Earthen Construction Technology

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Session IV-5

edited by

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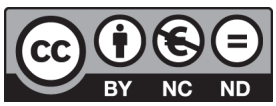

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FOREWORD TO THE XVIII UISPP CONGRESS PROCEEDINGS

UISPP has a long history, originating in 1865 in the International Congress of Prehistoric Anthropology and Archaeology (CIAAP). This organisation ran until 1931 when UISPP was founded in Bern. In 1955, UISPP became a member of the International Council of Philosophy and Human Sciences, a non-governmental organisation within UNESCO.

UISPP has a structure of more than thirty scientific commissions which form a very representative network of worldwide specialists in prehistory and protohistory. The commissions cover all archaeological specialisms: historiography; archaeological methods and theory; material culture by period (Palaeolithic, Neolithic, Bronze Age, Iron Age) and by continents (Europe, Asia, Africa, Pacific, America); palaeoenvironment and palaeoclimatology; archaeology in specific environments (mountain, desert, steppe, tropical); archaeometry; art and culture; technology and economy; biological anthropology; funerary archaeology; archaeology and society.

The UISPP XVIII World Congress of 2018 was hosted in Paris by the University Paris 1 Panthéon-Sorbonne with the strong support of all French institutions related to archaeology. It featured 122 sessions, and over 1800 papers were delivered by scientists from almost 60 countries and from all continents.

The proceedings published in this series, but also in issues of specialised scientific journals, will remain as the most important legacy of the congress.

L'UISPP a une longue histoire, à partir de 1865, avec le Congrès International d'Anthropologie et d'Archéologie Préhistorique (C.I.A.A.P.), jusqu'en 1931, date de la Fondation à Berne de l'UISPP. En 1955, l'UISPP est devenu membre du Conseil International de philosophie et de Sciences humaines, associée à l'UNESCO. L'UISPP repose sur plus de trente commissions scientifiques qui représentent un réseau représentatif des spécialistes mondiaux de la préhistoire et de la protohistoire, couvrant toutes les spécialités de l'archéologie : historiographie, théorie et méthodes de l'archéologie ; Culture matérielle par période (Paléolithique, néolithique, âge du bronze, âge du fer) et par continents (Europe, Asie, Afrique, Pacifique, Amérique), paléoenvironnement et paléoclimatologie ; Archéologie dans des environnements spécifiques (montagne, désert, steppes, zone tropicale), archéométrie ; Art et culture ; Technologie et économie ; anthropologie biologique ; archéologie funéraire ; archéologie et sociétés.

Le XVIII° Congrès mondial de l'UISPP en 2018, accueilli à Paris en France par l'université Paris 1 Panthéon-Sorbonne et avec le soutien de toutes les institutions françaises liées à l'archéologie, comportait 122 sessions, plus de 1800 communications de scientifiques venus de près de 60 pays et de tous les continents.

Les actes du congrès, édités par l'UISPP comme dans des numéros spéciaux de revues scientifiques spécialisées, constitueront un des résultats les plus importants du Congrès.

Marta Azarello

Secretary-General / Secrétaire général UISPP

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Introduction to the session

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The symposium 'Earthen construction technology', organised by the editors of this volume with support of CONACyT project CB254328, Mexico. It was presented as part of the theme: 'Fabrication procedures' during the XVIII Congress of the International Union of Pre- and Protohistoric Science, which took place from June 4-9 2018, at the Sorbonne University, in Paris. The general theme of the congress, 'Adaptation and sustainability in prehistoric and protohistoric societies confronted with climate change', offered a perfect context to open a discussion on construction techniques that use earth, a raw material particularly susceptible to climatic variations. The cases included do not specifically broach climate change, but always evaluate the effect of climate on the architecture and the diverse strategies developed by the ancient builders to avoid collapse and weathering, from careful selection of earthen mixes to mechanical reinforcement of walls, from stone or stucco facings to the use of organic additives to stabilize earthen renders, from surface waterproofing to enhanced drainage techniques, etc.

Though recently reevaluated because of its universal, sustainable, economical and bioclimatic values by ICOMOS (with its International Scientific Committee on Earthen Architectural Heritage - ISCEAH) and UNESCO (with the World Heritage Earthen Architecture Programme - WHEAP 2007-2017), archaeological earthen construction has traditionally been studied from the architectural point of view (evolutions in form, style and layout), on the one hand, and, on the other hand, from the focus on the conservation of existing heritage sites (where extensive excavations are limited because of the site's protected status), and on the understanding of extant vernacular building strategies. Unfortunately, vernacular building is generally geared towards domestic architecture for and by family units. The knowledge expressed in vernacular architecture does therefore not reflect the architectural and engineering know-how required to carry out the monumental achievements of civilizations like Mesopotamia, Andes or Mesoamerica, that were commandeered and backed by elite political programs. Thus, a deepened technological understanding of the finer constructive techniques of ancient monumental architecture, and its differences with domestic construction, developed worldwide over more than a 100 centuries, can only be obtained from archaeological research: extensive excavations with special attention to architectural and structural features, and their modification and collapse, coupled with typological, mineralogical, micromorphological, botanical, chemical (inorganic and organic) and mechanical studies of building materials. Most analytical techniques derive from geoarchaeology, also from engineering, but had to be adapted to analyze man-made earth mixes and their rubble (for which the Americans use the evocative term of 'adobe melt', although strictly speaking, sediment does not melt, but disaggregates).

While fabrication procedures are a common and longstanding topic of research in lithic, ceramic and metallic materials (and in a lesser degree in textile and woodcutting), architecture in Pre- and Protohistoric societies has mostly been approached in a descriptive way, with relatively little interest for its technological aspects (more so with earthen architecture as stone). Thus a technological approach is not only a novel way in the archaeology of earthen buildings, with the social and economic correlates of understanding technological procedures, but it additionally reveals a corpus of engineering and architectural know-how relevant for both the preservation of earthen heritage sites as well as the promotion of earthen architecture as a viable and economical alternative for modern construction.

Multidisciplinary approaches to earthen construction technology are a relatively new topic, acquiring a presence in archaeological literature around the 1990s, but is rapidly increasing. There is a definite snowball effect going on, as more and more results are obtained from postgraduate research and specialized publications. Mediterranean and Near Eastern archaeology is on the foreground, with mostly European teams leading the research. The French are very well represented in this volume, with references to Olivier Aurenche and Martin Sauvage for the Near East and Anne de Chazelles for the western Mediterranean, their interest in technology and operational sequences (*chaîne opératoire*), as culturally defined sets of choices that allow to understand human behavior, deriving from a longstanding research tradition arising with François Bordes and formalized by André Leroi-Gourhan and Pierre Lemmonnier; there are also research teams in Spain, England, Germany, Austria. America is still lagging behind in the aspect of multidisciplinary studies of earthen construction techniques and materials. A few US archaeologists active in North America have done micromorphological analysis with Paul Goldberg, a close collaborator of Richard Macphail. French, Spanish and German archaeologists are introducing construction sediment micromorphology and daub analysis in Central and South America, where Japanese teams are also leading important research in excavations, analysis and conservation of earthen heritage sites.

The call for papers was again answered by researchers working in Europe, Asia, America and Africa, like the preceding UISPP Memoir (Monumental Earthen Architecture in Early Societies. Technology and power display, Oxford: Archaeopress 2016). This time, the symposium consisted of 15 papers and 3 posters, presented by 34 researchers. The large number of co-authors reflects the existence of long-term projects and multidisciplinary approaches.

In this publication, only 8 papers and 2 posters are published. The 5 Mesoamerican papers will appear in extended version in the series 'Arquitectura mesoamericana de tierra' published by the Universidad Nacional Autónoma de Mexico: those on the origin of earthen architecture traditions in America (Annick Daneels), and on the sites of Xochitécatl-Cacaxtla (Mari Carmen Serra Puche), have come out in volume I, in 2019, those on Cholula (Nora Pérez), Tamtoc (Diana Zaragoza and Patricio Dávila), and Teotihuacan (Mareike Stahlschmidt, Susann Heinrich, Nawa Sugiyama, and David Carballo) are programmed in the next volumes. Unfortunately, authors Myriam Seco and Agustín Gamarra declined to send their paper on the construction sequence, building techniques and the preservation strategies of Thutmosis III's Million Year Temple at Luxor. So did the South American colleagues analyzing geoarchaeologically the construction sequences of monumental mounds in Brazil: Rafael Milheira on a 1st millennium CE mound in the Southern Pampa, and Kelly Brandão and colleagues on a 11-17th century mound in the Southwestern Amazon.

The present volume is ordered as the symposium was, going from general to particular, and more or less chronologically, starting from Near Eastern Neolithic to Mediterranean Bronze Age, then moving to America from north to south. The building techniques analyzed are mainly daub and mudbrick, though some cob is referred to.

Thus, the first paper of this volume is by archaeologists David Gandreau and Chamsia Sadozaï, and architect Sébastien Moriset, a team from CRATerre, the prestigious French institution part of the École Nationale Supérieure d'Architecture de Grenoble and UNESCO chair of earthen architecture, in acknowledgement of its 40-year trajectory. Their paper and illustrations present the major building techniques of wattle-and-daub, cob, mudbrick, and rammed earth, as well as the basic preservation strategies required when excavating earthen sites, using examples from their own research mostly in the Near East.

Emmanuel Baudoin, as part of his postdoctoral research, compares Neolithic cob and mudbrick construction in northern Mesopotamia and the Southern Caucasus, from a typological point of view, to evaluate the possible technological transfer from south to north by the 7th and 6th millennium BCE. Postgraduate researchers Paul Bacoup and Sandra Prévost-Dermarkar work on

5th millennium BCE Macedonian Neolithic architecture, that can generically be termed wattle-and daub, and through comparative paleobotanical analysis evaluate the interaction between wood selection, environment, and cultural choices. For the Upper Mesopotamian Late Chalcolithic to the Early Bronze age, Giovanna Liberotti uses architectural analysis, X-ray Fluorescence, and porosity and mechanical tests of mudbrick samples from nine buildings of five phases spanning the 4th to 3rd millennium BCE, at Arslantepe, Turkey, to assess the differences between a Syro-Mespotamian constructive tradition and that from Transcaucasian settlers.

Next is the study by Marta Lorenzon, using micromorphology, FT-IR and ESM of Middle of Late Bronze age mudbricks from three Minoan palaces in Crete, a topic, like Liberotti's, which furthers the research originating in her in-depth doctoral thesis. She addresses the effect of organic and mineral additives on the resistance of the bricks, and the thermal effect of conflagrations on the mineralogical composition of the sediments. The analysis of wood imprints and clay temper in burnt daub fragments allows Héctor Juan Fonseca to infer changes in wattle-and-daub constructive traditions between the Chalcolithic and the Bronze Age in Northern Spain, as subject of his doctoral dissertation. A second paper by Héctor Fonseca, with five co-authors and presented as poster, broaches the heritage and preservation problems of opening to public visit the earthen architecture site of El Castillar (dating to the Iron Age), 30 years after the site was excavated.

Turning to America, three papers are included. Long-time Southwestern archaeologists James Allison and Joseph Bryce describe the building systems of four types of constructions in an 8th century Pueblo village, including cob (in lumps and in layers, sometimes chinked with stones), wattle-and daub for walls and roofs, and mudbrick, reflecting a wide variety of traditions, that would ultimately be hidden behind uniform earth renders. This they can related to evidence of immigration of several groups, joining to form a new type of settlement, and also a new society. Robert Rosenswig, as part of his long-term project in Izapa on the Pacific coast of southern Mexico, uses LIDAR to survey settlement pattern in a humid tropical environment, obtaining evidence on recurrent urban layouts of earthen mounds that define the extent of Izapa's territory, and excavations to define the architectural growth of this capital of an early state in Late Formative Mesoamerica. Lastly, based on her doctoral research, Maria Torras compares in a poster the different construction techniques used to build the three major pyramids of Teotihuacan, Mexico, during the 3rd century, stamped earth vs earth contained in adobe or stone cells, evaluating the impact of monumental construction on the direct environment of the site, the subsistence of its population and the political clout of its leaders.

Some themes are recurrent in the papers and reflect the major problems associated with earthen architecture. The major one is the correct identification of the building technique. The lack of specialized courses in graduate schooling, excavation techniques switching to 'geological/ stratigraphic mode' when working in earthen strata, when 'architectural/construction sequence mode' should be prioritized, and reference books based on contemporary techniques mostly derived from vernacular systems, do not prepare the professional to tackle the diversity and the complexity of solutions invented by the ancient builders over the millennia worldwide. Very often, building systems are not identified, or worse, incorrectly identified, as cases of cob labeled rammed earth (*tapia*) or mudbrick. Some terms are confusing, like *adobe*, used in American English literature to cover not only sun-dried mudbricks, but also any kind of element made of a mud-mix: floors, plasters, renders, roofs. Wattle-and-daub covers a wide variety of techniques to build the supporting wooden frames and the latticework that will hold up the daub; therefore, a much more detailed typology of the wooden frameworks is needed to understand technological and cultural differences. Mudbricks have their own problems, particularly relating to the use of molds. In cultural terms, molds are extremely significant, as mass-produced standard-sized building modules are the base of a 'modern', professional architecture and generally relate to the emergence of complex societies. The use of mold is inferred from the standardization of brick size, as no molds have been reported so far from archaeological excavations, not even on the Peruvian

coast where conservation of organic material is extremely good and mudbricks exist by the million. Yet very little has been done to develop independent techniques to analyze the use of molds, like the striations or ridges on the brick due to unmolding. These are the features that Baudouin in this volume sees on plano-convex bricks, leading him to consider them mold-made, in opposition to the common appreciation that such a shape is indicative of hand-fashioned bricks. Another alternative has been proposed elsewhere, suggesting that standard-size rectangular bricks could be made in holes instead of wooden molds (Daneels, A. and Piña, J.S. 2019, 'Adobes prehispánicos fabricados en hoyo: un caso de la costa del Golfo de México' in del Cuero Ruiz-Funes, J.I., Méndez Pineda, V.M. and Huerta, S. (eds), Tercer Congreso Internacional Hispanoamericano de Historia de la Construcción, Volumen I. Madrid: Instituto Juan de Herrera: 267-276).

As the volume shows, typological analysis of architecture and of building materials are still the basic tools, but analytical techniques are plenty. As they are slow and expensive, some more than others, they are mostly only applied as part of long-term and well-financed projects; thus, building up databases will take time. The results achieved so far demonstrate they allow far-reaching anthropological interpretation of building traditions and cultures. Some are more recurrent (XRF, XRD, SEM, some FT-IR, mechanical properties, paleobotanical analysis of imprints and anthracology); the micromorphological analysis of construction material and rubble is on the rise, as it may well become the best way to distinguish between building techniques, by defining the features indicative of the amount of water in the mix and the degree and direction of compaction (Agnès Courty, Cécilia Cammas and Julia Wattez in France and Richard I. Macphail in England are pioneers in this respect). Other techniques, as GC-MS combined with IRMS, to identify residues of possible organic additives, are more rarely applied, because of the laboratory requirements and costs, and the difficulty to distinguish between natural and intentional residues, but such additives are part of the strategies to stabilize earthen architecture and their presence is therefore culturally significant (see for example Daneels et al. 2020, Bitumen-stabilized earthen architecture: the case of the archaeological site of La Joya, on the Mexican Gulf Coast, in JASREP 34).

As research teams working on archaeological earthen architecture increase in several countries, continued networking will be important. Several websites are already functioning, Réseau Terre (mostly archaeologists of the French speaking sphere), PROTERRA (including mostly architects and engineers but also some archaeologists of the Iberoamerican realm), while CRATerre and the Getty Conservation Institute have ongoing projects in heritage architecture preservation. Congresses specialized in earthen building and conservation, but that include archaeological research on the topic (though to a lesser extent) are the TERRA, organized by ICOMOS, UNESCO and CRATerre, Earth USA, SIACOT (Seminario Iberoamericano de Arquitectura y Construcción con Tierra), organized by PROTERRA, and the CIATTI by the Universidad de Valencia. Nevertheless, stronger interaction will be needed from archaeologists, so that a Scientific Committee specialized on Earthen Architecture could be warranted, as part of the UISPP domain of Technology and Economics. This was discussed at the symposium and remains as a proposal to be formalized in the 2021 UISPP at Meknès, Marocco, home to a distinguished earthen architecture tradition.