

Editorial

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It is with great pleasure that I write this *Construction Materials* Editorial for a themed issue on earthen construction. Over the last 25 years, worldwide research and development work in this most ancient and abundant construction resource has grown significantly. Scientific articles about earthen construction now appear regularly in leading international journals, including *Construction Materials*, with a renewal in both new construction and conservation developing alongside this work. The response to the call for papers for this themed issue was so positive that a second themed issue will appear in 2017.

Earthen construction encapsulates many different and varied forms of techniques and applications, which as a vernacular solution has developed over many thousands of years in all inhabited continents of the world. In many rural regions of Africa, Asia and South America, earthen construction remains the predominant building solution. Although concrete is now often cited as the most used modern construction material, over the course of human civilisation earth construction has undoubtedly played a much wider and, arguably, a more significant role. The raw material of earthen construction is usually sub-soil, sourced locally and mixed together with water – and occasionally other materials such as straw or animal dung – to form materials ranging from sun-dried mud blocks (adobe), compacted rammed earth, moulded cob, decorative plasters and renders for a range of buildings. Earth is most commonly used where other traditional materials, such as timber and stone, are not available or affordable. Consequently, earthen construction is often incorrectly seen as primitive, associated with poverty and vulnerability. However, many of the world's celebrated civilisations have used earth to build many of the world's greatest structures and buildings that remain to this day. Examples include ancient Egyptian pyramids, large sections of the Great Wall of China, the Alhambra Palace in Granada and the Great Mosque in Djenné, Mali. A number of countries around the world now have national standards or design guidelines specifically for earthen construction.

The modern development of earthen construction can often find its origins in the need to authentically conserve historic buildings; traditional techniques have been relearned and provided stimulus for new-build applications. In the search for lower energy (and carbon) alternatives, materials practitioners

and researchers have increasingly returned to earthen construction over the past 40 years. Earth offers the potential for a much lower impact solution in a range of applications, but it also offers interesting new benefits for building occupants and the building fabric, such as moisture buffering and hygrothermal performance. Passive regulation of internal relative humidity levels offers potential for improved health and well-being of occupants; since many of us spend around 90% of our lives inside buildings, better indoor air quality will be of great benefit to us all.

The four papers presented in this first part of the themed issue provide a window onto the much wider work that is currently ongoing in earthen construction and materials worldwide. In the first paper, McGregor *et al.* (2016) have provided an in-depth review of the moisture buffering capacity of earth building materials. As a concept, moisture buffering is not widely understood or appreciated by the construction sector. This paper provides a very helpful review of different experimental methods for determining moisture buffering values (MBV) of materials in the laboratory. Although principles are the same, there is not an agreed unified method to determine MBV. Experimental results from previous work are also reviewed together with findings from full-scale tests and in situ measurements. For anyone interested in hygrothermal regulation, McGregor *et al.*'s review is a very helpful introduction to the current state of the art for earthen materials.

Compared with many industrial era materials, earthen materials are relatively weak and brittle in both compression and tension. The unconfined compressive strength of natural earthen materials are generally under 5 N/mm² and frequently below 1 N/mm²; tensile strengths are correspondingly very low and in design they are often ignored. Consequently earth walls tend to be relatively thick to withstand the vertical and lateral loads imposed upon them. However, the need for massive construction consequently increases the building costs of both materials and labour. The use of natural fibres (straw) to strengthen mud bricks is well known, with Old Testament references. Readle *et al.* (2016) present an experimental study into fibre reinforcement for earthen materials. Pull-out tests are presented for jute fibres embedded in natural and stabilised rammed earth specimens. Embedded fibre length and moisture content are shown to be important factors

for improved resistance, with cement stabilisation further benefiting ductility.

Taking unfired clay bricks off the brick production line before kiln firing offers a ready supply of earthen materials suited to a variety of non-loading applications, such as in-fill for timber framed buildings. Using unfired brick units not only offers a ready supply, but offers thinner earthen wall elements overcoming some of the concerns in using traditional rammed earth or cob walling (Morton, 2008). However, reducing the thickness increases vulnerability of unfired wall elements to water damage, limiting their wider use as loadbearing elements. Increasing the water resistance of unfired clay elements has led to the investigation of many different types of stabilisation, with cement and lime being two of the most commonly used materials. However, the drawback of stabilisation is increased embodied energy. Maskell *et al.* (2016) reports on a study to develop affordable, high volume, unfired clay bricks, presenting selection criteria for stabilisers that seek to minimise the global warming potential and embodied energy.

The interest in earthen construction over the past 25 years has seen growth in research activity and has also led to various new conferences, seminars and symposia. The First International Conference on Rammed Earth Construction was held in Australia in 2015. In their paper, Ciancio *et al.* (2016) report on the conference, summarising discussions on some key research areas including thermal performance, soil suitability, insulation systems, design methods and standards.

We hope you enjoy this issue of *Construction Materials* and as always, we welcome your feedback and thank you for your support.

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