineer’s recommendations.

A comprehensive GI should be carried out in accordance with BS EN 1997-2, the recommendations of the ICE Site Investigation Steering Group publications, and other appropriate guidance documents such as those published by the Association of Geotechnical and Geoenvironmental Specialists (AGS) (see www.ags.org.uk).

A project involving piling requires an appropriate extent of GI to be carried out to assess the choice of pile type, design parameters and constructability, including temporary works. Typical requirements include:

- Several exploration points (BS5930 requires a minimum of three).
- Appropriate geotechnical characterization of the ground which would normally require boreholes.
- Depth of exploration at least to the deepest pile depth plus five times the diameter of that pile or to the depth of the maximum diameter pile plus five times its diameter, whichever is the greater.

A3.2.4 Workmanship

The Contractor’s or subcontractor’s responsibilities for their workmanship in achieving compliance with the design, drawings and specification provided to them in addition to other relevant information accessible to them, should be stated in the contract or subcontract documents.

Proper supervision of piling and embedded walling works by experienced site personnel is essential. It is preferable that supervision is provided by both the Contractor and the Engineer. The Employer should facilitate supervision by the Engineer. Supervision by the Engineer should be by a competent person with appropriate qualifications and experience.

A3.3 Environment

A3.3.1 Choice of foundation and requirements

The specification of appropriate performance and design requirements is an essential aspect of an economic and sustainable foundation solution. The aim should be to achieve the required foundation performance appropriate for the structural needs. Excessively conservative requirements can substantially increase foundation costs and lead to the inappropriate use of resources and energy.