Rammed earth: design and construction guidelines

Peter Walker, *University of Bath*
Rowland Keable, *In Situ Rammed Earth Co Ltd*
Joe Martin, *JM Architects*
Vasilios Maniatidis, *University of Bath*

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Preface

This publication is believed to be a landmark in that it represents the first guidance document for rammed earth construction published in the UK. It has been compiled as part of Partners-in-Innovation project *Developing rammed earth wall construction for UK housing* funded by the Department of Trade and Industry (DTI). The 30-month project has been led by the University of Bath and In Situ Rammed Earth Co Ltd, working together with Engineers HRW, JM Architects, Knauf Insulation and Mark Lovell Design Engineers as contributing industrial partners. Advisory steering group members included representatives from Bristol City Council, BRE, Day Aggregates, The Ecology Building Society, Feilden Clegg & Bradley Architects, International Heritage Conservation and Management, Grimshaw Architects, Simmonds Mills Architect-Builders and Somerset Trust for Sustainable Development.

The project has included an experimental investigation of material properties, including thermal conductivity testing, structural testing of walls and columns, a worldwide review of rammed earth construction publications and a pilot case study project. As a result we believe that these guidelines represent the current state-of-the-art best practice in rammed earth construction as applicable to the UK. We hope that they will promote and lead to a greater use of rammed earth wall construction and encourage its future development. We welcome feedback and comments for future editions. Finally, we wish to express our sincere thanks to all who have helped to make this publication a reality.

Peter Walker
Rowland Keable
Joe Martin
Vasilios Maniatidis

1 Introduction

1.1 Scope of guidelines

For most building designers, rammed earth walling is a novel, innovative and unfamiliar material and construction technique. These guidelines have been compiled with the specific aim of informing, developing and promoting the use of rammed earth wall construction in the UK as a high-quality and sustainable building technology for walls in housing and other low- and medium-rise buildings. Specifically, the guide seeks to encourage the greater use of rammed earth, free from additives such as cement, as an alternative, sustainable and beautiful wall building material.

These guidelines for rammed earth cover general design considerations, material properties, testing and selection, engineering design, wall construction, construction details, and maintenance and repair procedures. A glossary, reference list and bibliography are also included.

Note on stabilised rammed earth

Stabilised rammed earth is an alternative form of wall construction that uses the rammed earth technique, but includes cement, primarily as an additive to change the material's physical characteristics. Stabilisation enhances material durability and wet strength, but at the expense of using cement, a major contributor to global CO_2 emissions. Much of the guidance given here for rammed earth construction is applicable to stabilised rammed earth as well. Where the approaches differ, in material selection for example, these variances are briefly outlined in Appendix D. Further guidance on stabilised rammed earth is also available elsewhere[1,2,3].

1.2 What is rammed earth?

Rammed earth is a form of unbaked earthen construction used primarily to build walls. Other applications include floors, roofs and foundations. Recently it has also been used for furniture, garden ornaments and other features. Rammed earth is formed by compacting moist sub-soil inside temporary formwork (Figures 1 and 2). Loose moist soil is placed in layers 100–150 mm deep and compacted. Traditionally, manual rammers have been used for compaction but nowadays pneumatically powered dynamic rammers are commonly used. Once the soil has been adequately compacted the formwork is removed, often immediately after compaction, leaving the finished wall to dry out. Walls are typically 300–450 mm thick, but this can vary widely according to design requirements.

Rammed earth walls often exhibit a distinctive layered appearance as a result of the construction process, corresponding to the successive layers of soil compacted within the formwork (Figure 3). This attractive appearance is

(Grimshaw architects; In Situ Rammed Earth; 1999)

Figure 1 Rammed earth wall construction at the Eden Project, Cornwall

Figure 2 Construction of a rammed earth wall

2.1.5 Pre-formed rammed earth

In recent years, in line with the general move towards off-site fabrication of building elements, pre-formed or prefabricated rammed earth has developed. To date, prefabrication has been used by only a very small number of specialist overseas practitioners[8], and the wider use of pre-formed rammed earth is largely unproven in the UK. Prefabrication potentially allows higher-quality factory construction of elements under sheltered conditions whilst also minimising on-site construction time. Examples to date include large wall blocks (Figure 27) as well as 100–200 mm thick cladding panels. Although costs are likely to increase, owing to transportation and lifting requirements, the use of prefabricated rammed earth is likely to increase in forthcoming years.

Photo: Martin Rauch

Figure 27 Prefabricated rammed earth walls

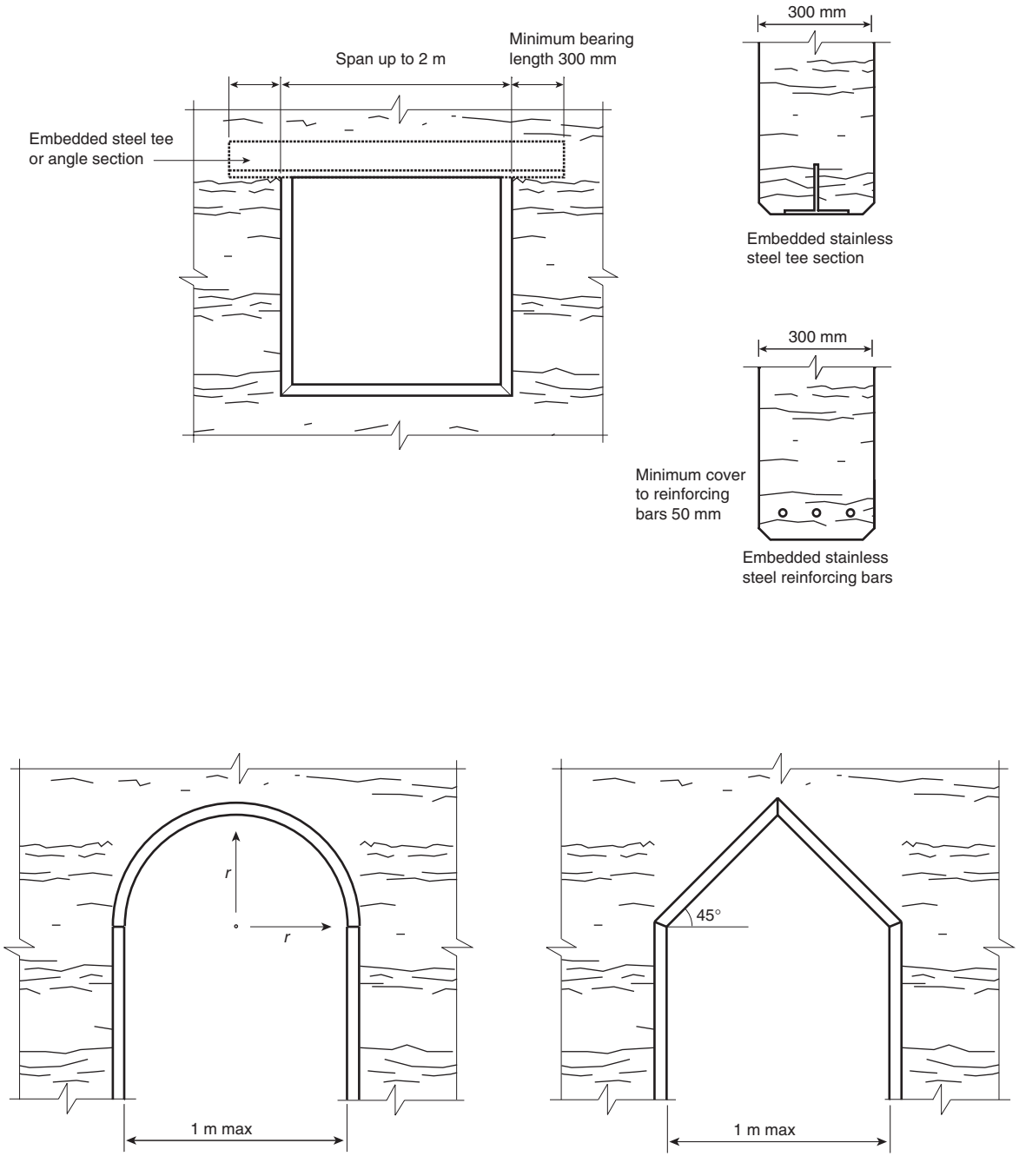

Figure 58 (continued) Opening details

8 Future of rammed earth

Although the combined number of UK rammed earth and stabilised rammed earth structures is presently believed to be no more than several hundred, the last decade has seen a significant renewal of interest, driven primarily by the demands for more sustainable building. Over the past 25 years a few thousand stabilised rammed earth buildings have been built in Australia.

Recent applications of rammed earth in the UK have been varied, including visitors centres, a sports hall, a business park development, a children's nursery, a conference centre, as well as a prize-winning exhibition wall at the Chelsea Flower Show. New rammed earth projects currently under development include the Genesis Project at the Somerset College of Arts and Technology in Taunton (Figure 84), a 200-seat lecture theatre in the WISE Project at the Centre for Alternative Technology in Wales (Figure 85), and the Aykley Heads Development in County Durham.

(Architype)

Figure 84 Genesis Project, Somerset College of Arts and Technology