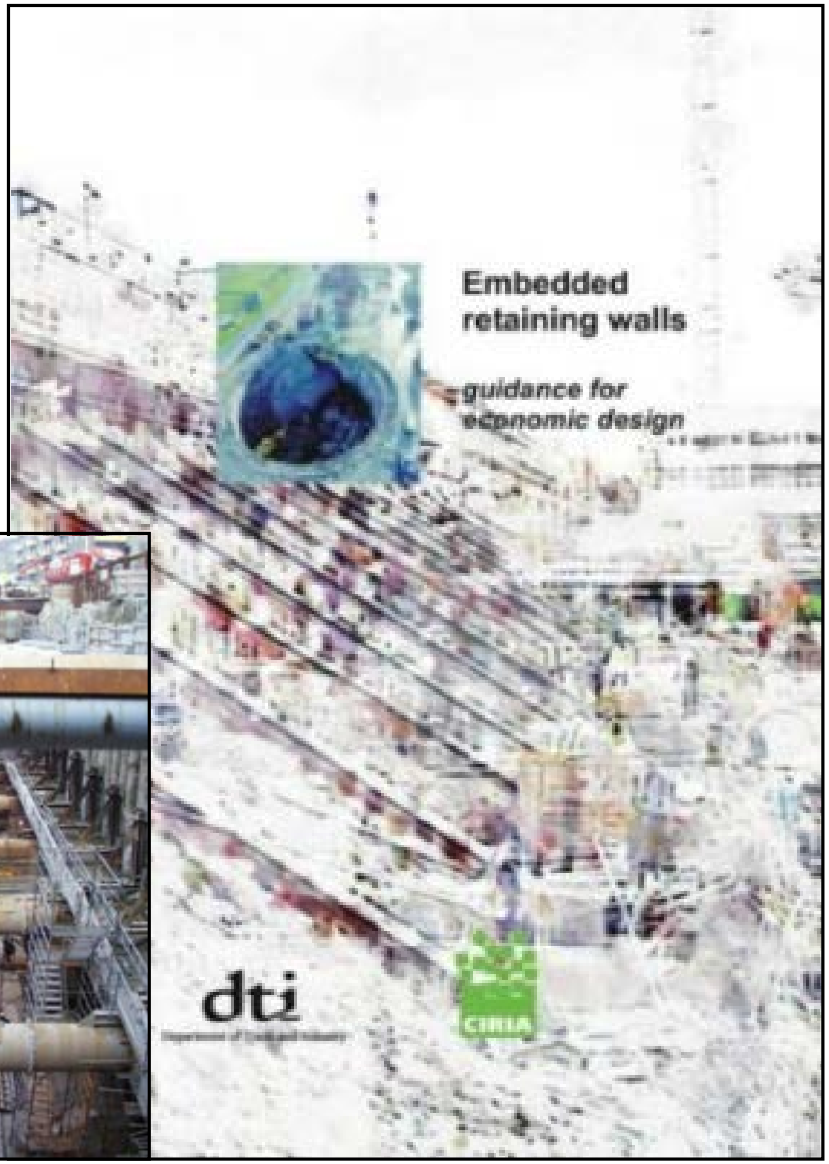
C580
Embedded Retaining walls:
guidance for economic design

progress update



Asim Gaba

Director

ARUP

Presentation Outline

- **Introduction**
- **Feedback on existing report**
  - Industry consultation
  - Where C580 is used
- **The C580 Update**
  - Scope
  - Research team
  - Project Steering Group
  - Project status and timeline
- **Key issues/challenges**
- **Closing comments**

Introduction - CIRIA embedded wall design guides

- **CIRIA Report R104 (Padfield & Mair, 1984)**
  Design of retaining walls embedded in stiff clay

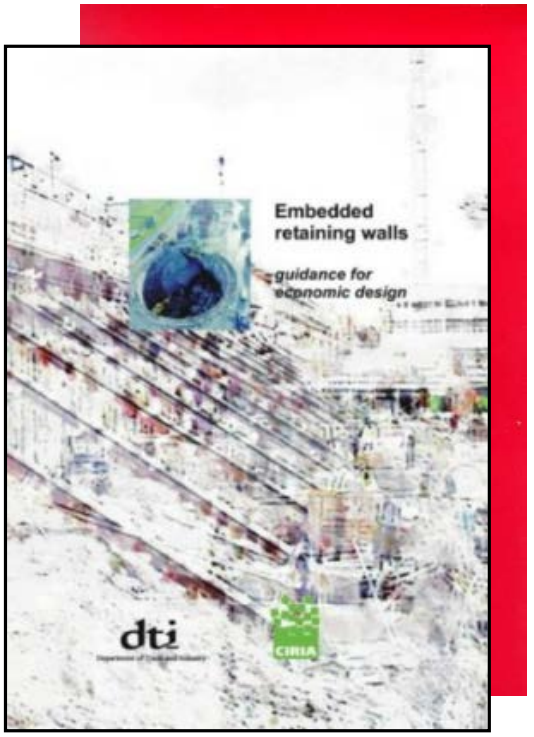
  Applicable to cantilever and singly propped walls embedded in stiff clay

  Hugely influential

- **CIRIA C580 (Gaba, Simpson, Powrie & Beadman, 2003)**
  Embedded retaining walls – guidance for economic design

  Applicable to cantilever and multi-propped walls embedded in stiff clay and other competent soils

  CIRIA's best selling design guide



- **CIRIA C580 update –** updates and extends C580 for application in soft clays, stiff clays, coarse grained soils and weak rocks plus compatibility with Eurocodes

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Feedback on existing report - Industry consultation

Questionnaire

Online survey via Surveymonkey & distributed via:

- BGA global mailing list & those on the ICE list with a geotechnical interest
- BGA LinkedIn & Facebook
- Arup global geotechnical community & forum
- CIRIA Industry Workshop mailing list

> 260 responses from 17 different countries

Workshop

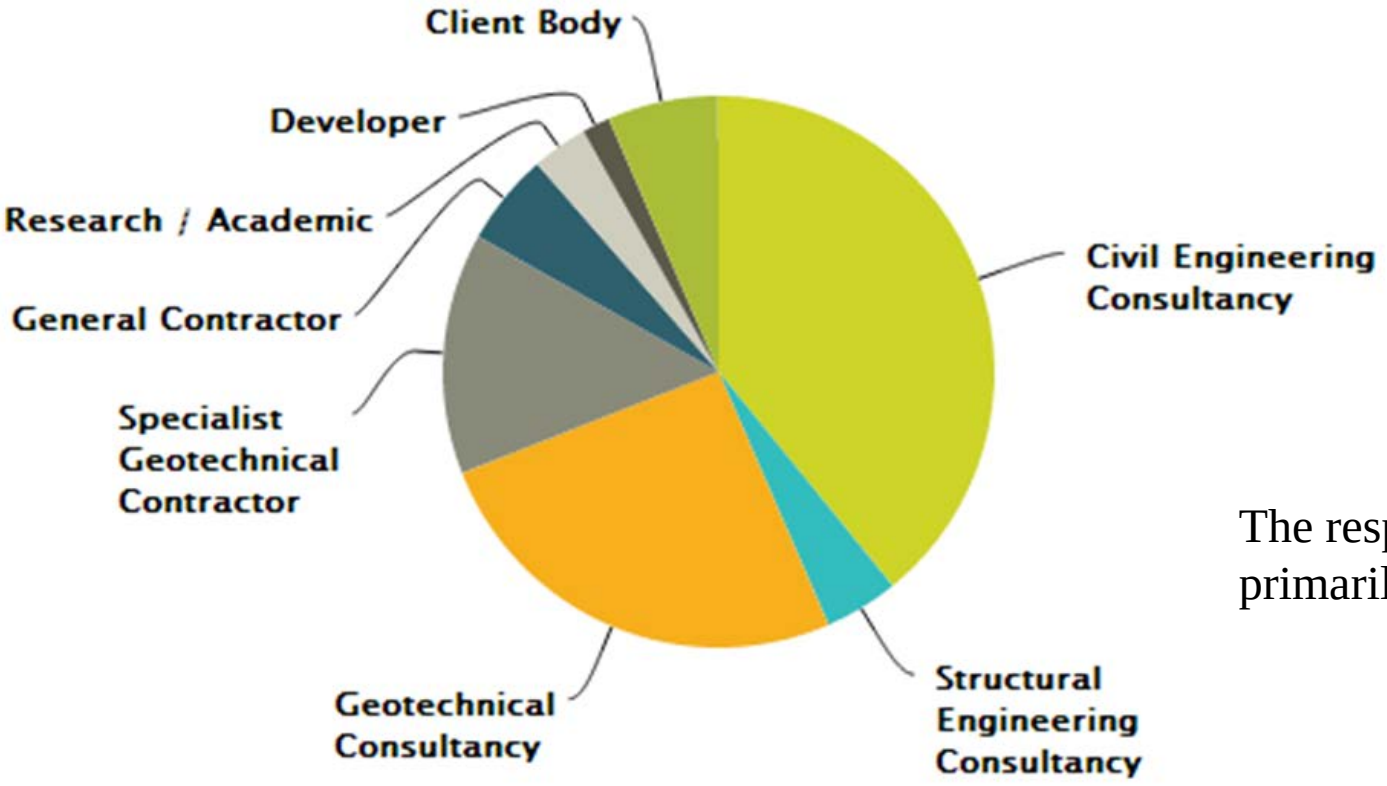
- Full day workshop: 9th May 2014
- 50+ attendees from Clients, Contractors, Designers & Academia, including 2 Rankine lecturers
- 10 facilitators

Questionnaire respondents

260 questionnaire responses from > 115 companies/organisations

Organisations: single person to > 60,000 members

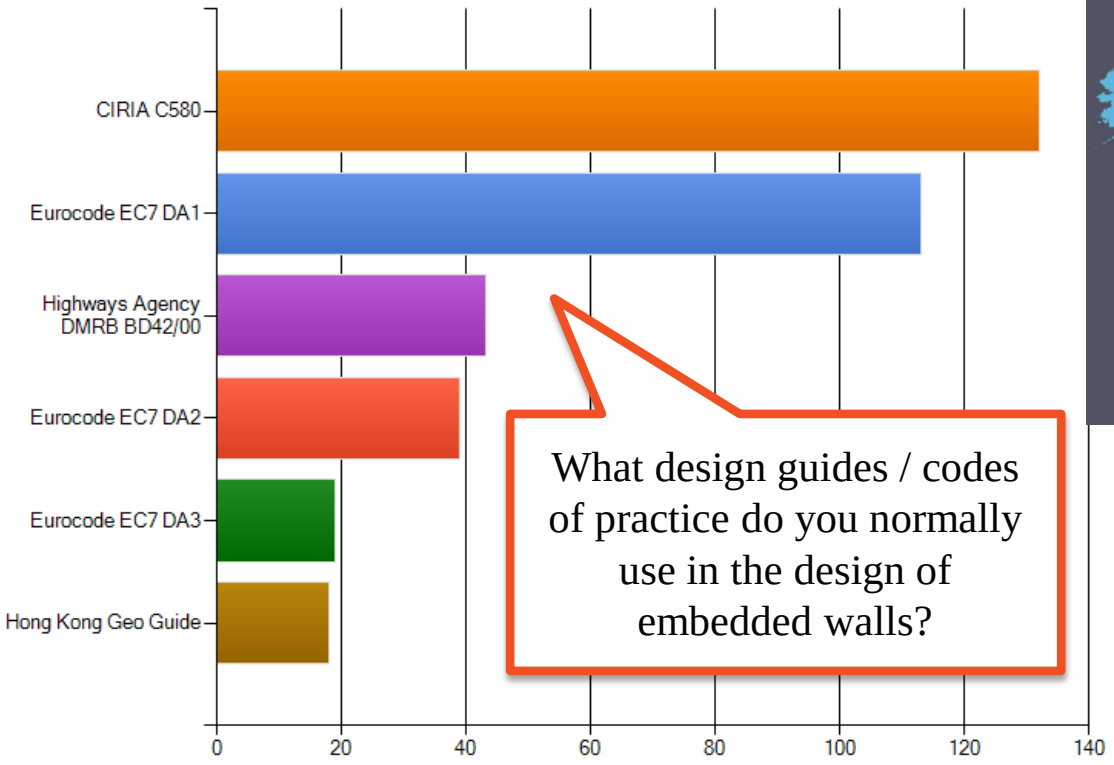
Typically, around 25% of the company staff were geotechnical specialists



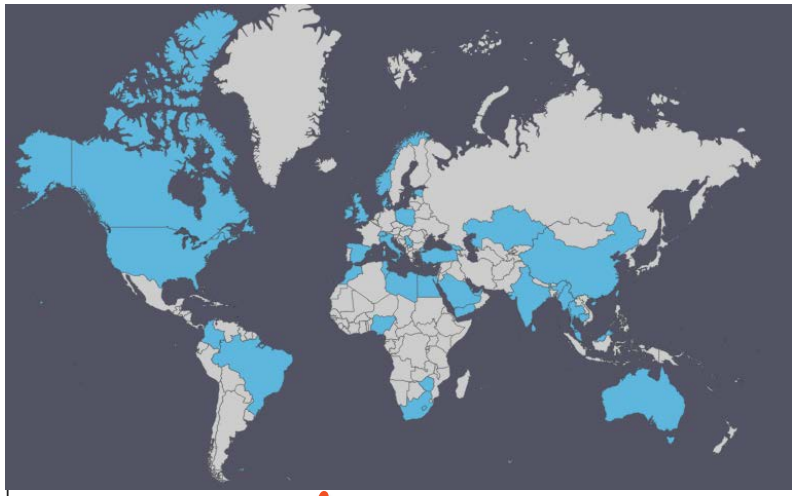
The respondents were primarily designers

Where C580 is used

- C580 used extensively for design of embedded retaining walls around the world
- 46% of respondents had used the report outside the UK
- Local guidance exists adopting C580 principles, particularly in Hong Kong



What design guides / codes of practice do you normally use in the design of embedded walls?



Where in the world have you applied the principles of C580 ?

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C580 Update: scope - general

C580 – global readership & application

- Extend application beyond stiff clays & competent soil conditions to include soft clays & weak rocks
- Update & extend ground movements database & guidance on estimation
- Guidance on use of 2D & 3D numerical modelling & analysis, including geometrical/corner effects
- Guidance on king post wall design
- Guidance on rock socket design
- Guidance on maintenance, inspection & monitoring

Update to be consistent & compatible with Eurocodes (essentially EC2/EC3/EC7) & other NCCI – and to influence proposed future development of EC7 in 2020

C580 Update: scope - contents

Follows same chapter structure as existing document:

1. Introduction
2. Design considerations
3. Construction considerations and wall selection
4. Analysis
5. Determination and selection of parameters
6. Design of wall (EC7 – DA1 compliant)
7. Design of support systems
8. Maintenance inspection and monitoring
9. Recommendations for further work and research (including proposals for possible amendments to EC7 methodology)

Plus associated appendices

The research team

The authors

Arup

- Asim Gaba
- Stuart Hardy
- Lauren Doughty

Southampton University

- Professor William Powrie

Cementation Skanska

- Dimitrios Selemetas

Peer reviewers (Arup Fellows)

- Brian Simpson
- Duncan Nicholson
- Nick O'Riordan
- Jack Pappin

Project Steering Group

Clients

- Brian McGinnity (Chair) – London Underground
- Colin Rawlings – HS2
- Duncan McFadyean – HS2
- Mark Shaw – Highways Agency
- Andy Tan – Environment Agency

Contracting

- Tony Suckling – Balfour Beatty
- John Wilkinson – Kier Construction
- Toby Hayward – Laing O'Rourke
- Malcolm Corlett – BAM Nuttall
- Graham White – Arcelor Mittal
- David Preece – Bachy Soletanche

Consultancy

- Tony O'Brien – Mott Macdonald
- Mick Gavins – Atkins
- David Beadman – Byrne Looby
- Peter Scott – SKM Jacobs

Academia

- Professor David Potts – Imperial College

Funders


hs2
engine for growth


HIGHWAYS
AGENCY
Safe roads, reliable journeys, informed travellers


Environment
Agency


UNDERGROUND


Balfour Beatty


LAING O'ROURKE


BACHY SOLETANCHE

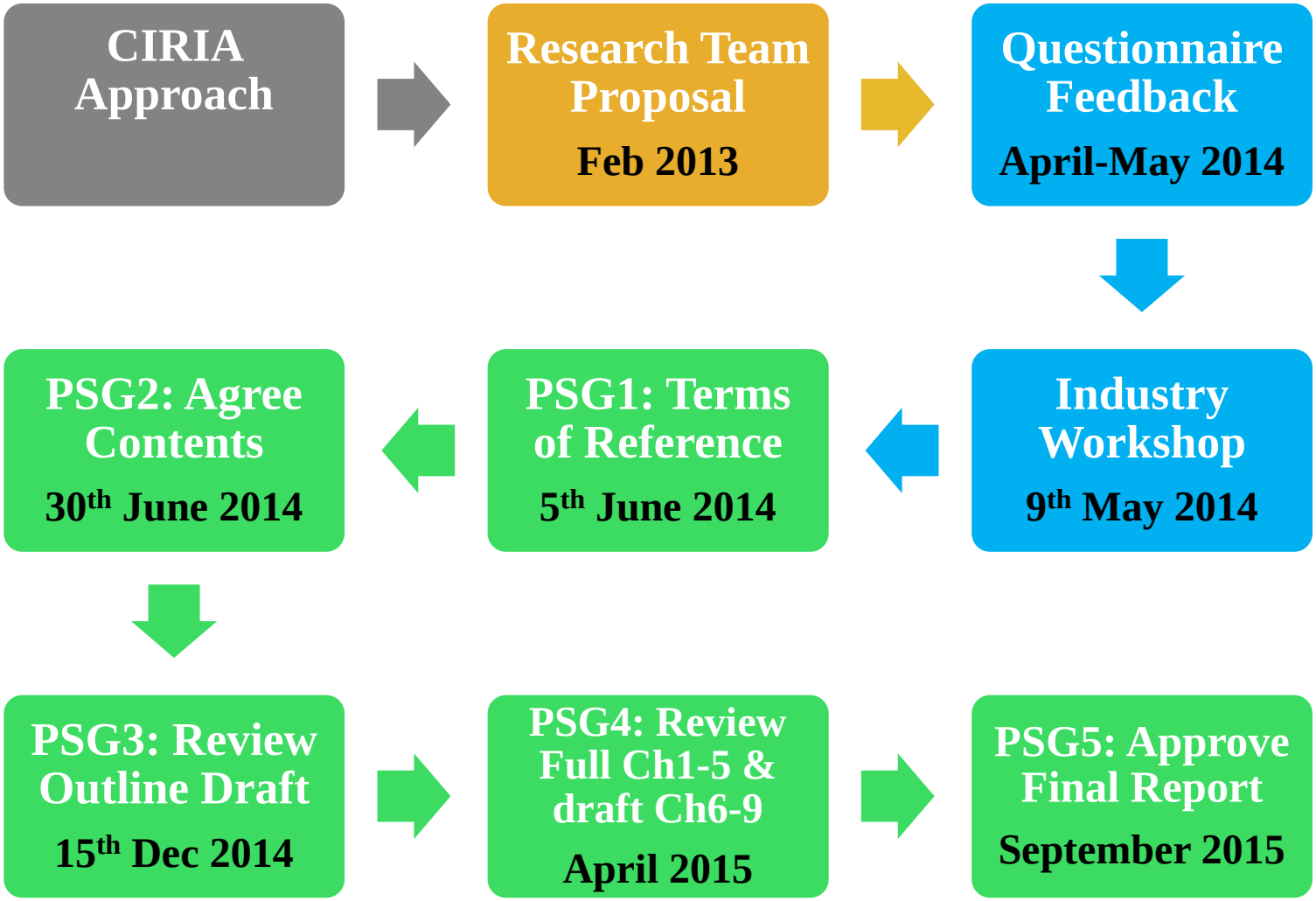

ArcelorMittal


Vp
plc
Groundforce Shorco
Excavation Support


SKANSKA


KIER
DEFINING TOMORROW'S ENVIRONMENTS

Project status and timeline



Project status and timeline – final steps

- Final report: 30th September 2015
- Funders' report
- Dissemination seminar
- Publication of Final Report

Key issues/challenges

- Misunderstandings about DA1 – C1 & C2: thought by some to relate to SLS & ULS respectively or Struct & Geo ULS – neither is correct – they are both overall ULS cases

- Designer to adopt characteristic value of ϕ' *affecting the occurrence of the limit state* under consideration and apply a partial factor of 1.25 to the tangent of that number: if applicable ϕ' is ϕ'_{crit} (e.g. cantilever wall) which in itself is a worst credible value, this would lead to very conservative design – does anyone apply $\gamma_{\varphi} = 1.25$ to $\tan\varphi'_{crit}$ in such circumstances?

- BS 8002 distanced walls from failure by use of a mobilisation factor applied in conjunction with indirect stipulations (e.g. unplanned overdig, minimum surcharge, conservative wall friction/adhesion, etc.) and gave logical guidance on ϕ'_{crit} and ϕ'_{peak}

- Treatment of extreme events?

- Characteristic values? Role of statistical analysis?

- Key is to capture the best ideas and practice from experience gained from the application of BS 8002, C580 and BS EN 1997:2004 to clarify misunderstandings and issues and put forward a coherent design approach that is compatible and consistent

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Closing comments - summary

C580 is a global phenomenon

The update will:

- Extend application beyond stiff clays & competent soils to include soft clays & weak rocks
- Update & extend ground movements database & guidance on estimation
- Provide guidance on use of 2D & 3D numerical modelling & analysis, including geometrical/corner effects
- Provide guidance on king post wall design & rock socket design
- Provide guidance on maintenance, inspection & monitoring

Update will be compatible with Eurocodes & other NCCI – and propose amendments to design method with the intention to influence proposed future development of EC7 in 2020