Las Cruces, New Mexico, U.S.A., October 14-19, 1990

6th International Conference on the Conservation of Earthen Architecture

Adobe 90 Preprints

A Note on the Cover

Historic photograph of Fort Selden courtesy of Museum of New Mexico State Monuments.

6th International Conference on the Conservation of Earthen Architecture

Adobe 90 Preprints

LAS CRUCES, NEW MEXICO, U.S.A., OCTOBER 14-19, 1990

6th International Conference on the Conservation of Earthen Architecture

Adobe 90 Preprints

Under the aegis of US/ICOMOS

Sponsored by:
The Getty Conservation Institute
Museum of New Mexico State Monuments
ICCROM
CRATerre-EAG
National Park Service, Southwest Region

THE GETTY CONSERVATION INSTITUTE

Los Angeles, 1990

Acknowledgements

Our appreciation and gratitude go to those who have contributed their ideas and services to this publication. My fellow Conference Co-Chairs—Michael Taylor, Alejandro Alva Balderrama, and Hugo Houben—provided essential editorial assistance at every stage. They assessed abstracts submitted in Spanish, French, and English; they reviewed full texts for approval and provided technical editing of accepted papers. Michelle Buchholz, Marta de la Torre, and Blanca Zimmerman furnished proofreading of the French and Spanish language papers as well as translations where necessary. Jo Ann Hill assisted with copy editing the English language papers.

Special thanks also go to those who have faced and met the many challenges of organizing this conference: in Los Angeles, Roland Tseng, Conference Coordinator, and Laura Sanders, Assistant Coordinator; in Santa Fe, Joan Pace and Margaret Alexander. These individuals deserve every recognition for their efforts.

—Neville Agnew
Conference Co-Chair for Publications

Editorial Review Committee
Neville Agnew,
The Getty Conservation Institute
Michael Taylor, National Park Service, Southwest Region
Alejandro Alva Balderrama, ICCROM
Hugo Houben, CRATerre-EAG

Managing Editor
Kirsten Grimstad

GCI Publications
Irina Averkieff, Publications Coordinator
Jacki Gallagher, Assistant Publications Coordinator

Design and Production
Marquita Stanfield

Printing
Franklin Press

Published by the Getty Conservation Institute, 1990
ISBN 0-89236-181-6
Printed in the United States of America

Available from:
J. Paul Getty Book Distribution Center
Box 2112
Santa Monica, CA 90406, U.S.A.

Contents

Conservation and Restoration

Site Preservation

Consolidation Studies

Seismic Mitigation

Current Field Research

Problems of Moisture

Clay Chemistry and Microstructure

Future Directions

Index

Introduction

Neville Agnew and Michael Taylor

The 6th International Conference on the Conservation of Earthen Architecture is convening at a time of growing awareness worldwide of the need to protect our earthen architectural heritage. The collective body of knowledge developed since the first international meeting on this subject in Yazd, Iran in 1972 has contributed to a new appreciation of earth as a viable and appropriate building material, historically a medium of choice rather than necessity. This improved understanding has, in turn, helped to generate needed funds to support new frontiers of conservation research as exemplified in many of the papers presented for this conference.

This meeting has been dubbed "Adobe 90" informally, in recognition of the importance of earth as a building material in the Americas and, in particular, in the American Southwest where the conference is taking place. Organized under the auspices of US/ICOMOS, Adobe 90 offers a forum for the exchange of ideas, methods, techniques, and research findings among scientists and practitioners specializing in the preservation of this ancient building material. The thirty countries represented at the conference and the nearly eighty papers accepted for presentation and prepublication testify to the expanding interest in preserving earthen architecture as well as to the wealth of new work being undertaken worldwide.

Adobe 90 bears witness in many ways to the strides that have been taken since the last international meeting held in Rome in 1987. Two of that meeting's objectives were to promote greater collaboration among institutions on related research projects and to recommend future research directions in the preservation of earthen structures. The GAIA Project, the subject of a plenary address, illustrates the joint efforts of ICCROM and CRATerre-EAG to promote an integrated program of training, research, documentation, development of standards and technical cooperation at international, national, and regional levels. The mandate of the 1987 meeting also inspired the collaboration between the Museum of New Mexico State Monuments and the Getty Conservation Institute to study chemical consolidants and physical protective measures for historic adobes through field evaluation of test walls. This involvement was extended recently to include the United States National Park Service, Southwest Region. The progress of this testing program and preliminary results are documented in the Fort Selden papers published here. This project represents the kind of interagency cooperation that is necessary to bring large, multi-phased research projects to fruition. During the half-day session at Fort Selden, 25 km northwest of the conference site in Las Cruces, New Mexico, delegates have the opportunity to view the results of the project firsthand and to exchange insights and experiences with the researchers who designed the two test wall projects adjacent to the historic ruins.

The largest number of papers submitted concerns the history and traditions of earthen architecture. It is encouraging to see that almost every country represented at the conference has presented a paper on its regional and historical architecture. The picture that emerges here, more clearly than ever before, is the ubiquitous use of earth over the broad span of history and throughout the world, in Europe—England, France, Germany, and Italy—as well as in parts of North America such as New York State and the Dakotas, where the use of earth as a building material has not been fully recognized nor appreciated.

The papers concerned with history and traditions also contribute greatly to our awareness of the connections that can and do exist between present-day living communities and their earthen structures. These cultures are to be found in many parts of the world, including our host state of New Mexico, where the maintenance of earthen buildings is often a community activity that fosters cohesiveness and cultural identity. The parallels that exist with other communities on other continents—Zambia, Tanzania, Kashmir, for example, as portrayed in these papers—will surely lead to productive discussions among delegates. The continuity between ancient usage of earth as a building material and its importance in present times will be illustrated further by the acclaimed photographic exhibition "Spectacular Vernacular," which presents magnificent African ceremonial structures—initiation houses, kasbas, mosques—made of earth. This exhibition is displayed at the conference on loan from the Smithsonian Institution.

It is also important to highlight here the progress of seismic stabilization studies, particularly in South America, which includes both examination of traditional stabilization methods used on historic adobes and research into modern methods. The vulnerable condition of historic adobe buildings in California, which are damaged or destroyed with every seismic event, underscores the urgent need for retrofitting these structures—in ways that are affordable, sensitive, and minimally invasive—against further damage by earthquakes. In other parts of the world—Kashmir and Macedonia, for example—earthen buildings have demonstrated remarkable resistance to seismic effects, achieved through trial-and-error evolution of building practice, materials, and techniques.

The active debate concerning the benefits versus disadvantages of chemical consolidants applied to historic and archaeological earthen structures is also represented among the Adobe 90 papers. This debate has arisen, in part, because of the relatively short evaluation period for a variety of different chemical treatments under different circumstances and on earthen types with different mineralogical composition. Among the papers presented is a review of chemical treatments implemented at field sites up to twenty years ago. This developing body of information, together with continuing consolidation studies also documented here, will facilitate future decision making concerning the benefits, or otherwise, of chemical consolidants.

The susceptibility of earth and clay to the effects of weathering will continue to pose difficult technical problems in our mission to prevent deterioration. It can be expected that answers and solutions to these problems will be found over time. However, as borne out by the range of papers contained in these proceedings, the dimensions to be addressed also extend beyond the reach of technical expertise. It is our hope that the collaboration and contacts established at this conference, together with the new findings presented, will go a long way to further the knowledge of the conservation needs of our earthen architectural heritage.

Introduccion

Neville Agnew y Michael Taylor

La Sexta Conferencia Internacional sobre la Conservación de la Arquitectura de Tierra se lleva a cabo en un momento de creciente conciencia sobre la importancia de proteger nuestro patrimonio arquitectónico de tierra. Los nuevos conocimientos obtenidos desde la primera reunión internacional efectuada en Yazd, Irán, en 1972, han contribuido en gran medida a apreciar la tierra como material de construcción viable y apropiado y a dilucidar que históricamente, su uso responde a una elección deliberada y no a la necesidad. A su vez, la comprensión de este concepto ha generado el apoyo requerido para llevar a cabo nuevas investigaciones en materia de conservación tal como lo demuestran los numerosos estudios presentados en esta conferencia.

Informalmente, se ha denominado a esta reunión "Adobe 90", reconociendo la importancia de la tierra como material de construcción en las Américas y en particular en el Sudoeste de los Estados Unidos, sede de esta conferencia. Contando con el auspicio del US/ICOMOS, Adobe 90 proporciona el marco ideal para el intercambio de ideas, métodos, técnicas y descubrimientos de investigación entre científicos y especialistas dedicados a la preservación de este antiguo material de construcción. Los treinta países asistentes y los casi ochenta trabajos de investigación aceptados para su presentación y publicación confirman el creciente interés mundial por la preservación de la arquitectura de tierra y dan fé de la importancia de los nuevos trabajos emprendidos en el mundo entero.

En gran medida, Adobe 90 sirve como testimonio de los grandes logros obtenidos desde la última reunión internacional llevada a cabo en Roma, en 1987. Dos de los objetivos principales de dicha reunión eran promover una colaboración más estrecha entre las diversas instituciones involucradas en proyectos de investigación relacionados y recomendar directivas e instrucciones claras para la preservación de las estructuras de tierra existentes. El Proyecto GAIA, objeto de una sesión plenaria, ilustra los esfuerzos conjuntos de las organizaciones ICCROM y CRATerre-EAG con el fin de promover un programa integrado de capacitación, investigación, documentación y desarrollo de normas para la cooperación técnica a nivel internacional, nacional y regional. El objetivo de la reunión de 1987 sirvió de inspiración para la colaboración entre el Museum of New Mexico State Monuments y el Getty Conservation Institute a fines de estudiar consolidantes químicos y medidas de protección para las construcciones históricas de adobe a través de la evaluación "in situ" de muros de prueba. Recientemente, este esfuerzo conjunto se ha ampliado incluyendo la participación del National Park Service, Región Sudoeste de los Estados Unidos. El progreso logrado en este programa de experimentos y sus resultados preliminares se documentan en los trabajos de investigación de Fort Selden que se publican aquí. Este proyecto representa el tipo de cooperación entre los diferentes entes que resulta imprescindible a fines de lograr el éxito en toda actividad de investigación de múltiples etapas. Durante la sesión de medio día que se llevará a cabo en Fort Selden, a 25 kilómetros al noroeste de la sede de la conferencia en Las Cruces, Nuevo México, los delegados tendrán la oportunidad de apreciar los resultados del proyecto e intercambiar sus impresiones y experiencias con los investigadores que diseñaron los dos muros de prueba adyacentes a las ruinas históricas.

La mayoría de los trabajos presentados tratan sobre la historia y las tradiciones de la arquitectura de tierra. Resulta alentador observar que casi todos los países representados en la conferencia han presentado un trabajo sobre su propia arquitectura histórica regional. De esto se desprende más claramente que nunca, el concepto de que la tierra ha sido utilizada casi constantemente durante la historia de la humanidad y en todo el mundo, en Europa - Inglaterra, Francia, Alemania e Italia - y en varias partes de América del Norte, como los estados de Nueva York, y las Dakotas del Norte y del Sur, donde el uso de la tierra como material de construcción no ha sido apreciado ni reconocido en toda su plenitud.

Los trabajos presentados relativos a la historia y a las tradiciones contribuyen en gran medida a nuestro conocimiento sobre la relación, probable o real, entre la vida actual de ciertas comunidades y sus estructuras de tierra. Estas culturas existen en la actualidad en numerosas partes del mundo, incluyendo el estado anfitrión, Nuevo México, donde el mantenimiento de los edificios de tierra constituye frecuentemente una actividad comunitaria que fomenta la unión y la identidad cultural. Los paralelos trazados con comunidades de otros continentes - Zambia, Tanzania, Cachemira, por ejemplo - descritos en los trabajos presentados - provocarán sin lugar a dudas, discusiones productivas entre los delegados. La continuidad entre el uso de la tierra como material de construcción en épocas anteriores y su importancia en los tiempos actuales se ilustrará con mayor detalle en la exhibición fotográfica "Spectacular Vernacular" que presenta magníficas estructuras ceremoniales africanas - construcciones para ritos de iniciación, kasbas, mezquitas - construidas en tierra. Esta muestra se exhibirá durante la conferencia gracias a la gentileza de la Smithsonian Institution.

Es importante, también, recalcar el progreso logrado en los estudios de estabilización antisísmica, particularmente en América del Sur, que incluye el examen de los métodos tradicionales de estabilización utilizados en estructuras de adobe históricas y la investigación de nuevos métodos. El precario estado de las construcciones históricas de adobe del estado de California, constantemente dañadas o destruidas por la actividad sísmica, subraya la necesidad urgente de reforzarlas - en forma económica, prudente y con el mínimo de alteraciones posibles - a fines de protegerlas contra futuros terremotos. En otras partes del mundo - Cachemira y Macedonia, por ejemplo - las construcciones de tierra han demostrado una resistencia notable ante los movimientos telúricos, lograda aplicando el método de prueba y error a las prácticas, materiales y técnicas de construcción.

Entre los trabajos presentados en Adobe 90 algunos tratan la controversia entre los beneficios y desventajas de aplicar consolidantes químicos a las estructuras de barro arqueológicas e históricas. En parte, este debate ha surgido a consecuencia del relativamente corto período de evaluación de una variedad de tratamientos químicos, que bajo distintas circunstancias, fueron aplicados a tipos de tierra con diferente composición mineral. Entre los trabajos presentados hay una revisión de los tratamientos químicos implementados en diversos emplazamientos, algunos de ellos con hasta 20 años de antigüedad. La compilación de esta información, conjuntamente con los estudios de consolidación que también se documentan aquí, facilitarán las decisiones futuras relativas a los beneficios o desventajas de los consolidantes químicos.

La vulnerabilidad de la tierra y la arcilla frente a los agentes climáticos continuará presentando graves y difíciles problemas técnicos en nuestra misión de prevenir el deterioro de las estructuras de tierra. Con el correr del tiempo, hallaremos soluciones y respuestas a estos problemas. Sin embargo, como se desprende de la gama de trabajos presentados, los temas a tratar sobrepasan nuestra capacidad técnica. Esperamos que la colaboración y los contactos logrados en esta conferencia, conjuntamente con los nuevos descubrimientos presentados, logren ampliar nuestros conocimientos sobre las necesidades de conservación de nuestro importante patrimonio arquitectónico de tierra.

Introduction

Neville Agnew et Michael Taylor

La Sixième Conférence Internationale sur la Conservation des Architectures en Terre se réunit dans un climat de prise de conscience mondiale sur la nécessité de protéger notre héritage architectural en terre. La masse de connaissances accumulées depuis la première réunion internationale sur ce sujet, qui prit place à Yazd (Iran) en 1972, a contribué à une nouvelle appréciation de la terre comme matériau de construction viable et approprié qui, au cours de l'histoire, fut utilisé non pas par nécessité mais par choix. Cette meilleure compréhension a, à son tour, facilité la collecte des fonds nécessaires au financement de ces avant-postes de la recherche en conservation comme le prouvent les nombreuses communications soumises pour cette conférence.

Cette réunion a été familièrement surnommée "Adobe 90", en reconnaissance de l'importance de la terre comme matériau de construction aux Amériques, et plus particulièrement dans le Sud-Ouest américain où va se tenir cette conférence. Organisée sous les auspices de l'US/ICOMOS, Adobe 90 offre une tribune propice aux échanges d'idées, méthodes, techniques et résultats de recherches entre chercheurs et praticiens spécialisés dans la préservation de cet ancien matériau de construction. Le fait que trente pays y sont représentés et que presque quatre-vingts communications ont été acceptées pour leur présentation et pré-publication témoigne de l'intérêt grandissant porté à la préservation de l'architecture en terre, ainsi que de l'abondance des travaux nouvellement entrepris de par le monde.

Adobe 90 atteste amplement des progrès importants réalisés depuis la dernière réunion internationale de Rome en 1987. Deux des objectifs de cette réunion étaient de promouvoir une collaboration accrue entre les institutions travaillant sur des sujets de recherche apparentés et de recommander des directions futures pour la préservation des structures en terre. Le Projet GAIA, qui fera l'objet d'un communiqué en séance plénière, illustre les efforts concertés de l'ICCROM et de CRATerre-EAG en vue de la promotion d'un programme comprenant la formation, la recherche, la documentation, le développement de normes et la coopération technique aux niveaux internationaux, nationaux et régionaux. Le mandat de la réunion de 1987 inspira également la collaboration entre le Musée des Monuments de l'Etat du Nouveau-Mexique et l'Institut Getty de la Conservation en vue de l'étude des consolidants chimiques et des mesures protectrices physiques pour les adobes historiques par évaluation sur place de murs de test. Le Service des Parcs Nationaux des Etats-Unis, région Sud-Ouest, s'est récemment joint à cette association. Les progrès réalisés au cours de ce programme d'essais et certains résultats préliminaires sont documentés dans les rapports sur Fort Selden publiés ici. L'ampleur et le nombre des étapes nécessaires pour mener à bien de tels projets de recherche illustrent le type de coopération nécessaire entre les différents organismes intéressés. Lors de la demi-journée de travail à Fort Selden (à une distance de 25 km et au nord-ouest de Las Cruces, Nouveau-Mexique, lieu de la conférence), les délégués pourront se rendre compte d'eux-mêmes des résultats et auront l'occasion d'échanger idées et expériences personnelles avec les chercheurs ayant réalisé les deux murs de test adjacents à ces ruines historiques.

La majorité des présentations nous ayant été soumises portent sur l'histoire et les traditions de l'architecture en terre. Il est encourageant de voir que presque tous les pays représentés à la conférence ont fourni un article portant sur leur architecture régionale et historique. Il est de plus en plus clair qu'au cours des siècles la terre fut utilisée non seulement en Europe (Angleterre, France, Allemagne et Italie), mais également dans certaines régions de l'Amérique du Nord telles que l'Etat de New York et ceux des Dakotas, sans que ce fait ait été pleinement reconnu ou apprécié.

Il est également certain que les communications ayant trait à l'histoire et aux traditions contribuent grandement à notre prise de conscience sur les rapports étroits qui existent de fait entre les communautés contemporaines et leurs constructions en terre. De telles cultures existent dans de nombreuses parties du monde, y compris au Nouveau-Mexique, notre hôte, où l'entretien de bâtiments en terre constitue souvent une activité communale qui stimule l'esprit de corps et l'identité culturelle. Les parallèles existant avec des communautés situées sur d'autres continents (en Zambie, en Tanzanie et au Cachemire par exemple, tels que décrits dans ces articles) susciteront sans aucun doute des discussions productives entre délégués. La continuité qui existe entre l'utilisation de la terre comme matériau de construction dans les temps anciens et son importance actuelle sera en outre illustrée par l'exposition photographique renommée "Spectacular Vernacular", une magnifique présentation de structures cérémoniales africaines (maisons d'initiation, casbahs, mosquées) construites en terre. Cette exposition fut gracieusement prêtée à la conférence par la Smithsonian Institution.

Nous devons également mentionner les progrès réalisés dans les études de stabilisation sismique, particulièrement en Amérique du Sud, études qui portent aussi bien sur l'examen des méthodes traditionnelles utilisées pour les constructions historiques en adobe que sur la recherche de méthodes modernes. La vulnérabilité des bâtiments californiens historiques en adobe, endommagés ou détruits lors de chaque secousse sismique, souligne le besoin urgent de protéger ces structures contre tous dégâts additionnels par tremblements de terre d'une manière à la fois abordable, pratique et présentant un minimum d'interférence. Dans d'autres parties du monde (comme le Cachemire et la Macédoine), les constructions en terre ont fait preuve d'une résistance aux effets sismiques remarquable, résultat de l'évolution empirique de la pratique, des matériaux et des techniques de construction.

Plusieurs présentations d'Adobe 90 illustrent également le débat animé sur les avantages et les inconvénients des consolidants chimiques pour le traitement des structures historiques et archéologiques en terre. Ce débat est en partie dû au fait que la période d'évaluation des divers traitements chimiques dans des circonstances différentes et sur des types de terre de compositions minéralogiques variées a été relativement courte. L'un des articles présentés passe en revue les traitements chimiques mis en uvre sur place au cours de ces vingt dernières années. Les décisions futures relatives aux bénéfices éventuels des consolidants chimiques seront facilitées par l'accumulation continue des informations sur ce sujet et par la poursuite des études sur la consolidation qui sont documentées ici.

La susceptibilité de la terre et de l'argile aux intempéries continuera à poser des problèmes techniques ardus pour nos travaux de prévention de la détérioration. Des réponses et solutions à ces problèmes seront éventuellement trouvées. La variété des articles rassemblés dans ces comptes rendus prouve cependant que le domaine de ce débat s'étend au delà de la poursuite de l'expertise technique seule. Nous espérons que la collaboration et les contacts établis lors de cette conférence, ainsi que les résultats récents qui y seront présentés, favoriseront une prise de conscience accrue sur la nécessité de préserver notre héritage architectural en terre.

History and Traditions

ABSTRACT

This paper presents the first case study dealing with a type of house built with earth, called "casoni," that is found in northeastern Italy.

The topics discussed in this paper include typological and technological research, inventory methods, observation and classification of deterioration, and initial programs in conservation on buildings of this type.

KEYWORDS

Inventory methods, typological research, technological research, cultural heritage, restoration, adobe, Italy.

CONSERVATION DE L'ARCHITECTURE EN BRIQUE CRUE:LA RECHERCHE SUR LES"CASONI" DU NORD-EST D'ITALIE

Mauro Bertagnin
Faculté d'Ingegnierie
Université de Udine
Via Larga 42 33100 Udine /Italie
CRATerre

1.Introduction

Après le Colloque de Rome,suite à une série des"recommandations" parues dans les Comptes Rendus,s'est formé un groupe italien(1) pour coordonner recherches et action dans le domaine de la connaissance et conservation de l'architecture de terre en Italie soit au niveau archéologique soit du patrimoine bâti encore habité ou en voie de disparition suite à l'abandon des habitants. Durant ces deux années le groupe a mis au point une strategie d'action qui se déroule dans les secteurs suivants:

-Méthodes d'inventaire et recherches typologique et technologique du patrimoine existant,

-Histoire et évolution de la construction en terre en Italie et recherches sur les traités d'architecture en terre italiens(2)

-Observation et classement des pathologies des bâtiments ,analyses chimiques sur les terres et sur les enduits des maisons en terre et premiers programmes de conservation sur les typologies d'échantillons.

Parmi ces actions est présenté ici un premier cas d'étude qui concerne une typologie,le "casone",qui correspond à la totalité de la maison en terre au nord-est d'Italie.
En abordant la recherche,on a suivi la démarche méthodologique résumée dans les trois secteurs de la stratégie d'action envisagée pour une approche globale.

2.Une typologie archétype:histoire et données anthropogéographiques

Dans les études sur les types anthropogéographiques de la basse plaine de la Padanie(3),on reconnaît le "casone" de la plaine entre Padoue et Venise comme la plus ancienne forme de maison rurale,type hybride entre hutte et maison,que des peintres tels que Giovanni Bellini,Giorgione et Tiziano fixent dans leurs paysages(4).
L'intégration au site est assurée par l'utilisation du matériau même qui compose le site,la terre,et des autres matériaux tels que le bois de chêne pour la structure du toit et la paille ou la roseau des lagunes vénitiennes pour la surface extérieure des couvertures.
Cette forme archétype de maison dégage dans les plaines du nord-est d'Italie trois modèles de base:

-Le premier type est caractérisé par un plan qui naît du contact de deux parties de la maison,dont la plus petite contient la cuisine avec la cheminée.La forme et la volumétrie sont particulières,approchant celle d'une tente.
Ce premier type se retrouve dans la basse plaine de la région de Venise et quelques exemplaires existent aussi dans la province de Treviso,tout près de la plaine du fleuve Tagliamento.
Normalement ce type comporte un rez-de-chausée qui représente la partie habitée et l'étage correspondant à la grange.

-Le deuxième type présente une forme strictement rectangulaire, avec les pièces aux surfaces régulières.La pente du toit est inférieure à celle du premier type.

Ce deuxième type se situe dans l'aire ouest de la basse plaine du Friuli.
Le logis ne comprend, le plus souvent, qu'un rez-de-chaussée habitable, recouvert d'une toiture régulière à deux versants. La grange en bois peut correspondre à l'étage ou être réunie sur le côté nord du "casone".

-Un troisième type, n'étant pas bâti en briques de terre crue, mais homogène au point de vue typologique et morphologique aux deux autres a été considéré dans la recherche seulement comme extension architecturale et géoanthropique de l'habitat ancien dont les "casoni" représentent les exemples les plus intéressants.

L'ensemble de ces constructions rurales analysées présente plusieurs caractères communs. Effectivement il s'agit de maisons rurales d'assez petite taille, l'étage correspondant souvent à la grange, le plan général très simple, plus souvent rectangulaire avec des adjonctions (granges ou abris pour les outils).
Le toit joue un rôle de grande importance, soit pour la détermination de la volumétrie et par conséquent de la forme du "casone", soit pour la structuration du logis. On retrouve aussi une utilisation fréquente des mêmes matériaux tels que la terre crue pour les murs, le bois (chêne, sapin ou orme), pour les planchers et l'ossature primaire et secondaire du toit et poutres éventuelles, tuiles pleines et roseaux pour la couverture.

3. Inventaire et recherches typologique et technologique

Le patrimoine bâti des "casoni" ayant déjà fait l'objet d'une série de publications (5), on a pu aborder le problème de l'inventaire de tous les exemplaires aujourd'hui encore existants à partir des données déjà partiellement acquises et ensuite on a pu établir une démarche d'analyse raisonnée devant servir à la définition d'un premier niveau de stratégie de conservation à proposer.
Les relevés ponctuels sur le terrain et la construction de fiches typo-technologiques a permis d'identifier et classer tous les "casoni" encore existants et bâtis en brique de terre crue (adobe) correspondants à la totalité des bâtiments en terre du nord-est d'Italie.
Une fois vérifiés du point de vue quantitatif, les exemplaires encore existants appartenant aux deux premiers types et correspondant aux "casoni" bâtis en briques de terre crue (adobe), on a pu organiser un inventaire complet de l'existant et essayer de retrouver des analogies même au niveau technologique.
En effet pour la plupart des "casoni" du premier et second types, le troisième étant exclu de l'inventaire, on a pu vérifier une technologie du bâti constante, expression du savoir-faire local, fixée dans l'architecture vernaculaire locale.
Dans la plupart des "casoni" analysés, les fondations sont traditionnellement inexistantes. Pour bâtir les murs en "adobe" des "casoni", on a vérifié qu'une fois fixé l'emplacement où le sol était jugé stable, on tassait tout simplement le sol à l'emplacement du futur "casone".
Ce choix technologique a signifié, par conséquent, la création des soubassements, dont le rôle était celui de répartir les efforts de la charpente et des murs tout en les transmettant au sol.
Ce choix de réaliser des soubassements a aussi conditionné l'adoption d'une série d'autres matériaux tels que galets, pierres ou briques cuites nécessaires pour éviter aux murs en "adobe" d'être détériorés par les eaux de ruissellement ou par le rejaillissement des eaux de pluies tombant des toits sans gouttières.
Pour les "casoni" de la plaine vénitienne, on a vérifié l'adoption des briques cuites tandis que la pierre et les galets constituent la plupart des soubassements des "casoni" de la plaine frioulaine du fleuve Tagliamento.
Dans les deux types, on retrouve une variation de hauteur des

soubassements entre 80 et 120 centimètres.
L'adoption de murs d'une hauteur réduite(2 mètres ou 2,25 maximum) et l'utilisation d'un grand débord sont plus marqués dans les "casoni" du premier type.L'adobe étant très sensible à l'humidité et à l'érosion de la pluie battante et aux eaux dont le vent rabat quelquefois des toitures sans gouttières,ces choix de la technologie vernaculaire ont été très valables pour la durabilité des bâtiments en "adobe" analysés.
Les "adobes" utilisés dans la basse plaine vénitienne et frioulaine ont des dimensions peu variables la plupart étant faits avec un moule en bois,souvent le même utilisé dans les briqueteries de l'aire du "casone".Les épaisseurs des briques crues varient donc de 7 à 10 centimètres,la largeur de 13 à 16 et la longueur de 26 à 32 centimètres.
Par conséquent les murs analysés ont en général 40/45/50 cm.
Pour les murs extérieurs et les murs de refend peuvent,selon le cas,varier de 13 à 16 cm.,de 26 à 32 cm. et de 40 à 50 cm. selon les choix du bâtisseur. Les points d'appui de la charpente et les angles sont quelquefois faits avec des matériaux plus résistants,pierre et briques cuites dans la majorité des cas.
Des pièces de bois reposant sur les murs d'angle pour soutenir la poutre en bois d'arête ou une sablière pour répartir l'effort de la charpente sont d'autres éléments constructifs vérifiés dans la recherche.
Dans les couvertures on retrouve,au contraire,une différence entre le premier et le second types.
Le premier type étant conçu pour une couverture en roseaux et le second pour une en tuiles pleines,les deux pentes étant différentes,la structure en bois de la charpente est differente.
Pour les deux structures de la charpente,on a fait une étude approfondie sur le savoir-faire traditionnel concernant l'utilisation du roseau dans le premier type et sur les chevrons caractérisant le deuxième type.Pour ce dernier,le recouvrement de tuiles sur le faîtage présente une particularité due à une orientation particulière qui évite le soulèvement des tuiles par le vent.
Les bois employés pour l'ossature primaire du premier type sont normalement le chêne et le lattis varie entre le chêne,le châtaignier et le sapin.
Pour les mortiers et les enduits employés dans les deux aires où se situent les deux types analysés on utilise toujours un mélange de terre et de chaux,ou moins souvent de chaux et de sable.
En ce qui concerne la mise en oeuvre de la maçonnerie en "adobe", dans la plupart des cas,on a pu vérifier partout une régularité des lits successifs de briques et par conséquent une horizontalité généralisée qui témoigne dans le deux aires d'une bonne exécution et donc d'un art de la maçonnerie même de ces habitations pauvres dans le domaine rural.

4.Classement des pathologies

Le travail engagé à l'échelle régionale du Veneto et du Friuli, doit aboutir selon les objectifs des chercheurs à des plans d'action de conservation de ces derniers exemplaires(dans les deux régions ils ne sont qu'une vingtaine encore) d'une typologie et technologie en voie de disparition.
L'étude des pathologies de ces bâtiments et les solutions techniques pour un programme compatible de conservation représentent une autre démarche opérationnelle de la recherche.
On peut grouper les pathologies rencontrées au cours de la recherche par classes homogènes.
On a vu que les "casoni" sont situés dans des zones humides de la basse plaine du nord-est de l'Italie caractérisée par une remarquable pluviosité,ce qui signifie que ces bâtiments sont dans la plupart des cas affectés par la pluie et par l'humidité.On a déjà rappelé que la structure typo-technologique des "casoni" est conçue pour une défense contre les pluies (pentes et débord de la toiture, murs extérieurs bas etc.)mais malgré cela on doit enregister plusieurs dégâts à cause des

eaux ,des pluies et de l'humidité.
La pluie et le vent ont souvent provoqué l'érosion des façades et en même têmps créé des dégâts dans la structure en bois dus à son infiltration dans la couverture.
L'absence de gouttières est responsable d'un rejaillissement marqué sur le sol,qui cause,malgré les soubassements,des dégâts aux enduits comme aux murs.
C'est un processus progressif entamé par la pluie qui est respon sable de la destruction de deux "casoni" dans l'aire frioulaine.
Cloques et décollements visibles sur les surfaces des façades, sont liés à des remontées capillaires dans les murs et surtout pour les "casoni" de la plaine frioulaine pendant les cycles de gel-dégel.
Une autre pathologie relevée dans l'analyse des deux typologies concerne les dégâts produits dans plusieurs "casoni" par le manque des chaînages puisque même dans le cas où les angles on été bâtis en brique cuite ou en pierre,ils sont désolidarisés du reste du bâti.
Des fissures dans la façade correspondant au point d'appui des chevrons sur le murs sont d'autres pathologies liées à la non adoption de la sablière pour l'appui des chevrons le long du mur et qu'on a pu vérifier dans certains cas.
En ce qui concerne la dégradation des enduits,on peut établir après la première partie de la recherche, que la plupart des dégâts signalés sont liés à deux genres de causes:viellissement des enduits par manque d'entretien ou mauvais dosage des enduits.
Dans la deuxième classe des pathologies on trouve surtout les essais d'entretien utilisant des matériaux tels que le ciment qui créent une dégradation de retour,causée par une mauvaise connaissance des réactions entre matériaux traditionnels et actuels.
Pour compléter les volets analytiques des pathologies,on doit aussi rappeler la dégradation des "casoni" non habités due sur tout au manque d'entretien et à la perte de savoir-faire à construire des toitures en roseaux de la lagune, qui ne sont connues désormais que de quelques anciens artisans locaux(6).

5. Programmes de conservation

Les "casoni" comme on l'a déjà souligné représentent aujour d'hui les derniers types d'habitat en briques de terre crue existant au nord-est d'Italie et sont un petit nombre de bâti ments encore utilisés mais de toute façon en voie d'extinction.
Ils peuvent être sauvegardés avec un peu d'effort du point de vue économique et socio-culturel.
La plupart des"casoni" ont été améliorés et réhabilités par les habitants qui ont dans la majorité des cas gardés les caractères typo-architecturaux des "casoni",favorisant la conservation de ces bâtiments traditionnels dans le paysage rural.
C'est un devoir social que de conserver ces bâtiments sans les dépersonnaliser,d'aider à l'entretien approprié aux caractères architecturaux et technologiques de ces typologies archétypes de la plaine du nord-est italien.
On a déjà essayé de sensibiliser les institutions à l'aide au développement d'actions au niveau local et au financement par les organismes publics(Régions,Gouvernement etc.).
L'introduction de ce patrimoine architectural vernaculaire dans le registre des"architectures à sauvegarder",la création de deux petits parcs régionaux pour le "casoni",une série d'actions pour la valorisation du savoir-faire artisanal local et une parfaite connaissance de la technologie et de l'art de bâtir concernant les"casoni" sont les programmes d'action envisagés.
Pour ce qui concerne les solutions techniques appropriées pour la conservation de ces bâtiments,à côté des relevés complets de tous les "casoni" existants(soit à travers l'utilisation des relevés dejà publiés dans les livres concernant ces architectures ou par la réalisation de relevés manquants),on on a fait démarrer d'autres actions aujourd'hui en cours.
Les analyses chimiques des"adobes" des différents bâtiments

et des enduits utilisés dans les différents types, les analyses des sols, les inventaires des matériaux locaux employés et les premiers essais de conservation typo-technologiques d'un échantillon de chacun de deux types étudiés sont les actions programmées pour la sauvegarde d'un témoignage encore vivant de l'habitat en terre en Italie.

6. Conclusions

Les bâtiments en "adobe" analysés représentent un patrimoine architectural dont la sauvegarde est indispensable pour préserver les derniers exemples de maisons en terre dans le nord-est de l'Italie.
La méthode suivie est, à notre avis, extensible à d'autres cas et peùt contribuer à la sauvegarde réelle du patrimoine architectural en terre italien.
Une fois démarrées les actions envisagées on pourra effectivement compter sur une série d'expériences de référence valables pour une approche plus efficace à la conservation du patrimoine en terre italien.

NOTES

(1) Alva A., Bertagnin M. (coordinateur), Bisconti G., Chiari G., Galdieri E., Laureano P.

(2) Voir Bertagnin M., "L'architecture de terre en Italie: connaissance et réhabilitation d'un patrimoine typologique méconnu" et Galdieri E., "Etat et futur des bâtiments italiens en terre: le cas du Piémont et de la Sardaigne" in Le patrimoine européen construit en terre et sa réhabilitation, ENTPE, Vaulx en Velin, Comptes Rendus, 1987

(3) Il s'agit de la plaine du fleuve Po, le plus grand fleuve italien

(4) Regardant les paysages des "Crocefissione" (Correr, Venezia) et "Allegoria sacra" (Uffizi, Firenze) de Giovanni Bellini, de la "Venere dormiente" (Gemalde Galerie, Dresden) de Giorgione et "L'amor sacro e l'amor profano" (Galleria Borghese, Roma) de Tiziano on peut reconnaître le "casone" comme typologie dominant le paysage agricole du XVe Siècle, dans la plaine de la région de Venise

(5) cfr. Tieto P. I casoni veneti, Panda editeur, Padoue, 1979

(6) cfr. note 2

ABSTRACT

It is in the earthen architecture of the Chilean central region where we can find the values of a real vernacular architecture which displays a unique spatial and cultural quality.

Space and matter thus determine a specific architectural form constituting a valuable heritage which ought to be preserved as a genuine model of representation and extension over time.

It provides us with the architectural "type" springing from a set of formal variables and becoming a basic form which in being applied to a new project should keep its distinctive spatial features and values immutable.

The typology and language observable in the models under analysis would enable the proposal of a contemporany architecture based on the values typical of such vernacular architecture.

PALABRAS CLAVES

Historia y Tradición
Arquitectura Vernácular
Tipología y Modelos Espaciales reconocibles
Vigencia del Tipo
Propuesta de Preservación del Modelo
Propuesta de Proyección del Tipo

KEYWORDS

History and tradition,
Vernacular architecture,
Typology and spatially recognizable models,
Validity of the type,
Proposal for preservation of the model,
Proposal for projection of the type.

ARQUITECTURA VERNACULAR DEL VALLE CENTRAL DE CHILE

Edwin Binda Compton
Martín de Zamora 4247
Las Condes - Santiago
Chile.

INTRODUCCION

El presente trabajo constituye el inicio de una amplia investigación que pretende demostrar la perfecta validez y contemporaneidad del modelo espacial que adoptó la arquitectura rural de tierra en el Valle Central de Chile desde las primeras manifestaciones de ocupación territorial pasando por los diversos siglos, desde la Conquista a la República.

El valiosísimo aporte que representa la tipología arquitectónica del modelo propuesto, se encuentra íntimamente ligada a la definición de "tipo" que da Quatrèmere de Quincy en su "Dizcionario Storico" (1): "la palabra "tipo" no representa tanto la imagen de una cosa que debe ser copiada o imitada perfectamente cuanto la idea de un elemento que debe servir, él mismo, de regla al modelo. ...El modelo entendido según la ejecución práctica del arte, es un objeto que se debe repetir tal cual es; el tipo es, al contrario, un objeto, según el cual cada uno puede concebir obras que no se parecerán en absoluto entre ellas. Todo es preciso y dado en el modelo; todo es más o menos vago en el tipo..."

Esta forma arquitectónica tradicional vernacular, se convierte así en elementos espaciales permanentes que definen de hecho, un valor patrimonial. La técnica y el material constructivo, tendrán sin duda un papel primordial que jugar, ligado lo anterior a los valores arquitectónicos que define formas en espacio y tiempo. "En la arquitectura actual, muchas ramas de su desarrollo se han apartado de las raíces primitivas. La falta de comprensión de los problemas fundamentales y la adopción de soluciones superficiales han conducido a la probreza de la construcción arquitectónica... Hasta el siglo actual el hombre construyó su hábitat, con materiales locales y de forma sencilla, natural y resistente. Las plantas eran directas e inequívocas, se basaban en exigencias y funciones, haciendo que el hombre se sintiera orgulloso de su ambiente." (2)

El surgimiento, por así decir espontáneo de las viviendas que se levantaban sin tener tras ellas ninguna especulación, siguiendo solamente los dictados de la tradición, la limitación o riqueza del material, las funciones que debían cumplir, produjo expresiones arquitectónicas locales que asombran por su variedad. En cambio, la vivienda producto de la especulación ha unificado las expresiones, perdiéndose ese gran atractivo que significa encontrar la manifestación genuina. Es por esto que nuestra arquitectura vernacular debe ser objeto de reflexión. Ella es la manifestación de una quizás no muy rica variedad de formas, pero es sabia en tanto corresponde a la expresión auténtica de un entorno y de un modo de vida particular.

"La Arquitectura del Valle Central de Chile ha recurrido como en toda civilización a condicionamientos espaciales que la han caracterizado, reflejando en sus formas y elementos, cualidades propias que la identifican. En ella no sólo hay una respuesta adecuada al medio geográfico natural, sino también al uso adecuado del material. El uso del adobe tratado tanto constructivamente, como en su distribución geométrica y espacial, nos permite sostener que su forma y calidad, obedecen a una condicionante espacial propia que la distingue y la define. Variados ejemplos podemos recoger en diversos autores y épocas, encontrando en ellos siempre un nexo que la identificará plenamente con nuestra idiosincrasia y estilo de vida". (3)

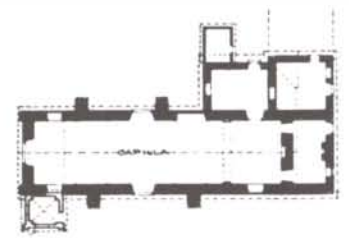
ARQUITECTURA RURAL DE LA ZONA CENTRAL DE CHILE

Tal vez las manifestaciones más interesantes de la arquitectura en Chile, por su sincera realidad local, sean los conjuntos rurales de la Zona Central.

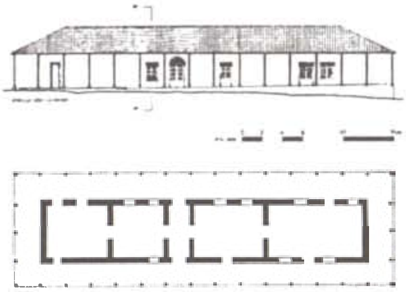
"Durante más de un siglo de soledad indiana, en un país casi sin núcleos urbanos, la única verdadera estructura caminera y territorial fue la rural que buscaba desesperadamente lograr un orden agrario, ocupando paulatinamente y en medida muy reducida, los valles transversales y costeros. Faltando aún ciudades y villas, casas patronales, caseríos y algunas aldeas, se ocupó este inmenso espacio, sólo en forma esporádica. Fue solamente en la segunda mitad del siglo XVIII que con la fundación de una larga serie de villas y ciudades alrededor del camino central, se creó una estructura agraria continua, permitiendo una colonización y explotación del Valle Central. Las casas rurales fueron adquiriendo siempre mayor importancia, manteniendo como una constante los conceptos formales y organizativos originales". (4)

Estos conjuntos rurales conformando haciendas son citados por destacados tratadistas extranjeros, como Angulo Iñiguez, Marco Dorta, Buschiazzo, Kluber, Wethey y Kelemen. Todos concuerdan en calificarla como el más interesante y completo exponente iberoamericano en su género, "conformando estos un capítulo fundamental de la historia de la arquitectura americana. Efectivamente, ningún otro

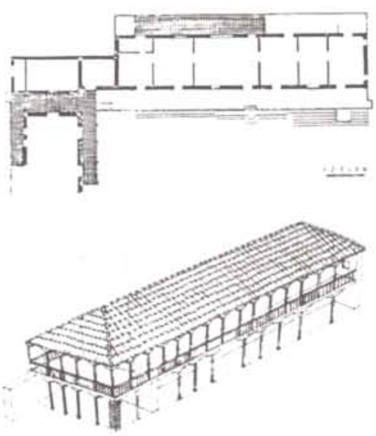
A. IGLESIA DE LA COMPAÑIA DE GRANEROS(20)



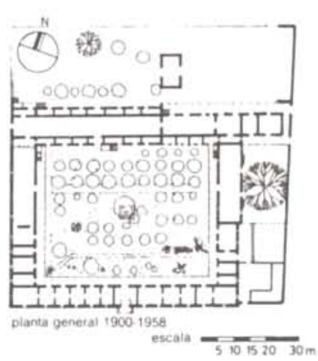
B. CASAS DE LAS AZULES DEL TABON (21)



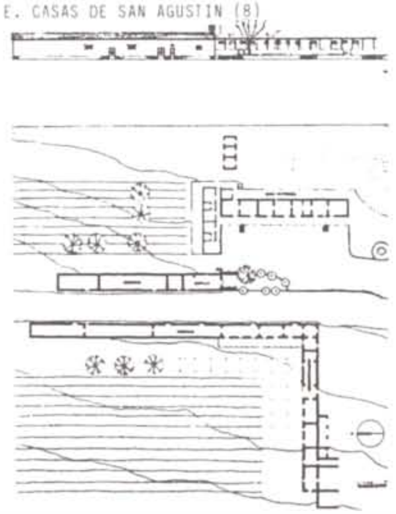
C. CASA DE LO MATTA (17)



D. CASAS DE LO CONTADOR (21)



E. CASAS DE SAN AGUSTIN (8)



país del continente presenta el caso de estas construcciones que se suceden contínua e ininterrumpidamente a lo largo de todo el territorio". (5)

En este Chile rural, las casas son un conjunto de edificios de apoyo a la faena rural, los caseríos y las aldeas se constituyeron los elementos reales de la ocupación territorial, y sucesivamente de su incipiente explotación.

Muchas de estas casas se iniciaron en plena Colonia y fueron centro de importantes núcleos agrícolas, conformando los principales hitos de nuestros primeros asentamientos desde Copiapó al Bío-Bío. "Una larga vivencia en una geografía a la que se van adaptando hombres y medios, donde se define un arte de vivir y permite concebir al pasado como origen de un saber habitar." (6)

La planta cuadrada fue el módulo básico y, por lo tanto, la más comúnmente empleada desde el siglo XVI hasta nuestros días, especialmente en aquellas regiones sureñas donde la frontera con las poblaciones indígenas se mantuvo hasta muy avanzado el siglo XIX. Otro tipo de planta usado desde el siglo XVIII, fue la "alquería", edificio de un solo cuerpo, pero en dos pisos, ocupando las bodegas el primero y las habitaciones el segundo, permitiendo con ésta conquistada altura, el dominio visual de las faenas agrícolas.

Una nueva tipología de arquitectura del Valle Central de Chile, surgirá a mediados del siglo XVIII para extenderse en el siglo XX. Serán las casas de enormes proporciones como San Vicente de Tagua-Tagua, Quinta de Tilcoco o San José del Carmen de Colchagua (El Huique), en las cuales casas y patios (algunas de ellas incluyen hasta quince de éstos) han conformado una extensión de unidades de adobe y tejas, formando llenos y vacíos que adquieren el aspecto de verdaderas casas-pueblos.

El profesor Romulo Trebbi del Trevigiano en su libro:"Desarrollo y tipología de los Conjuntos Rurales de la Zona Central de Chile, siglos XVI - XIX, (7) nos describe los tres conceptos formales y organizativos iniciales:

EL RELIGIOSO, en cuanto a su distribución pareciera originarse en la de un claustro o convento (b) EL MILITAR que se manifiesta en la solidez de los muros exteriores casi sin ventanas en la planta cerrada y en el uso de cuerpos altos y torreones, y finalmente (c) EL AGRARIO con el empleo de pórticos para las faenas, la importancia dada a las bodegas y corrales y la anexión de vastas explanadas para los trabajos.

La forma del complejo arquitectónico estará dada fundamentalmente por la explotación propia del Valle Central donde se emplean pórticos para protegerse del clima y para cobijar faenas de distinta naturaleza. Bodegas, corrales, llaverías, casas de inquilinos, capilla, se reunirán junto al patio o los patios de trabajo; sólidos muros de adobe cubiertos por grandes mantos de teja, serán los elementos que le darán el carácter de unidad espacial al conjunto.

DESARROLLO ESPACIAL

La casa tradicional de campo adopta desde su inicio hasta fines del siglo XIX diversas formas que explicaremos más adelante.

"Cada propietario o administrador principal, asumirá en su oportunidad la responsabilidad del arquitecto, utilizando espontáneamente (o quizás con determinantes establecidos por el lugar o las necesidades), tres tipos de espacios diferentes con los que organizaba el total del conjunto: las habitaciones, los corredores y los patios". (8)

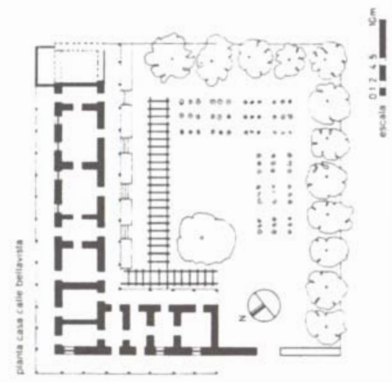
Los volúmenes presentan una rígida ortogonalidad, alternando espacios llenos y vacíos, representado por los sucesivos patios, ordenados casi siempre en cuadrículas, conectando todo lo anterior por amplios y largos corredores que permiten anexar todo el conjunto, solucionando así una alternativa de vinculación con características de espacio intermedio cubierto, pero abierto en uno de sus costados.

"En contraste con la variedad de dimensiones y ocupaciones de los patios de la Casa, sus espacios interiores son regulares, repetidos, salvo (si los hay) la capilla y las bodegas con recintos más amplios... los espacios interiores resultan muy semejantes entre sí, con anchos, largos y altos que no superan los 5 o 6 metros. Estas medidas establecen en cada Casa, una especie de módulo estructural que se respeta en toda la edificación, con raras excepciones, como en el comedor, en el salón, o en la sala de juegos, donde la longitud es mayor por ser estos lugares más representativos. Los dormitorios en cambio... tienen las mismas características y son multifuncionales" (9) admitiéndose con ello su calidad de diversidad de uso tanto en el espacio como en el tiempo.

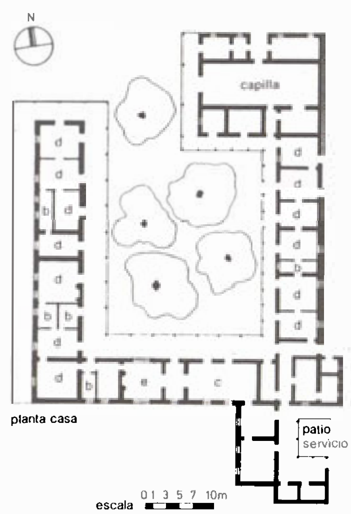
Lo esencial de la ordinación espacial de los conjuntos se expresa casi siempre en las siguientes constantes:

Un sentido del orden a partir de la ortogonalidad de la casa, se prolonga a la regularidad en los patios, los cuadros del jardín, el dibujo del huevillo en el suelo, los parrones, las calles y los caminos que llevan hasta los potreros cercados de árboles; formas claras que producen una gran armonía de conjunto dentro del marco general del Valle Central.

F. CASA EN PUEBLO DE MAIPO (21)

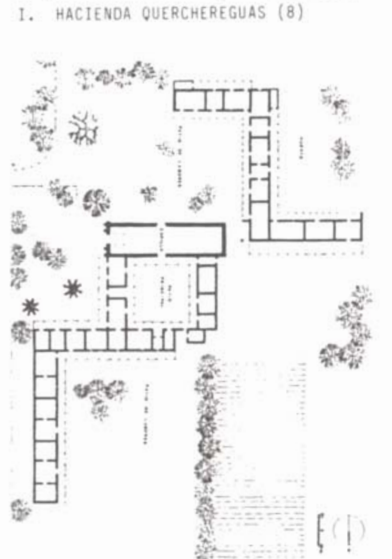


G. HACIENDA LOS LINGUES (21)



H. HACIENDA DE PELDEHUE (8)

I. HACIENDA QUERCHEREGUAS (8)



"Espacios interiores de la casa que no han sido creados para un fin determinado, semejantes en proporciones, iluminación y tamaño, la función que acogen les es indiferente, ora comedor, sala, habitación u oficina". (10)

Repetición longitudinal de un módulo que formando conjunto recto, es capaz de resistir en los dos sentidos los esfuerzos principales. Estructura racional de muros y contrafuertes para un territorio sometido continuamente a sismos. (45° constante en el cambio de giro de los muros).

"En una tierra de temblores constantes, serán necesarios muros anchos y de poca altura la mayor de las veces con contrafuertes laterales en aquellos cuyo largo es excesivo. Estas edificaciones se sostienen, más que por resistencia, por la estabilidad de sus apoyos; será frecuente que coincidan los muros transversales de los recintos para colaborar en el amarre y contraventación de las murallas longitudinales. Esta condición estructural sumada al concepto de casa fortaleza, se verán especialmente expresadas en líneas continuas de muros cerrados en los cuales se abrirán de trecho en trecho algunas ventanas y uno que otro portón principal; la greda cocida que se amoldará originalmente sobre el muslo de los operarios, serán a la postre los grandes mantos de teja que cubrirán finalmente la totalidad de la estructura". (11)

"Formas primarias de proporciones simples, fácilmente reconocibles. Volúmenes regulares, planos verticales e inclinados; llenos que predominan sobre los vacios, sucesión de pilares y de vanos. La luz anima la obra, los muros se iluminan, el sol marca la huella de la mano en el revoque de barro, textura que adorna la simplicidad de las superficies. La sombra se aisla en los vanos, en los aleros protectores y en la profundidad de los corredores". (12)

La homogeneidad del color en los muros donde predomina el blanco hace resaltar la masa del techo de tejas sobre la casa, el cual mantiene casi siempre la misma altura. Ocasionalmente presentará diversas alturas que no alterarán la homogeneidad del conjunto.

La repetición de vanos en los muros, la sucesión de pilares y vigas en los corredores; crean un ritmo ordenado que recorre toda la casa. El construir con adobe, teja de arcilla no impide que haya ligereza del conjunto, el gran peso del techo descansa en pilares delgados; junto a la macisez del muro trabaja la esbeltez de la madera.

Un paso gradual del interior al exterior a través de los corredores, patios, parrones y arboledas van abriendo progresivamente la intimidad de las piezas. Espacios intermedios que relacionan la pequeña escala de la casa con la gran escala del paisaje.

La conexión de los espacios interiores se produce normalmente en el centro de las habitaciones relacionando virtualmente todo el conjunto a través del eje central.

CONSTRUCCION Y MATERIALES

La característica constructiva de los volúmenes que componen las casas son estructuras de crujía simple con corredores a lo largo de sus costados en una u otra orientación, de preferencia norte y sur. Su cubierta de teja cocida a dos aguas sobrepasa con generosidad los bordes construidos.

Los materiales provienen en su mayor parte de la propia hacienda, son sencillos y familiares, son trabajados con herramientas tradicionales de poca elaboración.

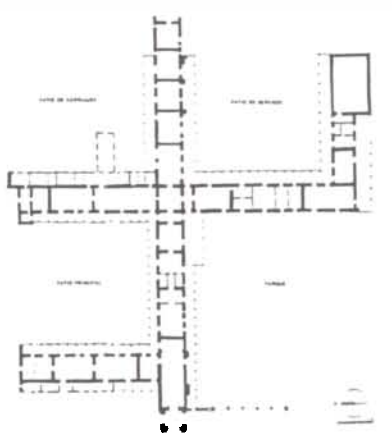
Piedra de bolón para los cimientos; muros de barro y paja; (adobe amoldado en el mismo sitio y el adobón que se construye al mismo tiempo que se fabrica el muro); madera para labrar vigas, costaneras, dinteles, soleras, pilares, canes sopandas y también para los centros de puertas y ventanas.

La arcilla cocida, es empleada en las tejas y ladrillo para los pisos. El polvillo, mezcla de arcilla fina, recubre el adobe tanto en el interior como en el exterior de los muros. Finalmente éstos son recubiertos por una capa de cal tiñendo de blanco los edificios, dándoles así unidad y buena apariencia al conjunto, todo ello dentro de una expresión sencilla, sin ornamentación que la identifique en tiempo y estilo.

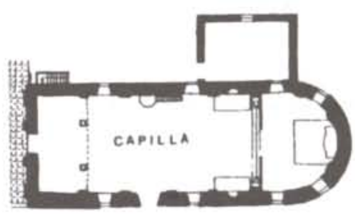
"Los muros de adobe periférico y los de refuerzo interior varían entre 0.80m. y 1.20 m., lo que asegura una excelente aislación térmica y acústica, generando un peso propio suficiente para resistir los esfuerzos sísmicos a condición de rigidizarlos a intervalos regulares con muros transversales y que la pesada carga del envigado, tijerales, ensordinado y tejas de la cubierta, no los desestabilicen" (13). Vanos pequeños, simétricos y no profusos en los muros, ayudan a los esfuerzos de tracción que pudiesen estar en algún momento sometidos.

Las técnicas empleadas para la construcción por los constructores anónimos, se encuentran sólo condicionadas por la tradición legada de generación en generación, así como también por el uso probado y popularmente aceptado de aquello que es útil y eficaz, sin vaguedad y que permite calidades probadas.

J. CHACRA LO VALDIVIESO (8)

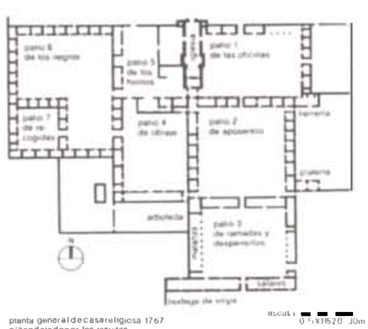


K I CAPILLA DE LO ARCAYA (8)

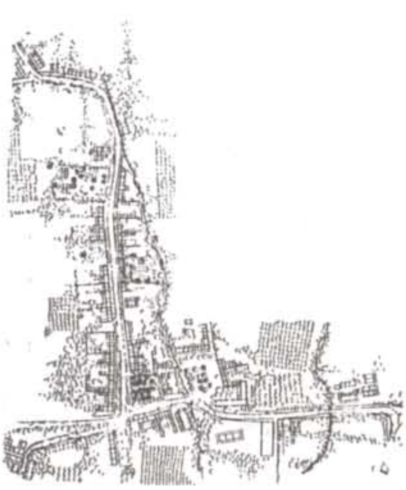


K II CABALLERIZAS DE ALCONES (18)

L. HACIENDA CALERA DE TANGO (21)



M. PUEBLO DE GUACARGUE (19)



SIGNIFICADO Y EXISTENCIA

Una de las características propias de la arquitectura vernácular es la persistencia en el transcurso y paso del tiempo, entendiendo todo ello como un espacio arquitectónico que conforma un ámbito de vida, de una sociedad determinada y que frente a las inevitables transformaciones cíclicas de la historia, pareciera querer brotar inesperadamente para controlar el destino.

"En su versión latina el término "VERNACULUS" significa, doméstico-nativo. A su vez doméstico nos lleva a la palabra DOMUS, casa residencia patriarcal y que nos recuerda el "dominicus", el señor de la casa, (el "PATER FAMILIAS") el usuario por derecho de tradición". (14)

Así la tradición vernácular nos transporta a la casa que encierra valores constantes de permanencia en el tiempo y en el espacio, en la cual, Señor, familia, propiedad, tierra y tradición se confunden con el habitar, donde todo aquello permanece inalterable y transmisible.

Una "FORMA" en el espacio que se traslada en el tiempo manteniendo el valor del espacio arquitectónico permanente; valores que hablan del momento del espacio como cualidad intrínsica de este "tipo" de arquitectura.

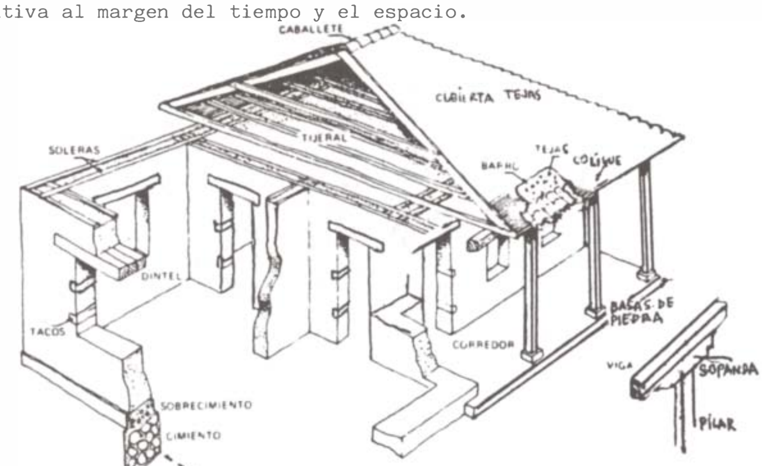
"Podemos considerar a nuestra arquitectura vernácula como una manifestación al parecer sencilla, generalmente simple en sus soluciones estructurales (y espaciales) y que sin embargo, se desarrolla sobre bases formales y conceptuales, ricas en soluciones diversificadas y hasta insospechadas que adquieren siempre una especial importancia histórica por ser el resultado de una tradición viva". (15) De esta manera su fuerza principal y vitalidad de persistencia arquitectónica pareciera ser entonces "la de preservar la memoria de los "tipos" lo que no es poco si pensamos que el principal problema arquitectónico es justamente aquello del génesis de las formas y de la relación forma-contenido" (16)

La lectura de la arquitectura vernácular constituirá un medio de reconocimiento de un panorama cultural que ha estado siempre presente como lo cotidiano; lo doméstico, aquello que tiene que ver con el uso diario y permanente, inmutable al tiempo y que permanece en la memoria de los hombres sin alteración y por lo tanto merece la permanencia en el espacio y aportando al hombre su "ser" cultural permanente.

La arquitectura vernácular, más allá de sus expresiones propias, nos llama a reflexionar acerca de los valores que el hombre contemporáneo va continuamente y sistemáticamente marginando, avanzando rápidamente a un desequilibrio cada vez más dramático entre el rítmo del progreso tecnológico y esa inevitable ansiedad de incorporarlo en la integración de una nueva personalidad de ser humano.

Es así que estas expresiones que llamamos vernaculares, espacios arquitectónicos, estructuras simples, materiales tradicionales, herramientas directas, parecen invitarlo a toda clase de esfuerzos para retomar el control de nuestro propio destino. En la casa tradicional de la Zona Central encontramos reunidas todas las consideraciones propias de lo vernácular que permitiría con las mismas formas espaciales, materiales y técnicas artesanales proponer un tipo de arquitectura que recogiendo valores patrimoniales proyecte la permanencia de estos valores, hoy.

En síntesis debemos reconocer que sin espectacularidades, el material de tierra, planteado con las características antes señaladas, tiene conferida una nobleza que se remonta al mismo origen de la habitabilidad y la ocupación del Valle Central, haciéndose por tanto merecedora de lograr su más genuina identidad en todo momento. Es más, es posible sostener que es allí, en esa determinada relación espacial-estructural, queda planteada una perspectiva de soluciones arquitectónicas diversificadas y hasta insospechadas, en una potencialidad creativa al margen del tiempo y el espacio.



N. PARTES CONSTRUCTIVAS PRINCIPALES DE UNA ANTIGUA VIVIENDA TIPICA DE ADOBE (23)

NOTAS

1.- G. C. ARGAN, Proyecto y Destino (Ediciones de la Biblioteca Central de Venezuela 1969) 57-61. En referencia a Quatremere de Quincy en su "Dictionnaire Historique de L'Arquitecture". Paris 1732.

2.- M. GOLDFINGER, Antes de la Arquitectura. Edificos y Habitat Anónimos en los países Mediterraneos (Barcelona Ed. Gustavo Gili S.A. 1970) 9.

3.- E. BINDA, La Casa Campesina Chilena en: ACADEMIA Nº13-14 (Universidad Metropolitana de Ciencias de la Educación, Santiago 1986).

R. TREBBI DEL T. "Arquitectura Chilena durante el Siglo XVIII: estilo "Mestizo, Del Norte, Barroco, Urbano y Vernaculo Rural" en: El Barroco en Hispanoamérica; manifestaciones y significación; Edición preparada por B. Bravo Lira, (Fondo Histórico y Bibliográfico José Toribio Medina, Santiago 1981) 110-113.

5.- H. RODRIGUEZ VILLEGAS, "Situación de las Casas Patronales en Chile" en: EL MERCURIO, (Santiago de Chile, 13 de Febrero, 1977).

6.- R. TREBBI DEL T., "Arquitectura Rural en la Zona Central de Chile", en: EL MERCURIO, (Santiago de Chile, 13 de Septiembre, 1980).

7.- R. TREBBI DEL T., Desarrollo y Tipología de los Conjuntos Rurales de la Zona Central de Chile, Siglos XVI - XIX (Santiago, Chile, Ediciones Nueva Universidad 1980) 38-39.

8.- J. BENAVIDES, M. ANDUAGA, J. DAROCH, C. MIRANDA, H. MONTECINOS, D. ORTEGA, S. PIROTTE Y I. SALINAS, Conjuntos Arquitectónicos Rurales, Casas Patronales 1 (Santiago, Chile, Universidad de Chile, Facultad de Arquitectura y Urbanismo. Edición Corporación Toesca 1981) 50-51.

9.- IBID 56-58

10.- P. GROSS, "Patrimonio Urbano Arquitectónico y calidad de vida" en: REVISTA UNIVERSITARIA Nº2 (Julio 1979) Pontificia Universidad Católica de Chile (Santiago 1979).

11.- C. VALENZUELA SOLIS DE OVANDO, "Cuatrocientos años de Construcción en Chile" en: DEKORATOR año 3 Nº2 (Santiago de Chile 1980).

12.- P. GROSS, "Patrimonio Urbano Arquitectónico)..."

13.- J. BENAVIDES Y OTROS, "Conjuntos Arquitectónicos" 82

14.- R. TREBBI DEL T., "Arquitectura espontánea y vernácula en América Latina. Teoría y Forma. (Ediciones Universitarias de Valparaíso; Alfabeta Impresiones 1985) 18.

15.- IBID 19

16.- IBID 20

17.- S. MIRANDA, E. BINDA Y S. ROJO, "El Adobe como base para un lenguaje Arquitectónico propio". (Informe de Investigación DIUC 1984. Proyecto de INvestigación 28 F/84 Universidad Católica de Chile, Septiembre 1985) 37-46.

18.- G. GUARDA O.S.B., Colchagua Arquitectura tradicional (Ediciones Universitaria Católica de Chile. Santiago 1988) 52-53. El ejemplo fue citado dentro del Capítulo "El habitante y sus Expresiones".

TIPOLOGIA Y LENGUAJE DE LOS VALORES EXISTENTES (16)

A VOLUMEN UNICO — Ver plano A (20)

1) ESPACIO Un solo espacio rotundo, estanco. Entrada jerarquizada por un eje de simetría. Simetría y equilibrio otorgados por el eje central.

2) VOLUMEN Volúmen único, como portador de toda la concepción.

B VOLUMEN UNICO PERIPTERO — Ver plano B (21)

1) ESPACIO Espacio interior centralizado, eje central perforado, presencia del perímetro en toda su extensión que impide la anexión de nuevos espacios.

2) VOLUMEN Estructura períptera con volúmen único central. La primera definida por los pilares y la segunda por la masa.

C VOLUMEN DE ALQUERIA — Ver plano C (17)

1) ESPACIO Dos niveles; espacios interiores rotundos y estancos. Ordenación de "Alqueria". El espacio intermedio exterior está conectado en el 2º nivel.

2) VOLUMEN Unico en dos niveles escalera exterior conecta primero y segundo nivel. Sistema volumétrico permite una extensión orgánica.

D PLANTA CUADRANGULAR EN □ — Ver plano D (21)

1) ESPACIO Planta octogonal, cuadrado riguroso. Predominio de la linealidad en el orden del cuadrado y sus extensiones. Módulo básico y cerrado.

2) VOLUMEN Compuesto y orgánico permite su extensión en diversas orientaciones. Espacio definido por una estructura perimetral definida exterior y períptera interior.

E PLANTA RECTANGULAR LINEAL EN — — Ver plano E (8)

1) ESPACIO La ley del desarrollo total está en la línea demarcando límite interior y exterior.

2) VOLUMEN Unico de simetría axial de ley de desarrollo formal en línea.

F PLANTA EN L — Ver plano F (21)

1) ESPACIO Espacio exterior; no conforma cerramento; planta en "L" con un lado dominante.

2) VOLUMEN La disposición volumétrica formula dos espacios definidos, norte-sur; este-oeste. Sistema de circulación paralela privada y pública exterior. Sistema en "L" crea un espacio rotular estanco.

G PLANTA EN U — Ver plano G (21)

1) ESPACIO Espacio interior rotundo, estanco.
Espacio intermedio se propone como estructurador de la idea casa.

2) VOLUMEN El partido general es una "U" elemental enriquecida por la incorporación de la topografía. Perspectiva visual en apertura.

H PLANTA EN H — Ver plano H (8)

1) ESPACIO El partido es una "H" con adosamientos de volúmenes varios y que genera todo el conjunto.

2) VOLUMEN Volumen compuesto; el patio central; permite el crecimiento orgánico en toda su extensión.

I PLANTA EN — Ver plano I (8)

1) ESPACIO Planta dinámica con un centro ortogonal que define el giro. La capilla y los volúmenes que conforman el nodo, permiten un patio interior.

2) VOLUMEN Volumen compuesto y tensional en diagonal.

19.- IBID. Dibujo del Pueblo de Guarcar - gue. 111.

20.- E. BINDA, "La Iglesia de la Compañia de Graneros; breve reseña Histórica" im - presión reducida (Escuela de Arquitectura, Pontificia Universidad Católica de Chile, Agosto 1987) Plano Nº11.

21.- GRUPO CIEN (Centro Interdisciplinario de Estudios Nacionales) AGENDA ESPECIAL. Arquitectura Tradicional del Valle Central de Chile 1980 (Ediciones Lord Cochrane S.A. 1980)Santiago de Chile.

22.- H. ECO La Estructura Ausente. Introducción a la Semiótica. (Editorial Lumen 1981) Sección C. La Función y el Signo 336-341.

23.- E. GUZMAN, Curso de Edificación (Ediciones Universidad de Chile 1968) Primer Tomo Cap. IV La Vivienda de Adobe, 204.

J PLANTA EN ✚ — Ver plano J (8)

1) ESPACIO — Espacio de característica lineal; lo interior dentro de la casa y lo exterior abierto fuera de ella, creando patios abiertos.

VOLUMEN — La disposición volumétrica formula dos espacios definidos, norte-sur, este-oeste con un encuentro en su eje central. Volúmenes adicionales a las alas principales, producen patios abiertos. Circulación del eje principal es periférica.

K PLANTA CURVA

I COMO OBRA INDIVIDUAL — Ver plano K I(8)

1) ESPACIO — Uno solo, rotundo, estanco.
Entrada jerarquizada que remata en el abside curvo.

2) VOLUMEN — Volumen aislado que participa de un conjunto complejo y total.
Abside circular (semi-círculo) como remate del total del volumen

II COMO OBRA DE CONJUNTO — Ver plano K II (18)

1) ESPACIO — Un solo espacio central trazado en círculo; insinúa la "trilla" o el "rodeo", ambas fiestas de trabajo con animal.

2) VOLUMEN — Circular formando un amplio patio central. Altura significativa volumen único lineal de vanos pequeños, ingresos e iluminación (caballerizas)

L PLANTA MULTIPLE (CASA PUEBLO) — Ver plano L (21)

1) ESPACIO — Conformación de infinidad de espacios abiertos que definen su propia especialidad con los mismos elementos tradicionales.

2) VOLUMEN — Volumen complejo. El muro y la suma de patios interiores conforman el volumen total.

M PLANTA DE PUEBLO (CONJUNTO MULTIPLE) — Ver plano M (19)

1) ESPACIO — Conjunto que insinúa una unidad lineal. Se entiende como un todo conformado a través de dos ejes principales, norte-sur y este-oeste.

2) VOLUMEN — Conjunto de volúmenes de características similares a los anteriores mencionados.
Se caracterizan por su angulación y reunión en angulo de 90°; Corredores y volúmenes que forman espacios abiertos y cerrados.

CONCLUSIONES

Humberto Eco sostiene en su "Introducción a la Semiótica" (22) "que el objeto arquitectónico puede demostrar la función o connotar determinada ideología de la función. El objeto de uso es, desde el punto de vista comunicativo, el significante del significado, denotando exacta y convencionalmente que es su "función", (el objeto arquitectónico denota una función).

La casa patronal que hablamos, reconoce en si misma un contexto de signos referibles a un código conocido con lo cual ella puede representar sin incomodar o innovar un habitat agradable y funcional.

Podríamos añadir que la forma arquitectónica puede también connotar otras cosas, en el caso de la casa patronal, connota la función "habitar" y que luego con el tiempo connotó además: "Familia", "Núcleo comunitario", "Núcleo de trabajo", "seguridad", "comunidad agrícola", "centro de la vida familiar", "núcleo de autosustento", etc. Siendo que la casa denota "utilitas" a los fines de la vida asociativa, no es menos cierto y de importancia que la valoración de connotación, que implica intimidad y familiaridad unidos a los valores simbólicos y existenciales y por lo tanto espaciales, son de notable importancia.

De este modo la casa campesina tradicional, que evidencia estas connotaciones simbólicas, se consideran funcionales no solamente en sentido metafórico, sino porque también comunican una utilidad social que no se identifica inmediatamente con la "función" en sentido estricto.

Cabe señalar finalmente que en los casos arriba analizados, encontramos bases espaciales y conceptuales ricas en soluciones diversificadas y hasta insospechadas que adquirirán siempre una especial importancia histórica y arquitectónicas dado el resultado de una tradición vigente.

CLAY-LUMP THE ENGLISH ADOBE

Dirk Bouwens F.R.I.C.S.
Paperhouse
West Harling
Norfolk
NR16 2SF
United Kingdom

ABSTRACT

In England adobe buildings are found only in East Anglia and were introduced around 1800. The distribution of the buildings and the possible geological influence are illustrated and the processes of manufacture and construction are outlined. The range of building types and the properties of the material are described as well as the present trends in conservation.

KEYWORDS

Earthen architecture, adobe, strength, conservation.

Introduction

The topography of the British Isles is remarkably varied. Changes occur every 70 km and in many places more frequently. The vernacular architecture changes in style and construction with the landscape.

There are clay buildings in several regions. These are of monolithic construction formed either by placing a mixture of clay and straw on the wall and paring the face level after the mixture has partly dried, or by placing the mixture between boards. The former method is known as 'cob' or 'wichert' and the latter 'shuttered or puddled' clay.[1] Adobe mud-brick construction is confined to the region of East Anglia in parts of the counties of Norfolk, Suffolk, Cambridgeshire, Essex and Hertfordshire[2] where it is loosely related to the superficial glacial deposits of chalky boulder clays (see Fig.1). These are up to 60 m thick over chalk sub-strata.[3] These clays vary in composition from chalk mud with pieces of chalk mixed in to clay with pieces of chalk varying in size from 1 mm diameter to over 25 mm diameter to clay containing a high proportion of sand with little chalk. Commonly the clay content varies around 15 percent of the total volume.[4] Suitable clays for making adobe occur elsewhere; why clay-lump, as this type of adobe is called locally, should be confined to one region is not known.

Fig 1
The areas of chalky boulder clay.

The main area where clay-lump buildings occur measures approximately 60 km square and straddles the Norfolk Suffolk border. Further west is another area about 45 x 15 km around the city of Cambridge. This area extends east into Essex. Further south are other areas in Essex (see Fig 2). Much work has still to be done in preparing the distribution map which is based on the writer's actual sightings and reports from several sources. The density of clay-lump buildings is highest in the centre of the main area, as is illustrated by the maps of the village of East Harling (see Fig 3) and the small town of Attleborough (see Fig 4).

Clay-lump was used in the construction of every type of building, from boundary walls and the smallest outbuildings to small houses and at Bridgham Hall Farm, (Ordnance Survey TL957 268) a large farmhouse. In between are thousands of small- and medium-sized houses built detached, in pairs and in terraces. All types of agricultural buildings were built of clay-lump, and farmers are still using barns 50 m long by 7 m wide. Shops and public houses built of clay lump are common. Clay-lump was used for schools like the one at Thompson (O.S. TL 923 966) and for vicarages and parsonages such as at Hepworth (O.S. 983 752). There were two tower windmills known to have been built of clay. At Carleton Rode (OS TM 099 945) the solid clay mill was 15 m high and

Fig 2
The general areas where clay-lump buildings are found.

Fig 3
East Harling (Population 2071) clay-lump houses shown shaded.

had five floors. It collapsed in 1958, one hundred years after it was built.[5] The clay-lump windmill at Attleborough (O.S. TM 053 949) collapsed in 1911.[6] Hingham watermill (O.S. TG 033 088) still stands and has been converted to a dwelling. The steam traction engine shed at East Harling (O.S. TM 995 882) was 30 m long 7.5 m wide and had walls 300 mm thick and 4.8 m high and was demolished in 1989.

In the centre of the main region of clay-lump construction, it is rare to find any buildings built between 1850 and 1900 which are not of clay-lump. Indeed for about 100 years clay-lump was the major walling material in this region and was still being used in the 1920s for public housing in a number of villages.[7] Clay-lump lost its supremacy to cheap mass-produced materials which were more durable and became more available as the motor lorry replaced horse-drawn transport.

Beginnings

John McCann has convincingly argued that clay-lump was introduced just before 1800.[8] He points out that whereas there are examples of buildings in other clay construction techniques from all periods, no clay-lump buildings before the early nineteenth century have been found. He also cites numerous writers who, in the first half of the nineteenth century, wrote in a way suggesting that clay-lump was an innovation. John McCann lists the reasons for the adoption of clay lump and expands on them:

"1. The cottage movement stimulated an interest in low-cost construction combined with presentable appearance.

2. The rising price of timber provided an incentive to use alternative materials.

Fig 4
Attleborough (Population 7230) clay-lump houses shown shaded.

3. The tax on fired bricks introduced in 1784 provided an incentive to seek tax-free materials.

4. Technical literature on building with unfired earth was available in 1790 and in wide circulation by 1797.

5. Foreign and classical influences.

6. Agricultural improvements of the time required many new buildings in an area where other materials were expensive owing to poor transport facilities."[9]

Manufacture

The clay was dug as near to the building as practical. The clay for the council houses at Garboldisham and Attleborough was dug from what became the back gardens of the houses.[10] The clay for the council houses at East Harling was quarried a short way from the site just over the brow of a slight rise. Instead of following the road the tumbrils took the direct route across the fields.[11] The clay was often dug in winter to allow the frost to break it up, to let water get into it and to take advantage of cheaper labour.

The clay was laid on a bed of chaff or straw to a depth of about 225 mm.[12] It was covered with straw and 'trodden' by a horse, pony or donkey until the clay and straw were thoroughly mixed. Ray Shinfield who was a building worker until he retired seven years ago was sometimes employed to make a few clay-lumps for repair work by R Hogg and Sons, a firm of builders, of Coney Weston and to do this an octagonal banker of scaffold boards was filled with clay and straw and the horse was led by a man outside the banker while another man threw water on to the mixture. The clay was ready if it did not fall through the tines of a fork when lifted.[13]

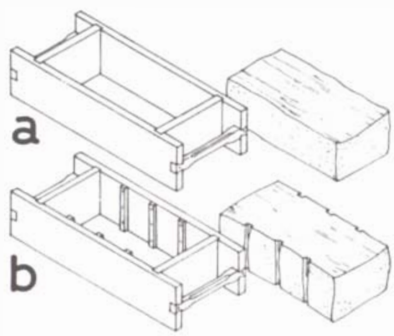


Fig 5
a. Clay-lump and mould

b. Keyed clay-lump and mould

The straw mixed with the clay was usually barley straw, although Mr Claude H Thompson who was over 90 and had seen clay-lumps made said dried spear grass (Agropyron repens) was considered best.[14] Other fibrous materials are also found but these probably got there by accident. The more chalk in the clay the less straw was used and the more sand present the more straw was used. Barley straw was cheap because the beard from the ears made it unsuitable for bedding animals. Harriet Sprigg, who during the 1970s largely rebuilt her clay-lump house and made the lumps that she needed, noted that the larger the proportion of straw in clay-lump the better it lasted when exposed to the weather. The straw may give some tensile strength to the clay-lumps when they are handled.

Moulding the clay was done close to the the treading bed. The moulds were bottomless wooden boxes with handles at both ends and could be made without nails (see Fig 5a). Some moulds were reinforced with iron straps fixed to the edges. If a key were required on the blocks, battens of wood were fixed inside the mould (see Fig 5b). The mould was placed on the ground, and the clay was placed inside the box, and packed into the corners with a shovel or fork, and scraped level with the mould which was immediately removed. Ray Shinfield dusted the inside of the mould with sand to prevent the clay sticking. Harriet Sprigg floated the moulds in water and used them alternately. The mould to be filled was placed close to the last clay-lump made. When the moulding was finished and the lumps had dried sufficiently they were turned on to their sides to prevent the blocks from distorting as the upper side dried. The clay-lumps would be turned again on to their ends and as soon as they were dry enough to be handled the blocks were stacked in open formation under cover to dry completely. Harriet Sprigg noticed that the lumps were most vulnerable from rain for about two days after they had been made. After that moderate falls of rain had no harmful effect.

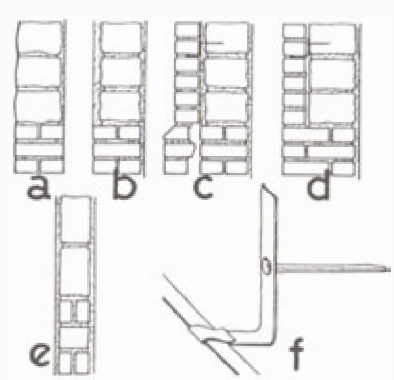


Fig 6
a. Tarred clay-lump wall plastered one side (section)

b. Clay-lump wall rendered externally, plastered internally (section)

c. Clay-lump wall with added brick facing (section)

d. Clay-lump wall built with brick facing (section)

e. 150 mm thick clay-lump internal wall (section)

f. Hoop iron tie (sketch view)

Construction

All external walls have a plinth between 150 mm and 1200 mm high (See Fig 6). The plinths are of brickwork or flint rubble and sometimes have a split flint facing. The purpose of the plinth is to check rising damp, however, its height seems to have been purely a matter of choice. The thickness of the plinth was equal to the wall or if there was a course of splay bricks at the top about 50 mm thicker. Load-bearing internal walls sometimes have no plinths. Partitions of blocks laid on edge have plinths of brick on edge tied together with cut bricks (see Fig 6e).

The mortar in which the clay-lumps were laid was usually composed of the same clay as the lumps, but with the stones removed. Mortar joints were between 12 mm to 20 mm thick. Hydrated lime ($Ca(OH)_2$) was sometimes added to the clay. Edward Skipper used a lime mortar for the council houses at Garboldisham because the blocks were not completely dried.[15] The blocks must be dry if clay mortar is used so as to absorb the moisture from the clay and prevent it from being squeezed out.

Openings were formed as work progressed, with door frames placed in position against which to build the lumps. Lintels were of wood and were between 300 mm and 600 mm longer than the width of the opening. In some houses it is clear that the windows were put in after the walls were complete, possibly to take into account any shrinkage in the clay.

Floor joists were built into the wall and bore directly on the clay-lump or on a timber plate or on a single brick. The wall plate at the top of the wall on which the roof framing bears is usually substantial - 150 x 100 mm is a common section.

Hearths on the ground floor are always of brickwork. On upper floors the openings are often of clay where a cast iron fireplace was fitted. Brick flues were always lined with clay because the condensates from the flue gasses attack mortar, and some flues were entirely of clay-lump. Above roof level, chimneys were always of brick.

Clay-lump requires a covering to protect it from the weather. Exposed clay-lumps gradually disintegrate at each frost. Water alone has little effect as the clay will absorb considerable amounts of water without damage, provided it can dry out. The most common surface treatment was tar, either coal tar (a by-product of gas and coke ovens) or hot bitumen. Both will craze as the oil in them evaporates, and these cracks allow moisture to escape. Although it is not used often on houses, tar is common on agricultural buildings and out-buildings and can be painted or rendered if sand is stuck to it while it is still wet (see Fig 6a).[16] Renders were originally made of the same clay as the clay-lump, with short straw and other fibres added. The clay is put on in two 9 mm thick layers inside and thicker externally. The first coat is scratched to form a key for the second coat and lime putty was used as a finishing coat inside and sometimes outside. Corners and reveals sometimes have wood beads. Lime-tallow paint provides a durable water-resistant finish which was applied directly to the lumps and over sanded tar as well as to renders. Nowadays cement renders laid on wire mesh fixed to the walls are used with modern waterproof paints instead of clay renders and limewash.

Many clay-lump buildings are faced with brickwork which was added to existing clay-lump houses over the original render (see Fig 6c). Hoop-iron ties fixed with 100 mm nails secured the brickwork to the clay-lump. The ties were bent over horizontal hoop-iron bands which were built into joints in the brickwork (see Fig 6f). Some houses were designed to be faced with brick immediately and have the facing brickwork bonded to the plinth (See Fig 6d). On the public housing in Attleborough (O.S. TM 038 947) the swan-necks of the cast-iron rainwater pipes are built into the brickwork which shows that the roof and gutters must have been completed before the brickwork facing was finished. Flint rubble with brick dressings was also used as facings. Research is hampered by the apparent similarity of such walls to walls constructed of solid flintwork.

A small number of clay-lump buildings still have roofs of thatch. Thatch was often replaced with fired clay pantiles which together with natural stone slates are the most common roof covering. Roofs on clay-lump buildings usually project over the walls and, because clay-lump gables are difficult to make stable, are often of low pitch or of hipped construction.

Properties

Clay-lumps were made in a number of sizes:

A. 65 x 90 x 215 mm
Similar to unburnt bricks except that the chalk in the clay would prevent its being fired.
Used on chimney stacks and as backing bricks to facing brickwork.

B. 140 x 140 x 295 mm
Found in a chimney stack.

C. 140 x 140 x 440 mm
Used to make internal load-bearing partitions at the public housing at Garboldisham and by Harriet Sprigg who could not lift larger blocks.

D. 140 x 215 x 440 mm
The universal block used to make walls 215, 140 and 440 mm thick.

E. 140 x 295 x 440 mm
Used to make walls 140, 295 and 440 mm thick.

F. 215 x 215 x 440 mm
Although this size has often been reported[17] The author has never seen one.

One clay-lump measuring 140 x 215 x 440 mm weighs about 25 kg or 1576 kg/m^3. That clay-lump can be used on edge or on bed suggests that there is no compression in the manufacture of the block.

The Department of Scientific and Industrial Research, Building Research Board recommends "a maximum compressive strength of 1.08 - 1.30 N/mm^2 ("10 to 12 tons per sq ft")".[18] Tests carried out at Norwich City College of Further and Higher Education on 5 October 1987 on four clay-lumps taken from an internal wall resulted in failure at an average pressure of 1.58 N/mm^2 (14.6 tons per sq ft). In order to obtain the samples which were tested two workmen working from both sides of the wall with 1.8 kg hammers and bolsters took 6 minutes to fragment one clay-lump. Nails driven into clay-lump like those which secure the hoop iron ties require a pull of at least 30 kg to remove them.

Lime was burnt locally from chalk which produced a mortar with a safe crushing strength of 0.5 N/mm^2[X] clay-lump was therefore as strong as brickwork built with this mortar.

Conservation

The cob and wichert buildings of the southwest and the midlands are thoroughly surveyed and protected. The same cannot be said of clay-lump. Its conservation is a sorry tale of ignorance and neglect, although this situation is being changed through the work of a small number of people by means of lectures and the publication of articles. In the United Kingdom buildings are legally protected when included on the list of "Buildings of Special Architectural and Historic Interest".[20] A small number of clay-lump buildings are on the list but this is chiefly because of their architectural interest; very few are listed soley because of their structure. The demolition of the public housing at Garboldisham in 1987 and the traction engine shed in East Harling before they could be listed has resulted in other clay-lump buildings being listed. The authorities now seem much more responsive to the protection of such buildings.

The attitude of the mortgage companies has changed in recent years so now clay-lump houses are regarded as good security. This has helped change the commonly held view that clay-lump is an inferior material since public perception is based on the few dramatic collapses which do occur. In every case water had got into the clay and in several recent cases structural alterations were being made. Portland cement based renders crack and let water in but not out. Similar less marked effects are caused by modern waterproof paints.

In the case of brick faced buildings the hoop iron ties eventually rust and fail. The traditional repair is to replace the brick veneer. The patent devices for repairing similar defects in modern walls of cavity construction are effective on clay-lump walls.

The Society for the Preservation of Ancient Buildings set out the principles of the proper repair of clay buildings in 1929[21] but is only now in the process of preparing a leaflet on the subject. Cambridgeshire County Council has such a leaflet; other authorities expect to follow. The universities of Bristol, York and East Anglia have all included clay-lump buildings in conservation conferences.

Conclusion

The author's own work in preparing the distribution map is far from complete and only identifies the range of clay-lump buildings. Conservation can only be hit or miss until the number and density of the buildings is known. Nearly all clay-lump houses are lived in and the vast majority are owner occupied and will have a secure future when the public understands the different requirements by way of maintenance and repair. Agricultural buildings have a less certain outlook. The success of clay-lump as a building material in what might seem a hostile climate should encourage those concerned about the high cost of modern walling materials in terms of the energy consumed in their manufacture and distribution.

Acknowledgements

The author's research would be impossible without the kindness of many who let me into their houses and provided valuable information: Harriet Sprigg of Bridgham, Roper Reeve of East Harling, Roy Shinfield of Barningham, R V Ramm of Attleborough, Robert Hogg of Coney Weston, Claud Thompson of Besthorpe, Harry Apling of East Dereham.

References

1. 'Cob' in Devon 'wichert' in Buckinghamshire 'shuttered or puddled clay' are East Anglian names and differ from 'pise de terre' which entails ramming.

2. 'Building in clay-lump in England seems for some undiscoverable reason to have been confined in the past to East Anglia'. Department of Scientific and Industrial Research Building Research Board, Special Report No.5, Building in Cob and Pise de Terre (London: His Majesty's Stationery Office, 1922) 14.

3. Geological Survey map, Sheet No.161 (London:British Geological Society)

4. John and Nicola Ashurst, Practical Building Conservation, English Heritage Technical Handbook, Volume 2 (Aldershot: Gower Technical Press, 1988), 93.

5. Information given on 11 Jan 1988 by Mr R V Ramm, Cypress Road, Attleborough who was the miller at Carleton Rode until 1944.

6. Letter from Harry Apling, Swanton Grove, East Dereham dated 18 Jan 1988.

7. 'Watton, East Harling and Gorboldisham (sic)' Building Research Board Special Report No.5 16.

8. John McCann 'Is Clay-lump a Traditional Building Material?' Vernacular Architecture No.19 (Vernacular Architecture Group 1988) 1 - 16.

9. Ibid.,6.

10. Verbal information given by tenants in both groups of houses in 1987.

11. Verbal information given by Mr Roper Reeve, The Crescent, East Harling 1985.

12. Verbal information given by Claude H Thompson, Silver Street, Besthorpe 12 Jan 1988 who was 90 years old and had helped to make clay-lumps and had ridden the horse round the treading bed.

13. Verbal information given 27 May 1987.

14. Claude H Thompson 12 Jan 1988.

15. Local tradition and Building Research Board Special Report No.5, 17.

16. Clough Williams-Ellis, Cottage Building in Cob, Pise, Chalk and Clay A Renaissance (London : Country Life 1919), 108.

17. Building Research Board Special Report No.5, 17

18. Ibid, 10

19. George H Blagrove, Dangerous Structures : A Handbook for Practical Men (London B T Batsford 1892) 14

20. Historic Buildings and Ancient Monuments Act, 1953.

21. A R Powys, Repair of Ancient Buildings (London S.P.A.B. 1929) 58.

INSOLITA TRADICION DE TAPIAL EN CUBA

Arq. Francisco T. Casal Iglesias
Unión de Arquitectos e Ingenieros de la Construcción
Humbolt 104 Esq. A Infanta, Vedado
Ciudad de la Habana
Cuba

ABSTRACT

The paper deals with a carbonate-soil-based traditional building technique frequently used in one of the easternmost regions of the Republic of Cuba, its historical evolution, present situation, construction mistakes most commonly encountered and the most rational solutions for both buildings and maintenance. Emphasis is made on the economical and environmental benefits of this building technique for different kinds of architectural programs. The need to disregard certain subjective barriers regarding its use is also underlined, since weather proofing solves earthen architecture's most commonly signaled drawback. Recommendations for the extended use of this technique within and beyond Cuba are also included.

KEYWORDS

Compaction, crystalization, calcium carbonate "coco soil," blocks, manual press, earth, pisé, tamped earth

Introducción

En la región de Puerto Padre, al norte de la provincia Las Tunas, al este de la Repúplica de Cuba, se construyen viviendas económicas y otras construcciones con una insólita técnica denominada localmente como obras de "cocó" o de mampuestos. Esta solución es similar al tapial ("pisé de terre") y consiste en la compactación de un material calizo, convenientemente humedecido, en forma directa en el muro con el auxilio de guarderas de madera o metálicas (Fotos 1 y 2). Determinados suelos calizos de la región, conocidos como "cocó", ofrecen un buen comportamiento constructivo, ya que sin ningún aditivo logran alcanzar después de diez semanas resistencias superiores a 26 Kg/cm2. Este endurecimiento se origina en la cristalización del carbonato húmedo consolidado en un proceso similar al de la formación natural de algunas rocas. Una vigorosa compactación es la condición básica para obtener la resistencia requerida capaz de garantizar un buen comportamiento ante el severo régimen de lluvias tropicales sin acudir a terminaciones como resanos y pinturas. Estas obras de "cocó" resuelven uno de los mayores inconveñientes para el uso de la tierra en construcciones que radica en su limitada resistencia ante los agentes atmosféricos. Es éste, el manido argumento que se le ha señalado casi a nivel ecuménico para limitar o rechazar el uso del más abundate y económico material de construcción: el suelo.

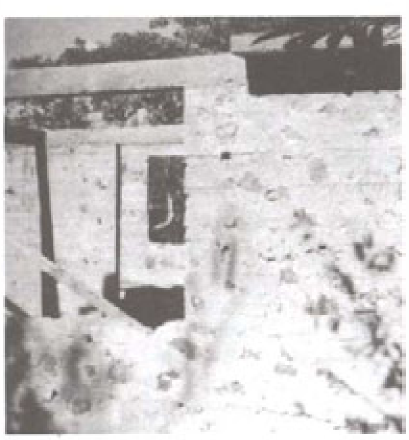
Características del Suelo Apto

Internacionalmente se conocen por suelos calizos los que presentan una alta concentración de carbonato de calcio ($CaCO_3$) en todo el perfil. Generalmente se trata de suelos jóvenes formados sobre calizas blandas y margas que han retenido un alto por ciento del carbonato de calcio, en algunos casos como partículas y fragmentos de rocas calizas, pero principalmente como carbonato de calcio gredoso o blando, más o menos disperso en la masa del suelo. En la zona en cuestión, los suelos pertenecen a la era geológica del neógeno. El "cocó" es un eluvio de caliza con igual o más del 70% de carbonato de calcio en su composición, libre de materias orgánicas, color blanco y olor característico cuando se humedece. En la región aparece como bolsones por debajo de la capa vegetal, y, en algunos casos, bajo formaciones rocosas calizas superficiales conocidas como "diente de perro" por su textura muy afilada.

Origen y Evolución

La incorrecta denominación de mampuesto nos ayuda a develar el hilo de su origen. Los legendarios muros de mampuestos han sido ejecutados con piedras irregulares unidas con un mortero de arena y cal. En Puerto Padre el más notable ejemplo de su uso el es

VIVIENDA DE "COCO" CON COLUMNITAS PREFABRICADAS



VIVIENDA DE "COCO"

BOHIO

MAMPUESTO CON RESANO

Fuerte de la Loma (Fotos 3 y 4) construído por los españoles el siglo pasado como parte del sistema defensivo costero. El mismo fue recientemente restaurado y ostenta la distinción de Monumento Arquitectónico Nacional. Originalmente en él se empleó el "cocó" como elemento de unión de las piedras calizas lográndrose un hermoso efecto de color y textural rugosa uniformes (Fotos 5 y 6). Su curiosa volumetría exalta la fuerza contínua de los muros cilíndricos, con una expresión muy orgánica, a la vez sólida y desenfadada, como brotada de la loma, pues en su concepción general se emparenta más a las vanguardias del diseño contemporáneo, que al academicismo imperante en la época. También en el casco histórico del poblado abundan las construcciones de mampuestos, aunque siempre con las superficies resanadas y pintadas. Sin embargo el nuevo aporte constructivo aparece en las zonas campesinas. Allí se modificó la vivienda típica conocida con su nombre indígena: "bohío". Este se construía a lo largo de la isla aprovechando integralmente determinadas palmáceas, principalmente la palma real. El bohío se construía a partir de un esqueleto de palos redondos (varas) enterrados en el suelo, con una cubierta muy inclinada de hojas de palma (guano) y paredes con la corteza endurecida de su tronco (tablas de palma) o la resistente prolongación de la hoja que la fija al tronco (yagua). ¿Cuál tecnología apropiada desarrollaron los constructores campesinos? Tomaban el "cocó" que extraían de los pozos para el agua y la letrina sanitaria y con él levantaban los muros de su bohío con un espesor de unos 25cm, invirtiendo las proporciones del mampuesto, es decir, aumentando el aglomerante y disminuyendo las piedras que generalmente aparecían mezcladas en el suelo. Se introducen las guarderas de madera para conformar los muros. En algunos casos se combina con el esqueleto de palos redondos. Surgen los primeros bohíos de "cocó". La cubierta continua siendo el típico guano. Sus ventajas son sus mejores condiciones sanitarias y su adecuación climática, pues es tan fresco en verano como el bohío tradicional, pero resulta mucho más confortable térmicamente en el invierno. El "cocó" también es utilizado para consolidar los pisos de tierra.

Deficiencias y Mantenimiento

Su eficiente resistencia al intemperismo, como ya se ha señalado, depende de la compactación. En el año 1962, cuando un ciclón tropical de gran intensidad asoló la zona durante varios días con fuertes lluvias, pocos fueron los casos de colapso de estas construcciones. Sin embargo la acción combinada del agua y el viento debilitó las aristas de las ventanas y las esquinas, erosionó algunas secciones de los muros donde dejó la piedra a vista y sólo en muy pocos casos produjo ahuecamiento. Este comportamiento refleja sus dos puntos débiles; la falta de un diseño redondeado en las aristas y la dificultad en obtener una compactación manual uniforme debido a la técnica tan primitiva al uso, que no ha introducido pisones sino un madero corto. Véase erosionada una vivienda construída hace 20 años (Foto 7) con muros de 25cm de "cocó" sin resanar y techo de hormigón armado. El proceso de mantenimiento (Foto 8) acude a un simple mortero de

TEXTURA DEL MAMPUESTO

FUERTE DE LA LOMA EN PUERTO PADRE

arena y cemento que se adhiere sin dificuldad y recupera la forma perdida. Lo mas importante es que en ningún caso existen fallas de orden estructural que puedan provocar derrumbes. Esta es una vivienda atípica, pues ya es práctica generalizada proteger los muros con resanos o emplear una pintura cementosa.

COMPACTACIONES DEFICIENTES

Un Nuevo Enfoque

En los últimos años se ha modoficado el uso de este material que consiste en su combinación con otros, principalmente columnas de 11 X 11cm producidas regionalmente según un catálogo nacional. Estas columinitas están concebidas para un prefabricado ligero donde se combinan con paneles de pequeña dimensión sin refuerzo para estructurar muros, cercas y similares. Ellas son colocadas en la esquinas (Foto 1 y 2) y en otras posiciones estratégicas. Las guarderas se sustentan sobre ellas manteniendo el espesor de 11cm. Una cuidadosa compactación permite inclusive mantenerlo a vista. Una variante de esta solución le añade una pequeña cantidad de cemento (3 a 4%) para aumentar su dureza. Con este nuevo enfoque, si bien se superan sus deficiencias mayores, continúa siendo un procedimiento sumamente agotador para el hombre. Por ejemplo, la compactación con pisones en la parte alta y final del muro después de varias horas de labor produce una gran fatiga física que atenta contra la calidad de la terminación. Aún así, se están construyendo numerosas viviendas en cooperativas y comunidades campesinas.

Otro enfogue muy curioso es la combinación aparentemente arbitraria con muros de ladrillos (Fotos 9 y 10). Siempre se mantienen las columnitas como elemento de transición y refuerzo de las esquinas. En el ejemplo de la biplanta donde emplearon el "cocó" en los bajos y el ladrillo en los altos; a contrapelo de la lógica constructiva, la solución es todavía más insólita. El constructor argumenta con la disponibilidad coyuntural de materiales, ya que tanto el "cocó" como el ladrillo debe trasladarse en camiones al lugar, y el resano final unificará el conjunto.

COMBINACION CON LADRILLO

Continuar Perfeccionando

Recientemente se ha experimentado con la fabricación de bloques compactos de "cocó" con muy satisfactorios resultados. Para su ejecución se emplea un modelo experimental de prensa mecánica de diseño cubano. Esta comprime con doble acción y su cofre es intercambiable lo que facilita ejecutar piezas de formas diferentes tanto compactas como ahuecadas. Se han obtenido resistencias siempre superiores a 30 Kg/cm2 después de las diez semanas. Su mayor ventaja radica en una major garantía de calidad, eliminación de las columnas armadas y la humanización de trabajo a pie de obra. También puede completarse su uso integral, pues la cubierta puede construírse con una bóveda de bloques convenientemente impermeabilizada. La cimentación con ciclópeo de "cocó" (mampuestos) completaría el esquema constructivo que obvia la viga de zapata y reduce el uso del hormigón armado sólo a la viga de cerramento superior.

EROSION EXTERIOR Y REPARACION CON MORTERO

Actualmente se ejecuta una vivienda experimental con este proyecto.

BOVEDA DE BLOQUES

Otros Programas Arquitectónicos

Hasta ahora su uso dominante se reduce a las viviendas económicas y algunos ejemplos de paradas de ómnibus y pequeños locales comerciales. No obstante, por sus indudables ventajas económicas recomendamos extender su empleo a otros programas afines como cabañas turísticas, pequeños moteles, locales, sociales y además en otras construcciones que demanda el agro: pequeños almacenes, cercas, canteros para hidropónicos, naves de cría y otros.

¿Inconvenientes?

El más peligroso inconveniente que debe enfrentar esta técnica es de orden subjetivo: es el prejuicio generalizado que asocia las obras de prestigio y calidad con las técnicas y materiales tradicionales, y considera las construcciones con suelo como precarias y, por tanto, sin prestigio. Razonamiento equivocado, ya que sus posibilidades constructivas permiten diseños de la mejor calidad tan imperecederos y válidos como el logrado con mampuestos en el Fuerte de la Loma. Por suerte en la región, ésta inercia subjetiva esta declinando, pero el "cocó" abunda en muchas otras regiones el país y resulta necesaria una inteligente campaña divulgativa para introducir su uso como una de las tantas soluciones constructivas disponibles.

Valoración Económica

Aventaja a las otras técnicas en uso por la sensible disminución de los costos provocada por los ínfimos consumos energéticos, la mejora del confort témrico de los espacios y la prácticamente inexistente afectación al medio natural. El costo de una vivienda de "cocó" se estima que es un 40% menor que una de columnitas y paneles. Quiere decir que con el presupuesto de tres viviendas se pueden ejecutar cinco de mejor calidad. Pero si la obra se realiza por autoesfuerzo las ventajas son superiores ya que el costo de materiales es reducido y si se emplea la cubierta en bóveda, la cantidad de cemento y acero es mínima.

Conclusiones

Continuar perfeccionando las técnicas en uso, insistiendo principalmente en la fabricación de bloques, las soluciones de cubierta y la disponibilidad de suelos aptos.

Generalizar estas experiencias a otras regiones del país que cuenten con suelos adecuados, estableciendo una inteligente campaña de divulgación.

También puede ser posible que estas técnicas sean del interés de otros países tropicales con los que estamos dispuestos a co-laborar.

UNA TECNICA ADECUADA AL TROPICO Y MUY ECONOMICA

ABSTRACT

1. Objectives:

   a. Collect the knowledge on "Earth Based" construction technology that exist in Antigua Guatemala as part of the culture inherited from generation to generation.

   b. Use this knowledge in current investigations.

   c. Combine and apply the knowledge to the restauration of colonial adobe buildings in Antigua Guatemala.

2. Methodology:

   a. Consult authors of previous "earth" architecture investigations.

   b. Contribute with personal experience from 10 years of field work in the restauration of the cultural heritage of Antigua Guatemala.

   c. Tests and essays on Granulometric Composition and general characteristics of earth materials.

3. Summary:

Adobe used in Antigua Guatemala Granulometric composition, general characteristics of earth material, construction systems, adobe in colonial buildings, deterioration agents.

4. Conclusions:

Intervention, preservation, consolidation, conservation, restauration, maintenance of adobe colonial buildings.

KEYWORDS

Mound of earth, adobe, wattle and daub, rammed earth wall.

RESTAURACION DE ADOBE EN EDIFICIOS COLONIALES DE ANTIGUA GUATEMALA

Mario Ceballos
Maestría en Restauración de Monumentos
Facultad de Arquitectura, Universidad de San Carlos
Ciudad Universitaria, Zona 12. Guatemala City.

1. Introducción

1.1 Justificación

La construcción de tierra sin cocer en Guatemala y en general en América data de épocas muy lejanas, incluso pre-hispánicas, existiendo hasta ahora vestigios arqueológicos muy importantes entre los que cabe señalar particularmente Kaminal Juyú en Guatemala, Chan-Chan, en Trujillo, Perú, Taos y Las Cruces en Nuevo Mexico y otras. Con la conquista del territorio por parte de los españoles, se incorpora a la técnica constructiva del viejo mundo, el uso del adobe y tierra sin cocer en edificios con las características propias de la cultura occidental como los del Manierismo y el Barroco.

Es por ello que consideramos sumamente necesario aportar todo conocimiento adquirido en los cursos de la maestría en Restauración de Monumentos de la Facultad de Arquitectura, de la USAC, a la restauración de un material que había sido utilizado tan eficazmente en Guatemala, y que continúa usandose, y se seguirá usando en el futuro por muchos años, lo cual justifica plenamente todos los esfuerzos de investigación que se hagan para mejorar la tecnología de Restauración de ese material.

1.2 Delimitación del tema

Estudiaremos en lo posible desde los tipos de suelo existente en Guatemala, su naturaleza, su composición granulométrica, así como las pruebas y ensayos para evaluar las características del suelo para hacer adobe o restaurar el ya existente.

También nos proponemos describir los sistemas de construcción de tierra sin cocer que se usan en Guatemala, como lo son el tapial, el adobe, y el bahareque.

Los materiales utilizados para construir con estos tres sistemas así como las causas de deterioro de los mismos. Y como conclusiones nos proponemos indicar cuales deben ser los procedimientos y las técnicas adecuadas para su conservación y los procesos de intervención.

1.3 Objetivos

El objetivo fundamental de esta investigación de construcción y restauración de ADOBE en edificios coloniales de la Antigua Guatemala, es recuperar en lo posible los conocimientos que sobre las tecnologias de tierra existen como acervo cultural de sus pobladores, sumando a ello los conocimientos tecnológicos modernos, para contar con técnicas mejoradas que permitan hacer intervenciones en los Bienes Culturales Inmuebles, sobre todo ante las contínuas acometidas telúricas, tan frecuentes en este país.

1.4 Metodología

La metodología a seguir esta basada en la investigación científica de varios autores, tanto nacionales como extranjeros que han dedicado horas de su vida a la Arquitectura de tierra. También aportamos de la propia experiencia en el campo ya que tenemos 10 años de ser restauradores de bienes culturales en la Antigua Guatemala y en el Interior del País, en donde hemos tomado algunos ejemplos gráficos asi como datos estadísticos.

2. Contenido:

2.1 Los sistemas constructivos de tierra sin cocer más usados en Guatemala y sus usos:

2.1.1 El tapial:

Este sistema consiste en apisonar tierra húmeda dentro de un encofrado de madera deslizante. Fue utilizado por los indígenas antes de la llegada de los españoles quienes ya lo conocían porque era utilizado con frecuencia en su tierra de origen. El tapial fue utilizado por los indígenas principalmente para muros exteriores de separación entre linderos, así como para construir murallas en algunas ciudades importantes, ya que se conocen ejemplos (Iximché, Gumarcah) en donde se alcanzan tres metros o más de altura.

En nuestros días también sigue siendo utilizado el tapial para construir paredes de colindancia. En los alrededores de Antigua Guatemala casí todas las fincas y propiedades principales estuvieron cercadas por muros de tapial que algunas veces tienen 0.80 metros de ancho por 2.00 metros de alto y con una cubierta triangular en la parte superior para protegerse del agua y que se llama "albardón". En algunos lugares de Antigua Guatemala también se conoce la utilización del tapial como relleno constructivo en muros de piedra combinada con ladrillos, donde algunas veces la estructura principal es una arquería y los muros de los rellenos son los tapiales.

2.1.2 El adobe o mampuesto:

Es probable que este sistema sea el más popular en la Antigua Guatemala y sus alrededores y el mas utilizado desde antes de la llegada de los conquistadores españoles hasta nuestros días. Consiste en la fabricación de mampuestos de tierra cruda. El nombre más popular es el de "adobe" en toda latinoamérica, aunque es de origen árabe. En el altiplano guatemalteco también se le conoció con el nombre de "chan".

La fabricación mas conocida de estos ladrillos de tierra cruda consiste en rellenar un molde de madera con barro, luego se desmolda y se deja secar durante cierto tiempo que varía de cuatro semanas a dos meses, según las condiciones atmosféricas.

En cuanto a las dimensiones más utilizadas, se han encontrado en Antigua piezas de 0.10 x 0.30 x 0.60 metros y de 0.10 x 0.20 x 0.40 metros. Su uso más frecuente es el de levantado de paredes de 2.50 a 3.00 metros de altura y se han dado casos de construcción de dos niveles.

Es de hacer notar que hasta hace algunos 10 años, el 75% de las viviendas en Antigua Guatemala y sus alrededores estaban construidas con mampostería de adobe (10).

2.1.3 El bahareque:

Casa construida con el sistema de BAHAREQUE, Chiquimula de la Sierra, Guatemala.

Casa de BAHAREQUE, Chiquimula de la Sierra, Guatemala.

El nombre de este sistema, muy conocido en Guatemala, también es de origen árabe y se popularizó mucho en la vivienda popular en las zonas de clima cálido debido a su fragilidad, ya que el techo permanece soportado por otra estructura.

En el área de Antigua Guatemala este sistema es utilizado con frecuencia para tabiques interiores de una construcción, ya que la estructura principal es por lo general un marco de madera o de caña. Existen dos variantes muy conocidas del bahareque:

1. El sistema de relleno de una estructura independiente de madera reforzada con alambres o cinchos de cuero, a la que solo se agrega el barro para formar el paramento; y

2. El sistema de una estructura de madera (piezas de 2" x 3") dentro de la cual se levanta con adobes puestos de canto (11).

2.2 Usos del adobe en edificios coloniales de Antigua Guatemala:

2.2.1 El tapial fue muy usado en los edificios coloniales en dos formas:

A. En muros de colindancia para separar propiedades en "muros de colindancia", "linderos" o "paredes medianeras" como se les conoce popularmente.

El sistema constructivo es el de apoyarlos en un cimiento de piedra, o un sobrecimiento y luego empleando moldes o formaletas rellenándolas con tierra apisonada hasta una altura aproximada de 3 varas castellanas (0.84) equivalente a unos 2.50 mts..

Actualmente se pueden ver todavía por toda la ciudad de Antigua Guatemala no solo en propiedades privadas, sino en los conventos y monasterios como por ejemplo en la Recolección.

B. Fue utilizada también como elemento de relleno en las grandes estructuras de paredes, o entre los marcos estructurales, formando un esqueleto de mampostería y rellenando con tierra apisonada, tal es el caso de la mayor parte de los edificios religiosos de la Antigua Guatemala. Contándose entre ellos la Recolección que tiene muros de 17 varas castellanas de altura (±15 mts.). Otro ejemplo muy a la vista es el de el convento del siglo XVI de San Francisco El Grande. Por abandono y falta de mantenimiento quedan al desnudo dichos tapiales.

2.3.2 Los mampuestos o adobes como se les conoce en Guatemala fueron utilizados más que todo en la construcción de muros de colindancia y en muros de carga pero en viviendas de tipo popular y también en la arquitectura vernácula.

En muchas ocasiones también se utilizó en la construcción de algunos edificios religiosos o en casas de 2 niveles pero se popularizó mucho este sistema sobre todo en el altiplano; como un ejemplo podemos citar la iglesia del cementerio de Chichicastenango dedicada al padre ROSSBACH.

2.2.3 El bahareque, más que todo fue utilizado en la arquitectura popular y vernácula para construir muros divisorios entre ambientes o bien en segundos niveles para "aligerar" la carga en el entrepiso.- También podemos decir que se extendió su uso en el altiplano aunque en el oriente y en el norte (Depto. de Chiquimula o el Petén) se utilizó como muros de exteriores de las viviendas a igual manera que los muros divisorios o de tabicación (ver fotos).

2.2.4 La Recolección de Antigua Guatemala:

Se utilizó como relleno en los esqueletos estructurales, aunque por el buen estado de conservación de los repellos es dificil distinguirlo, en los muros del convento o de la iglesia, pero su uso mas extendido fue en los muros perimetrales de la propiedad recoleta, ya que por azolvamientos continuos del río Magdales, el terreno se le ha visto constantemente inundado y los muros han sufrido muchas alteraciones causadas por las humedades y cuyo efecto ha sido la caída de los repellos afectándole directamente a los tapiales que se han visto afectados por todo tipo de agentes de deterioro.


La utilización de tapiales en la construcción colonial, Convento Franciscano del Siglo XvI, Antigua, Guatemala.

2.3.5 Agentes de deterioro:

- HUMEDAD O AGUA - POLVERULENCIAS - ESFOLIACIONES - INSECTOS - MICROORGANISMOS
- MACROFLORA - HUMANOS

3. Conclusiones:

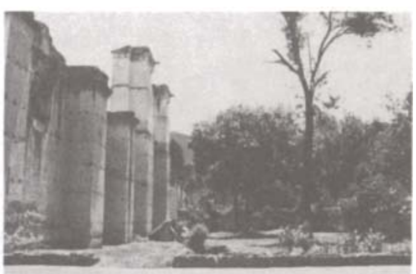
3.1 Procesos de intervención:

De acuerdo a las normas internacionales vigentes subdiviremos las intervenciones en tres grupos principales:
* PRESERVACION
* CONSOLIDACION
* CONSERVACION
* MANTENIMIENTO

La primera conclusión es detectar los deterioros, estudiando sus causas y dando un diagnóstico de que está sucediendo con el muro y por último dar su dictámen de como intervenirlo, de donde tenemos:

3.1.1 Preservación:

Es de suma importancia las labores de preservación de un edificio detectando inmediatamente cualquier alteración o deterioro y encargar al técnico adecuado o especializado para iniciar una intervención.


También en la Construcción de la Recolección, así como en muchas otras, muros de mas de 17 vrs. de alto, con Tapial.

La segunda conclusión es que una vez detectada y cortada la causa de deterioro, deberá hacerse la intervención adecuada para cada caso, mencionamos los más comunes:

a.- Repellos b.- Muros sin albardón

a) Repellos:

1. Lo primero es establecer la proporción del repello original, es decir con que proporciones fue fabricado.

2. Se retira todo el material (repello) en mal estado o desprendido.

3. Se limpian con brocha o cepillo de fibra natural las superficies expuestas y toda la zona que va a entrar en contacto con el nuevo repello.

4. Se inicia la colocación del nuevo repello colocando una capa muy líquida que puede aplicarse con brocha como si se tratara de pintura, (se recomienda hacer esto principalmente en tapiales).

5. Se van agregando con cuchara las subsiguientes capas guardando similitud con el grosor del repello existente.

6. Se recomienda dejar alguna diferencia de textura entro lo nuevo y lo antiguo.

b) Muros sin albardón:

1. Establecer en que condiciones se encuentran las últimas hiladas de adobe, (si es tapial y existe alguna grieta, ver consolidación).

2. Si las hiladas se encuentran en mal estado, reintegrar con material fabricado en condiciones similares al existente y construirle cubierta que puede ser:
   - ALBARDON
   - DE TEJA
   - DE BALDOSA O LADRILLO

3.1.2 Consolidación:

Cuando un muro no presenta deterioros importantes o al contrario, que la ruina sea irreversible, estamos ante casos en que la tarea a realizar es una consolidación, esto quiere decir que dejaremos las casas "como están" no innovar, no arreglar, pero tampoco permitir destrucciones, es muy común usar estas técnicas en edificios que están restaurando.

La tercera conclusión es que la consolidación es posible efectuarla por medio de sistemas mecánicos y químicos; los sistemas mecánicos serán todo el aparato mecánico necesario para tener al alcance el objeto a restaurar, por ejemplo andamios, entramados, puntales, etc.

Los sistemas químicos pueden ser:

a. Productos industrializados
b. Sintéticos
c. de Laboratorio
d. Caseros (substancias naturales como: vegetales y animales)

a. Los productos industrializados:

1. Las resinas polivinílicas utilizadas desde hace ya más de 20 años en la consolidación de los pueblos indios del sur de E.E.U.U. pero que no dió muy buenos resultados.

2. Consolidantes Poliuretánicos, solubles en petroleo se han utilizado en Europa y Asia Menor, pero aún no se ha tenido un resultado 100% eficiente (12).

b. Los productos sintéticos:

1. En Mesopotamia se ha utilizado mucho en la decada de los 80 el Silicato de etilo, que penetra por capas sucesivas y va polimerizando. Es sumamente caro y se aplica en forma de fumigaciones, con bomba, (lo producen las firmas UNION CARBIDE y MONSANTO). Se recomienda tener cuidado con su uso porque altera el color de la pintura, y hay que tener mucho cuidado en presencia de pintura mural (12).


Construcción de dos niveles en el sistema de Bahareque, Santo Tomás Chichicastenango.

c. De laboratorio:

1. El profesor Giacomo Chiari del ICCROM (13) en investigaciones realizadas en el Perú llegó a la conclusión de que los adobes fabricados con caldos en vez de agua dieron como resultado piezas resistentes al agua.

d. Caseros

Es muy importante volver la vista atrás y recapacitar sobre el uso que daban en la colonia a ciertos elementos naturales que contienen substancias ligantes debido al contenido de savias y almidones, por ejemplo:

BANANA, COCO, BABA DE NOPAL O CACTUS, MAGUEY, LINO, PAPA, MIEL, LECHE Y ARROZ.

En muchos casos algunas de estas substancias producen por cementación procesos químicos ligantes, impermeabilizantes, repelentes de insectos, etc. (14).

Recomendación: Dependiendo del estudio de cada caso en especial y del material que se trate, así como del aspecto económico, se debe elegir el producto adecuado para cada intervención, dado a que en la restauración no se pueden dar recetas de cocina.

3.1.3 Restauración: Cuando haya que reponer partes caídas (Anastilosis) o deterioradas, o de integrar nuevos elementos, estamos ante una restauración de donde debemos de respetar los principios de homogeneidad y continuidad (15).

3.1.3.1 Humedades en partes bajas: Particularmente las arquitecturas de tierra son atacadas por el agua y las humedades por lo que tendremos problemas como los siguientes:


Construcción de adobe, como arquitectura vernácula en una población del Altiplano, San Andrés Xecúl, Totonicapán.

- Malas condiciones Hidrófugas: Puede ser que no exista ninguna capa aisladora o solera de humedad por lo que pueden hacerse cortes horizontales por segmentos a manera de integrar una nueva solera hidrófuga, que puede estar echa a base de materiales eficaces para el aislamiento del agua, (por ejemplo adobes impermeabilizados). En tapiales tener el cuidado de hacer el corte coincidiendo con las capas de fabricación. También pueden usarse algunas técnicas como las mencionadas en el inciso anterior (substancias químicas y sintéticas) pero tener mucho cuidado porque como ya se dijo estan en fase experimental y son demasiado onerosos.

- Humedades Interiores: Por la cubierta; cuando son provocadas por filtraciones en la cubierta, lo primero es detener esta causa reparando el techo y luego intervenir el muro haciendo las actividades que sean necesarias dependiendo del criterio del arquitecto restaurador.

- Fisuras y Grietas: a) Si es una fisura probablemente desaparecerá al detectar la causa, pero muchas de ellas siempre subsisten aunque pueden ser rellenadas con un mortero de arcilla similar al utilizado originalmente. b) Si es una grieta más profunda y atraviesa de lado a lado la pared se recomienda quitar los mampuestos que sean necesarios y reintegrarlos nuevamente pero colocándolos en la posición de punta y soga si fuera posible. c) Si es un tapial, puede remendarse con mampuestos de adobe si las dimensiones lo permiten y si no, cortar lo necesario y reintegrar con material similar en proporciones al material original.

d) Perforaciones de insectos y erosiones:

* Si es en mampostería o aparejos, retirar piezas destruidas y reintegrar nue-

vas manufacturadas en condiciones similares a originales.
* Si es en tapial cortar el espesor que sea necesario empezando de abajo hacia arriba y reintegrar con mampuestos de adobe o bien, si es posible, colar y apisonar nuevamente con material similar al original.

3.1.4 Mantenimiento: El mantenimiento es necesario para evitar que el edificio se deteriore por lo que se recomienda mantener atención entre otros a:

a) Encalar periodicamente los muros.

b) Hacer drenas en los muros cuando se notan humedades.

c) Cuidar los albardones de los muros para evitar entrada de humedades.

d) Revisar los techos sobre todo antes de cada invierno para ver si no hay tejas rotas en los tejados.

e) Fumigar contra insectos y plagas.

Notas de referencia:

1. Alejandro Alva Balderrama; Universidad Católica del Perú, Simposio Internacional y curso taller sobre conservación del Adobe, Lima 1983.

2. ASTM, 1979 Annual Book of ASTM Standars, part 19 SOIL, pp. 187.

3. CLIFTON, JAMES R: Preservation of Historic Structures, NBS Technical Note 934, Washington D.C. National Bureau Standards 1977, pp. 4.

4. ID. Ibid pp. 4.

5. Ceballos Mario, Construcción de Tierra en Antigua, Suplemento CARTA INFORMATIVA, Consejo Nacional para la Protección de La Antigua Guatemala, enero/febrero 1985, pp. 5.

6. Id. Ibid. pp. 5.

7. Laboratorio de materiales Fac. de Ingenieria, USAC, 1984.

8. Alejandro Alva Balderrama: Notas para la manufactura del bloque de adobe para la restauración de arquitectura de tierra, Lima, 1983.

9. Ceballos Mario: Earth based construction in Antigua Guatemala, CIB/86 Shelter for the homeless in Developing Countries, Vol 4, Washington D.C. Sept 1986, pp. 1221-1228.

10. ID. Ibid. pp. 1223.

11. ID. Ibid. pp. 1224.

12. Torraca, Giorgio y otros: Report and Mubrick preservation in Mesopotamia No. VII, Universitá di To rino Giappachelli, edit Totino 1972.

13. Chiari, Giacomo: Caracterization of adobe as building material, preservation techniques, ICCROM, Lima, Peru 1983.

14. Viñuales, Graciela María: Restauración de Arquitectura de Tierra, Instituto Argentino de Investigaciones de Historia de la Arquitectura del Urbanismo. Universidad de Tucumán, Argentina 1984.

15. Carta de Venecia, 1964.

EARTH USED FOR BUILDING IN THE HIMALAYAS, THE KARAKORAM, AND CENTRAL ASIA - RECENT RESEARCH AND FUTURE TRENDS

Anne Chayet, Corneille Jest* and John Sanday
23 Quai le Gallo
Boulogne 82100
FRANCE

ABSTRACT

The use of earth, as either rammed earth (pisé de terre) or sun-baked bricks (adobe), is characteristic of the Himalaya/Karakoram range and central Asia. Earth is combined with timber and stone as the major construction material used in this area. Examples from archaeological excavations dating from 7000 B.C. demonstrate the importance of this construction technology. Methods of adobe and pisé construction are described and comments made on the variations in application of techniques and their geographical distribution.

A multi-disciplinary approach involving archaeologists, historians, architects and craftsmen will help identify conservation methods for earthen structures and enable the decision makers to incorporate these methods and appropriate technical information into new construction as well as the preservation of historic monuments and sites.

KEYWORDS

Adobe; Archaeology; Central Asia; Himalaya; Karakorum; Pisé de Terre; Tibet.

Fig. 1. Map showing the region of Tibetan civilization

Introduction

The use of earth for construction either in pisé de terre (rammed earth) or adobe (sun-baked) bricks is common throughout Central Asia, especially in the provinces of West China, Xinjiang, Quinghai, Gansu, Sichuan, Xizang (the autonomous region of Tibet) and in the highest regions of the Himalaya Karakoram range, located 70 to 110 degrees east longitude and 25 to 45 degrees north latitude (1) (see fig. 1).

The absence of other suitable building materials has caused man to use earth as a means for construction over a period of many centuries. Archaeological excavations have shown structures in rammed earth dating from as early as 7000 BC (2).

The latest information concerning adobe technology can best be demonstrated by using the method of house construction in Tibet as an example. Different examples will show the diversity of technology to be found in these regions.

The principles of construction, as well as the type of material used, provide a link for the architecture of this region to that of the ancient middle eastern civilizations of the 6th century BC in the Achemenide Period around Persia, which in turn has influenced India on one side and Central Asia on the other.

Techniques of Construction for a Tibetan House.

The structural module of a Tibetan house is established by four load bearing walls, positioned at right angles to one another, which support a flat roof of rammed earth, laid over unhewn timbers. This module can be expanded both horizontally and vertically as necessary. Generally, the houses have two floors and a terraced roof (3).

Religious rituals precede all construction. Using astrological forecasts as a guide, a site is checked to see that it is not contaminated with evil spirits and is not inhabited by earth deities (4).

1. Foundations and walls

The foundation trench is excavated according to the existing conditions of the terrain and the intended height of the building. There is never a basement and the foundations are constructed of rubble stone when it is available.

As opposed to the methods of construction generally used in China where a timber structural frame is employed (5), the adobe brick walls in this example are load bearing. The wall thickness is dependent on the type of load transferred from above. As rammed earth and adobe have a tendency to compact under heavy loads, the wall bases are thicker and, wherever possible, earth

Anne Chayet
Charge de Récherche
Center National Récherche Scientifique (CNRS)
CNRS/URA 1229 "Langues et cultures de l'aire Tibetaine"

Corneille Jest*
Directeur de Récherche, CNRS
GRECO Himalaya Karakoram

John Sanday
Conservation Architect
Getty Grant Program
Architectural Conservation Grants

*Author to whom correspondence should be addressed.

construction is replaced with stone. In addition, because of the mud mortar's lack of cohesion and the fragility of the adobe brick structure, vertical loads cause the structure to buckle at its base and for this reason, the lower part of Tibetan buildings are heavily buttressed. Alternatively, the walls may be battered approximately 3 to 6 degrees on the outside, thereby providing more resistance to earthquakes and producing a silhouette characteristic to all Tibetan buildings.

Fig. 2. Bhutan, process of constructing "pisé de terre".

2. Rammed Earth

Tibetans consider this form of construction as the oldest, simplest and cheapest of building techniques. It is widely used throughout Tibet as well as in some regions on the southern slopes of the Himalaya such as in Bhutan where conditions are slightly more humid. The method of construction is similar to that used in Western Europe.

A clay-based soil is wetted and worked by foot. Aggregate is often added to the mix. Two planks are set on edge on top of the foundation and held in place by wooden poles driven into the ground. Wooden cross bars set between the planks establish the width of the wall which is usually between 60 and 90 centimeters.

Teams of women place the prepared clay between the planks and ram it with wooden rams, beating in time to the rhythm of traditional songs (see fig. 2). After two or three hours the planks are struck and reset at a higher level and the process is repeated (see fig. 3). The junction between these lifts or layers, as well as the holes created by the cross bars, becomes a decorative feature on the building.

In the meantime, carpenters prepare the timbers for the doors, windows, and floors (see fig. 4). Doors and windows are prefabricated on site, erected in position as the construction progresses and are built in place. In some regions it is customary to place one long timber lintel at the correct level in the wall and to cut the necessary doors and windows out of the walls below the lintels.

Fig. 3. Setting the planks.

3. Adobe or Sun-Baked Bricks

Adobe bricks are always made close to the building site and the matrix is prepared by trampling the mud under foot. Gravel, grass, or straw can be added to the matrix. The mold is a wooden frame that is 35 x 18 x 16 centimeters with extended sides, one of which is removable to enable the brick itself to be freed. After placement the bricks are removed from the mould and three days later placed on edge to help with the drying process. Placing the bricks on edge minimizes the bricks' exposure to the sun, slows down the drying process, and therefore prevents cracking (6). The first layer of bricks are placed as "headers" and the mortar joints between the bricks are the thickness of a finger. The next course or layer of bricks are placed as "stretchers" forming an alternating header stretcher bond often referred to as the English Bond. Thicker walls are based on two rows of headers to create double the width. When walls of a lesser thickness are prepared, adobe bricks are laid on edge in parallel similar to boards and the matrix is placed in between. This method of construction, however, is not as strong because the matrix is not compacted and it lacks the cohesion found in a properly bonded adobe brick wall.

Fig. 4. Placing the windows.

4. Floors and roofing

The ground floors of houses are usually set on virgin ground that has been levelled if required. Sometimes, a layer of rammed earth is used to provide the necessary finish.

The flat roof or terrace is constructed in the following manner. Unhewn beams are set close together and a layer of twigs from the "Caragana" shrub placed above the beams to prevent the moist earth from rotting them. A layer of rammed earth is placed over the twigs and covered with a final layer of waterproofing clay to prevent water penetration.

Fig. 5. Bhutan, Valley of Paro: Construction of a farm house using "pisé de terre" with a light timber framing for the upper floor.

5. Plastering

Occasionally, when an appropriate material with a high content of clay is available, the rammed earth or adobe walls are plastered externally. Otherwise the walls are left plain. An application of wet clay of porridge-like consistency is prepared and applied by hand. This allows for some form of decoration to be added to the exterior of the building.

Some examples earthen construction in the region

1. The Himalaya

In Dolpo, a Tibetan valley located in northwest Nepal at an altitude of 4000 meters, the different types of material described above are also in common use. The foundation as well as the back and side walls are in rubble stone and the facade is in adobe (7).

In Bhutan, located in the eastern Himalaya, where the population is of Tibetan origin, the houses follow the same model as those in the Tibetan cultural area. In addition, above the flat roof, the Bhutanese extend a light timber pitched roof structure which generously overhangs the external walls. The foundations are made of large stones and the walls are of rammed earth. The Bhutanese house is an impressive architectural achievement combining utility and technical skill with a great aesthetic sensibility (8) (see fig. 5).

In Ladakh, in the western Himalaya, the oldest constructions are always of rammed earth. Today, pisé de terre has been replaced by the adobe brick. The Palace of Leh presents an interesting example of the use of sun-baked bricks (see fig. 6). The palace was built in the early 1600's as a royal residence and is a building of great dimensions. The palace is the largest of a group of buildings crowning a seven kilometer ridge overlooking the city of Leh.

The fortress of Namgyal peak located high above the palace of Leh, was built in the 16th century out of rammed earth and adobe brick (see fig. 7).

Fig. 7. The Fortress of Namgyal.

Fig. 6. Ladakh, 17th century palace of Leh overlooking the city.

Fig. 8. Central Tibet, a fort in "pisé de terre" surviving from the 18th century

The palace is built into the rocky outcrop with the main facade measuring about 60 meters in length and 58 meters in height overlooking the city. The foundations, which are of granite, grow out of the bed rock itself and the lower part of the battered walls is formed in cut and dressed granite. As the walls rise, the structure becomes lighter and the windows in turn become wider. The upper third of the building is constructed of mud bricks with the roof terraces formed of earth and clay. The method of construction for the adobe structure is almost exactly the same as for a traditional dwelling.

The palace was abandoned and, because of the total lack of maintenance, snow and water have infiltrated the adobe walls causing damage and collapse to much of the upper structure (9).

2. Karakoram

An interesting example of reinforced adobe structure can be found in buildings such as the 15th century Baltit and Altit Forts in the region of Hunza, in northern Pakistan. Here, the use of a timber cribbage at the corners of the tower with an infill of adobe brick creates a flexible structure capable of withstanding the seismic activity which is prevalent in this region.

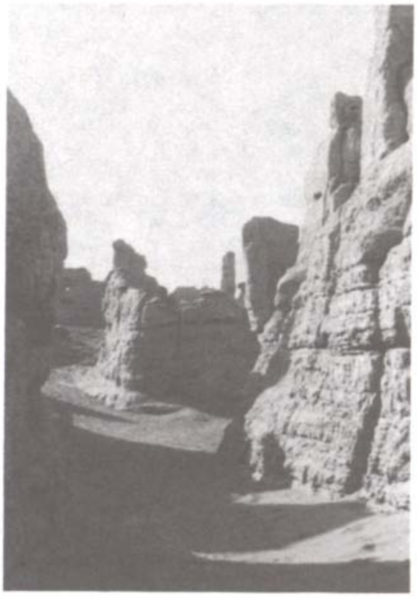


Fig. 9. Turfan, Citadel of Jiaohe, part of the main thoroughfare.

3. Central and Western Tibet

The oldest monuments to be found in Tibet are the Royal Tombs located in central Tibet, the most well known being the Tsetang (Pyong Rgyas), which are tumuli of rammed earth interlayered with slate and timber planks dating from 650-815 AD (10).

More recently, the fortifications have been built in adobe and rammed earth. For example, in Lha-artse, located in central Tibet, defense towers still remain in a state of decay and neglect. These structures therefore show the lower levels in rammed earth and the superstructure in adobe. From time to time during previous restoration efforts random stonework has been used instead of earth (see fig. 8).

In eastern Tibet, the village of Tsaparang is another particularly interesting example of the use of earth in construction. It is here that certain unusual technical details, such as the use of pebbles as a capping for the walls and the presence of forms of arches that have not been found elsewhere, can be seen. Within the cliff dwellings above Tsaparang some unique structures using adobe walls have been studied (11).

Fig. 10. Turfan, City of Gaochang, central part of a stupa.

4. Xinjiang

The architecture of the oases around Xinjiang are entirely of adobe. In Turfan, the cities founded during the Han Period (206 BC to 220 AD) demonstrate the diverse uses of earth. For example, Jiaohe was built on a limestone spur and Gaochang was built on a flat plain, both of which were undoubtedly abandoned in the Ming Period. In Jiaohe, the main thoroughfare of the town has buildings constructed of rammed earth at ground level, with large adobe blocks at mid-level and smaller adobe bricks at the upper level (see fig. 9). The monuments, including the enclosure walls, temples, and stupas in these two towns, are of sizeable dimensions (see fig. 10). Interesting architectural features such as the arch and the tiered vault can be seen in Turfan where they have been used to support several floors. Erosion, especially wind attrition, has caused major damage which is only apparent when comparing early photographs taken by such well-known explorers as Le Coq and Stein at the beginning of this century.

In the graveyard of Astana there are examples of rammed earth tumuli covering funeral chambers which have been decorated with murals. A series of monasteries carved out of cliffs, such as those at Bezeklik, were enclosed with adobe structures as the external facades. These structures have remained unchanged to this day.

The large mosque of Turfan built in the 17th century was restored in 1980. The structure is capped with a series of domes and the method of decoration for the minaret has been used as a model throughout Central Asia and Iran (13) (see figs. 11, 12).

Fig. 11. Turfan: General view of the Friday Mosque.

Fig. 12. Turfan: Detail of the minaret of the Friday Mosque.

5. Qinghai

Circa 2000 - 500 BC, earth has also been used in the areas between Tibet proper and Central Asia. Three sites from the Nuomhong Period have been discovered in the Tsaidam Region. These correspond to a nomadic civilization largely independent of the bronze period of the Qinghai-Gansu. Remnants of architecture consisting of foundations of houses, walls, and ditches using adobe and rammed earth have been found on a site which may have been a resting place for these nomads (14).

Conclusions

The above examples drawn from Central Asia and Tibet demonstrate the unique qualities of earth when used as a building material. The technology used in earth construction advances the following observations:

The house is often regarded by architects and planners as a geometric element that needs to be "rationalized" to suit the assembly of structures, voids, and spaces. In practicing architectural conservation, however, it is necessary to discover through analysis how building design has been adapted to suit specific conditions and climates. Central Asia provides an excellent example of this principle.

Today, due to the fashions fostered by the pressures of development, it is unlikely that new buildings in these regions will be permitted to evolve from traditional technology. Therefore, in order to retain these traditional structures, restorers and "conservationists" need to not only find ways of preserving traditional technology, but also convince potential clients that the traditional structure will provide suitable, if not preferable, living conditions. For obvious reasons, one cannot expect new hospitals to be built in adobe, but perhaps some of the less sophisticated structures may employ this technique in recognition of this longstanding tradition.

As many archaeological sites along the Silk Road in such places as Turfan and Khocho have been exploited, and where many of the sites are still being "mined" by farmers as a source of fertilizer for their fields, it is hoped that the Adobe 90 Conference will promote an active interest in the technology of adobe. This kind of information will help local decision makers responsible for the conservation of historical sites to protect their cultural heritage and prevent the exploitation of these ruins.

Finally, it is essential to sensitize the conservationists in this region to help them avoid the indiscriminate use of "modern" materials, such as cement, and to teach them simple but appropriate conservation techniques as well as some specific ways to preserve this unique but fragile building tradition.

NOTES

1. S. Hummel, "Tibetische Architektur," Bulletin der Schweizerschen Gellschaft für Anthrologie und Ethnologie 40, (1963-1964): 62-95.

J. Qimin, L. Jan, S. Haillang, Earth-sheltered Architecture in China (Peking: 1985) in Chinese and English.

2. G. Quinron, "L'Architecture Néolithique de Mehrgarh," Les Cités Oubliées de l'Indus-Archéologie du Pakistan (Paris: 1989): 47-51 (Exhibition Catalogue)

J.F. Jarrige, "Chronology of the Earlier Periods of the Greater Indus as seen from Mehrgarh, Pakistan," in South Asian Archaeology, ed. B. Allchin (Cambridge: C.U.P., 1989), 21-28.

3. Demeure des Hommes, Sanctuaires des Dieux, Sources, Développement et Rayonnement de l'Architecture Tibetaine, ed. G. Beguin, P. Mortari (Paris: 1987) (Exhibition Catalogue)

Series of chapters by F. Meyer et C. Jest on Tibetan Architecture.

L. Gyatsho, Gateway to the Temple, (Kathmandu: Ratna Pustak Bhandar 1979).

L'Homme et la Maison en Himalaya, ed. L. Barré, C. Jest, G. Toffin (Paris: CNRS, 1981).

4. C. Jest, Monuments of Northern Nepal (Paris: UNESCO, 1981): 25-28.

5. L. Dunzhen, La Maison Chinoise (Paris: Berger Levrault, 1980).

6. In Tibetan Architecture baked bricks are not used, except in a few religious buildings in Central Tibet influenced by China (esp. the monastery of Kumbum)

7. C. Jest, Dolpo, Communautés de Langue Tibetaine du Nepal (Paris: CNRS, 1975): 74-81.

8. P. Denwood, "Bhutan and its Architecture," Objets et Mondes, XVI, 4, (1974): 337-346.

C. Jest, J.A. Stein, "Dynamics of development and tradition: the architecture of Ladakh and Bhutan," in Himalaya Ecologie et Ethnologie, ed. C. Jest (Paris: CNRS 1977): 343-350.

A.D. Ranade, "Bhutanese Architecture," Journal of the Indian Institute of Architecture 38, 4, (1972): 14-19.

9. A.H. Francke, Antiquities of Indian Tibet (New Delhi: 1914-1926).

C. Jest, J. Sanday, "The Palace of Leh in Ladakh, an Example of Himalayan Architecture in Need of Conservation," Monumentum 25, 3 (1982): 179-193.

R. Khosla, Buddhist Monasteries in the Western Himalaya (Kathmandu: Ratna Pustak Bhandar, 1979).

10. S. Wangdui, Qiongjie xian wenwu shi (In Tibetan: Bsod-nams dbang-'dus, Cultural remains in the district of Chongye) (Lhasa: Xisang zizhiqu wenwu guanli puchadui, 1986)

11. J. Aschoff, Tsaparang Konigstadt im Westtibet (Echin V.M.: Verlag, 1989).

Kwang Chen Yian, et al l'Architecture des Ruines du Royaume de Guge (Peking: 1988) (in Chinese)

12. Liu Dunzhen et al. Zhongguo gudai jianshu shi (Ancient Architecture of China) (Peking: 1980)

M. Maillard, Grottes et Monuments d'Asie Centrale (Paris: Maisonneuve, 1983).

13. G.A. Pougatchenkova, Chefs d'Ouvres d'Architecture de l'Asie Centrale XIV-XV Siécle (Paris: UNESCO, 1981) (see for comparison).

14. Wenwu no. 6 (1960): 37-40

Kaogu Xuebao n. I, (1963): 17-44.

Xu Xinguo, "Qinghai sheng wenwu kaogu gongzuo sanshi nian," in Wenwu kaogu gonzuo sanshi nian 1949-1979 (Thirty years of archaeological findings in the province of Qinhai) (Peking: 1979): 160-167.

EARTHEN WALLS FROM FRANCE AND ENGLAND FOR NORTH AMERICAN FARMERS, 1806-1870

Jeffrey W. Cody
Department of City & Regional Planning
Cornell University
Ithaca, NY 14853-6701

ABSTRACT

This paper discusses the transfer of earthen wall building technology from France and England to North America during the nineteenth century, connections which have remained obscure for many reasons. Emphasis is here placed on the rationales and variations of earthen walling methods from France, where, in the context of the French Revolution, pisé (rammed earth) was heralded as a technique for the "common man," to England and America, where the virtues of using earth for rural structures were subsequently extolled. In discussing major personalities, publications, and trends, the paper argues that earthen wall construction was more widespread than has sometimes been assumed. It demonstrates that not all American "adobe" buildings are in the Southwest and that they were stylistically and technologically versatile. Protective measures taken by their builders are likewise explained. A proper historical and technological context is thus provided for understanding the significance of earthen wall structures in areas not normally associated with their existence.

KEYWORDS

PISÉ
RAMMED EARTH
UNBURNT BRICKS
TAPIA
EASTERN UNITED STATES
NINETEENTH CENTURY

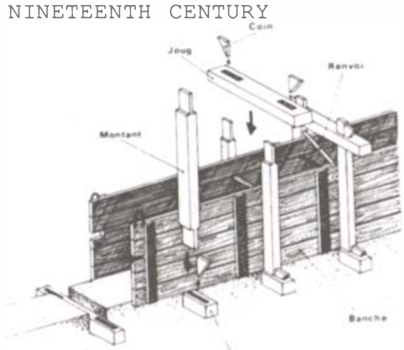


Fig. 1. Schematic assembly of a mould used in Auvergne, Source: P. Doat, et al., Construire en Terre, 16.

Introduction

In American architectural traditions the logic and viability of building with earth has been documented only superficially, hence the astonishment of most who learn of the use of rammed earth or "unburnt" bricks east of the Mississippi River as early as 1806. Although one does not normally associate New Jersey with adobe, it was in this state that some of the earliest East Coast experiments with earthen wall technology were conducted.[1] To understand how and why this occurred, it is necessary to cross the Atlantic Ocean.

Pisé, or rammed earth walls in western Europe, were erected most often on a masonry foundation. The walls were formed by pounding a mixture of sand, silt, and clay into a case, or shutter, which was characterized by moveable frames of wood held parallel by a set of supports. This set often consisted of lower and upper horizontal struts, vertical support posts, countershafts, and wedges (see Fig. 1). European traditions of ramming earth into solid walls or of drying soil mixtures in the sun to yield a suitable building material have been traced to the Phoenicians, the Romans and the cultures that came under their influence.[2] By the eighteenth century, certain regions, at least partially because of their favorable geologic conditions, were better known than others for their success in utilizing time-worn building traditions related to earthen walls. One of the most famous was the French Lyonnais, where the rich, sedimentary deposits along the Rhone River provided a useful variety of clays and sands for builders to mix into economical and fireproof building materials.[3] This paper will concentrate on this circuitous documentary link between south central France and the eastern United States, establishing that firm rationales, building methodologies and European precedents existed as American farmers in the nineteenth century began considering whether to adopt, adapt or reject these precedents under new conditions. Between 1806 and 1870 they tried all three alternatives, finally rejecting earthen walls in favor of wood or brick.

The pisé, or rammed earth, connection from Lyon to New Jersey can first be traced by examining the key publications that emerged in late-eighteenth-century France to encourage more scientific analyses and practical applications of rammed earth structures. The most important of these analyses was by François Cointeraux in 1790, but other pisé propagandists helped set the stage for him. For example, Georges-Claude Goiffon's "L'Art du Maçon Piseur" (1772) was an obscure, unsuccessful treatise written by a nonpracticing academician for practicing masons (see Fig. 2), but it represented the emergence of a rational understanding of pisé technology, briefly reflected in 1777 by Diderot in his Supplément, and more substantially nine years later by François Boulard in Abbé Rozier's popular Cours Complet d'Agriculture.[4] Boulard first focused on the coagulating qualities of soil appropriate for ramming ("strong earth," a humid mixture of clay and sand with no roots or gravel). He then emphasized construction procedure, paying particular attention to the problem of how to merge two perpendicular wall segments, and he suggested a rough-cast plastering as an exterior finish (see Fig. 3).

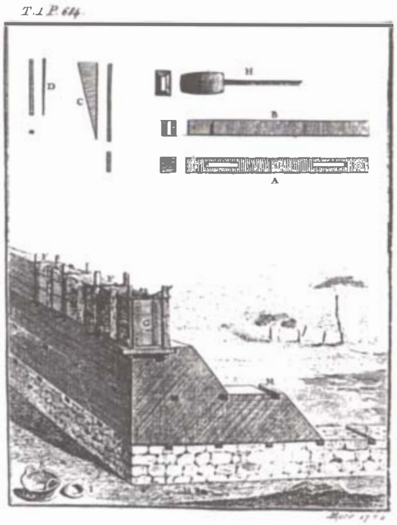


Fig. 2. Goiffon's depiction of pise construction, 1772.

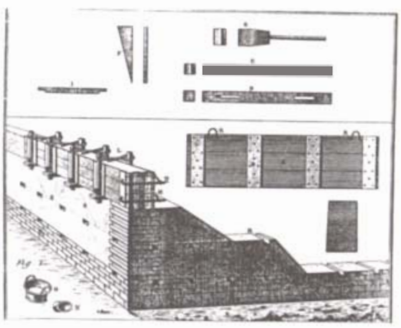


Fig. 3. Boulard's depiction of pise construction, 1786.

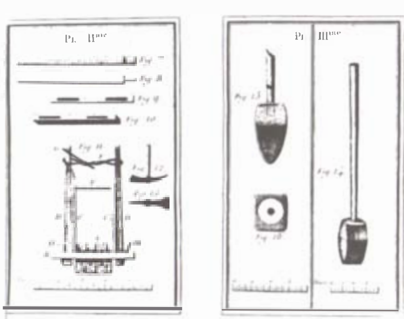


Fig. 4. Plates II and III Cointeraux's First Cahier

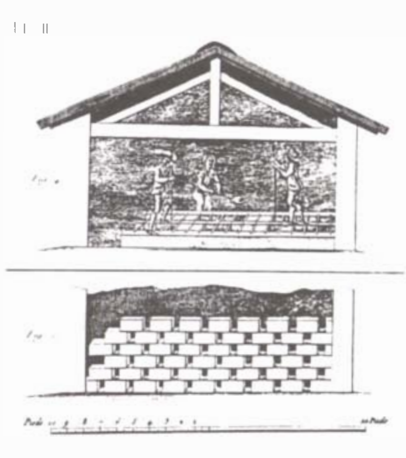


Fig. 5. Plate II from Cointeraux's Fourth Cahier

Boulard's description, although empirical, lacked zeal. Such could not be said of Francois Cointeraux, an avid Lyon builder and agriculturist, who in the 1780s began experimenting in northern France with the rammed earth technology he had learned in the south. Aided in 1788 by royal officials of the newly formed Société Royale d'Agriculture, Cointeraux moved to Paris the following year, when he inaugurated a "school for rural architecture" in order to promote the use of pisé as an economical method of erecting farm structures and as a way of building "incombustible" structures for French cities. Cointeraux, whose motto was "Theory is beautiful, but practice surpasses it," sought to make a "patriotic contribution" in the spirit of the Revolution.

Pisé became his passion. "My desire is to advance only that which is practical," he wrote. "Honor engages me to prove it by all the means within my power. My style perhaps is not brilliant, but it will be useful; I will render it clear and simple, to be within reach of everyone, particularly workers."[5] Cointeraux viewed his mission as a course of public instruction, effectively eliminating poverty by occupying beggars in "major works."[6] For Cointeraux, pisé was not simply a man-made architectural technique; rather, it was:

> a gift of Providence. . . a present which God has made to all people. If agriculture is the basis for all science, pisé is also the first of all the arts. . . . Factories will multiply with pisé and commerce will flourish. . . .One should employ this kind of building throughout the realm, for the decency of villages and the honor of the nation, to save wood, which is used in such great abundance in constructions, to avoid fires, to protect laborers from cold or excessive heat, at the same time to conserve and protect their health, and for so many other objectives, too long to list, so useful to the state and to private landowners.[7]

This rationale illustrates the connection Cointeraux made between nature and pisé construction, and the rapport he saw between an architecture for the common man and the political upheavals. Cointeraux was thus expressing, in terms of pisé's origin (the soil) and utility (for the common good), what Voltaire and Rousseau were arguing in terms of political philosophy -- that society should recognize its natural link with the soil upon which men and women tread.

Cointeraux published four cahiers, or "notebooks" between March 1790 and November 1791. The first provided construction details made more palpable by costly, copper-engraved plates (see Fig. 4), while the second (published in March 1791) was concerned with soil qualities, further construction details, and the artistic rendering of wall surfaces. The third cahier was a plea to "men of commerce" to consider incorporating some earthen walls with those of brick in order to economize factory construction. In the fourth cahier, Cointeraux extolled the "new pisé," referring to the construction of more portable and adaptable unbaked bricks of rammed earth which could be moulded indoors and used at a later date (see Fig. 5). Cointeraux's notebooks were more popular than earlier pisé publications not only because of the author's passion for his subject, but also because of the imaginative and graphic way he addressed a wider audience and the innovations in technique he espoused.

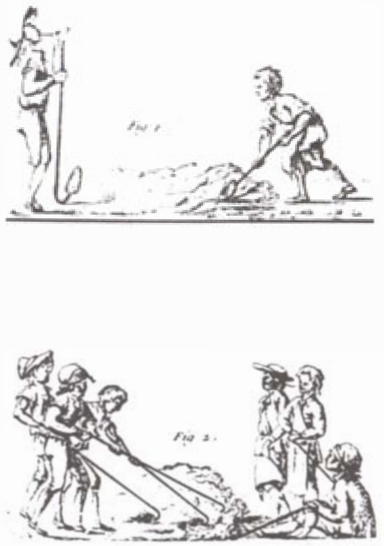


Fig. 6. Plate XII from Cointeraux's Second *Cahier*, showing workers mixing soil.

Three of those innovations are particularly noteworthy: Cointeraux's *pisé* pick, his conservation precautions, and his recommendations to adopt more than one sort of *pisé* technology (see Figs. 6, 7). The "pick" was a curved hoe, adapted for the requisite mixing of clay and sand, and the engaging way the author depicted this new tool helped make its use more understandable. Regarding conservation, Cointeraux adroitly discussed those materials -- stone or brick -- which could most effectively be used around doors and windows, where joints were more susceptible to damaging moisture intrusions and where tensile stresses led to structural weaknesses. In this regard, he suggested using more expensive lintels and sills in place of those made from wood, because the harder materials joined more solidly to the earthen wall. Furthermore, the hot lime-whiting which Cointeraux suggested applying as a coating would adhere, he asserted, more easily to the stone or brick than to the wood elements. Because Cointeraux envisioned rammed earth as a liberating technique, he was more amenable than any of his contemporaries to include variations, as well as the "standard" Lyon method, in his recommendations. Therefore, Cointeraux not only promoted the "new *pisé*," but he also lauded the sort of rammed earth technique devised in Bugey (Bresse). The Bugey method differed from that of Lyon because of the use of wood braces angled from the ground to the frame, which kept the vertical panels of the *pisé* shuttering more perpendicular to the ground, thus ensuring a flatter and more regular wall surface (see Fig. 7). By using the external braces it became unnecessary to insert lower horizontal supports at the base of the shutters. These lower supports required leaving gaps in the walls, which then had to be filled once the wall was complete. By using the Bugey method, Cointeraux observed, "All is whole from the ground level to the roof."[8] Cointeraux's inclusion of the Bugey method made a stronger case for *pise* because it demonstrated the versatility of the technology.

Through Cointeraux's persistent litanies, *pisé* became a technique for rural housing known far beyond the Lyonnais, although the author's personal success lagged behind his architectural notoriety.[9] There was an almost immediate reissuing of Cointeraux's findings, for example, in several other European countries.[10] In Britain, the initial impulse for considering rammed earth sprang from personal friendship between Cointeraux, his disciples, and British patrons rather than from French publications. Between 1791 and 1793, Cointeraux made a journey to the British estate of Philip Yorke, the third Earl of Hardwicke, a learned agriculturist who had purchased Cointeraux's *cahiers* in Paris and financed Cointeraux's trip in order to see *pisé* being implemented firsthand.[11] But even before Cointeraux's journey, two

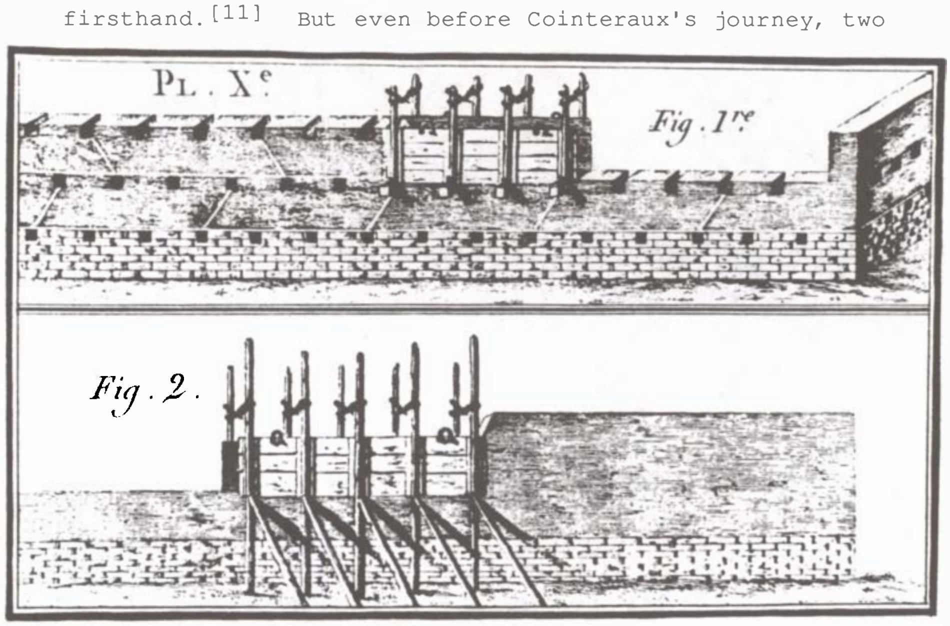


Fig. 7. Plate X from Cointeraux's First *Cahier*, 1790, comparing two, commonly-employed French methods for ramming earth: Lyon (above) and Bugey (below).

French pisé craftsmen trained by Cointeraux at his "school" in Paris were contracted in 1789 by Thomas Eccleston, of the Academy of Arts of London, to venture to Lancashire in order to erect experimental walls there.[12] British writings followed quickly on these heels of pisé experiments with, and on, English soil.

By the mid-1790s, British rural architects, seeking a cheap alternative to wood framing, began to consider pisé as a counterpart to the more common British methodology of erecting earthen walls, known as clay-lump walling or "cob," whereby clay was mixed with straw and then superimposed by layers before wall surfaces were pared down until flat.[13] John Plaw, in his Ferme Ornée (1795) was the first to acknowledge Cointeraux in print, but he was more an intermediary voice with access to a publisher than a practitioner of earthen constructions.[14] The most important British architect to give legitimacy to earthen walls was Henry Holland, who probably was introduced to the French methods by virtue of the curiosity of his patron, Francis, the fifth Duke of Bedford, a renowned agricultural promoter. The Duke's surveyor, Robert Salmon, later recalled how Francis was so interested in the Lancashire pisé experiments that he paid for a French worker to reside at his Woburn estate to build pisé walls there.[15] Holland and Salmon became immediate converts, but because Holland was enlisted to contribute to the popular Communications of the Board of Agriculture, his work, though more imitative than innovative, became more well-known than Salmon's. Salmon, for example, proposed using iron clamps to keep the shuttering taut, and at the troublesome junctures of two perpendicular wall segments he suggested using a long iron bar, connecting the shuttering of each segment, to maintain a right angle (see Fig. 8).

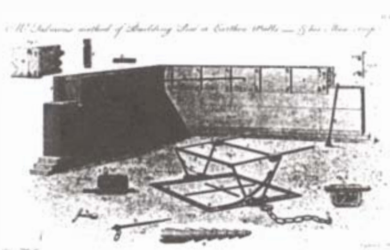


Fig. 8. Salmon's depiction of pise construction, 1809.

In praising pisé buildings, Holland simply offered a digest of Cointeraux's first two cahiers for the English practitioner. Holland emphasized Cointeraux's principal sections concerning the erection and dismantling of the wood forms, proper soil composition, and wall coverings. In most cases he even reproduced Cointeraux's graphics. But Holland omitted what he deemed less crucial to the case for pisé: Cointeraux's pisé pick, the Bugey method, the "new pisé," and the discussions about the preferred use of stone and brick lintels and sills. Either Holland knew of Cointeraux's other writings and simply chose to ignore them, or he remained in the dark concerning the later cahiers. In any event, Holland's edited translation helped lend enormous credence to the pisé technique. At the dawn of the nineteenth century, several British builders and agriculturists elaborated upon Holland's suggestions.[16]

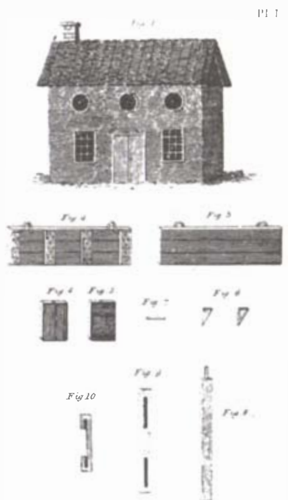


Fig. 9. Stephen Johnson's pise construction, 1806.

So, too, did some Americans. The most notable was Stephen W. Johnson, a lawyer and builder who hailed from New Brunswick, New Jersey. Precisely what drew Johnson to Holland's work is unknown. By 1804 the American had read the Communications and near Trenton he was in the midst of erecting his own pise experiment, 27 ft. long, 19 ft. wide, and 15 ft. tall (see Fig. 9). Contemporaries gawked and Johnson decided to publish his observations as part of a text concerning rural economy. Johnson's approach was to quote Holland freely without proper acknowledgment, alter the placement of whole sections of Holland's translation, and then lace these sections with his own observations, criticisms, and suggestions. Although he included depictions of his own work (along with copies of Holland's illustrations), Johnson never explained oddities such as circular window openings. Based upon his own practice, Johnson also significantly altered Holland's translation of Cointeraux. For example, he reduced optimum foundation height from 2 ft. 6 inches to 2 ft; where Holland specified a frame 10 ft. long, Johnson suggested 10 to 15 ft.; where Holland suggested using twisted rope as a means of keeping the frames parallel, Johnson recommended wood clamps; and where Holland saw the logic in battering the walls to alleviate tension at the building's base, Johnson thought this unnecessary. Johnson, then, had only a dubious faith in his *pisé* predecessors. Undaunted by critics who even before publication tried to vilify him, Johnson hoped to appeal to Americans who might buy a construction manual for a newly settled, soon-to-be-improved farm.

Johnson hit a responsive chord, but with regards to *pisé* he was not the only American to do so. John Stuart Skinner, the Baltimore-based editor and publisher of *The American Farmer* from 1819 to 1830, was the most notable of Johnson's contemporaries to disseminate European knowledge about earthen walls to North American farmers. He not only entirely reproduced Holland's translation, but he also publicized actual American experiments which documented the use of Johnson's book. Skinner first demonstrated an interest in earthen agricultural structures in 1820, but it was a year later before he reissued Holland's translation for an American audience.[17] By this time Skinner was intrigued with John Hartwell Cocke's experiments with rammed earth slave quarters and outbuildings at Bremo Plantation, near New Canton (Buckingham County), Virginia. Cocke admitted using Johnson's book as his guide, but he had problems with workmen becoming confused about how to erect the wood frames, and he discovered that the moisture of Virginia was more damaging to the walls than he had anticipated. Therefore, he wrote Skinner, it would be more sensible to make use of smaller shuttering systems, fortified by iron clamps instead of wood, yielding more adaptable blocks of unbaked brick. Unconsciously, by using Johnson's book Cocke had "discovered" Cointeraux's "new *pisé*" with the help of Salmon's suggestions about iron clamping.

As Skinner indicated for his subscribers, Cocke was not alone in his fascination with rammed earth. William Anderson's experiments in Statesborough, South Carolina were particularly noteworthy; between 1821 and 1824 this plantation owner proudly constructed five *pisé* structures on his land. Three of these are extant, and together with a nearby *pisé* church erected at Anderson's behest in the 1850s, these buildings represent the largest existing concentration of rammed earth examples in eastern North America.[18] Anderson wrote Skinner that he disagreed with Cocke's suggestions about making smaller wall sections. In South Carolina, he maintained he had experienced little difficulty in training workers to use the larger shutters, and furthermore he claimed great success with a lime stucco which, when troweled smooth, was easily marked to resemble ashlar stone.[19] In the American southeast, then, by the 1820s, two *pisé* methods were being adapted concurrently. This was also the case further north along the coast. In Baltimore, at least one landowner used Johnson's book to erect large wall sections in 1813, and in the state of Maine, two patents were secured in the late 1820s for devices that could fabricate "unburnt brick" blocks.[20]

By 1827 these two methods were related to a third analogous technique in the American southeast, called *tapia* or tabby.[21] *Tapia* walls differed from *pisé* in the quality of the soil mixture rather than in the method of moulding that mixture. Shells, small stones, and lime were crucial ingredients in tabby, which, when rammed with correct proportions of sand and water, formed a moist cementicious mix by molecular and capillary action. When dry, the mixture formed a solid mass. *Pisé* shared with tabby the use of wood moulds, braces, and rammers; a masonry foundation; similar wall thickness; and the common rationales of cheapness and durability. *Pisé*, however, was characterized by different soil components and was less moist when rammed.

Alexander Macomb and Thomas Spalding were two of the most important tabby enthusiasts in the late 1820s. Their experiments in South Carolina demonstrated that the technique of rammed earth construction was just as significant as the material being rammed. Macomb, Spalding, and those who continued using rammed earth technology in the 1830s, such as Benjamin Rivers Carroll, Nicholas Herbemont, and Philip St. George Cocke, concentrated upon the economic rationale for pisé to build factories, fences, a wide range of agrarian buildings, and even railroad ties.[22] They also obliquely indicated some of the pitfalls associated with the method. These included the damage inflicted by water if walls were not properly coped or if a wide enough overhang was not constructed, and the spalling that resulted from applying a lime-based covering to a predominantly clay wall.[23]

Once again, the intensifying interest in pisé or tabby structures in the coastal southeast during the 1830s was matched by similar curiosity in the northeast. Several letters and short articles from 1834 to 1838 in the Genesee Farmer (based in Rochester, N.Y.) attest to this popularity.[24] But it was not until the 1840s that rammed earth technologies became most accepted by American agriculturists. The figure most responsible for this acceptance was Henry L. Ellsworth, America's first Patent Commissioner, whose annual Reports between 1843 and 1845 lauded the use of "unburnt brick" as a sensible "mode of constructing houses."[25] Ellsworth based his praise upon his own experiments with rammed earth in Washington, D.C. and in Grand Prairie (Tippecanoe County), Indiana (see Fig. 10). Although not immediately apparent, Ellsworth's Reports were widely read,[26] and his opinions sparked editors of many agricultural periodicals to ask their subscribers for advice based upon empirical experience with earthen buildings on the American frontier.

Fig. 10. Henry Ellsworth's rammed earth house in Indiana.

The most supportive editor was John Stephen Wright, of Chicago's Prairie Farmer. Between 1843 and 1855 there were over forty references in this periodical which discussed earthen wall mixtures and examples, more than any other American journal. Farmers throughout the upper Midwest wrote to the Prairie Farmer with their favorable or critical comments. But by the early 1850s other cheap materials for economical houses, such as sawn lumber and fired bricks, were more popular, more abundant, easier to handle, more portable, and they more easily coincided with prevailing tastes of what constituted proper domestic architecture for those no longer poor and indigent on the prairie. Based upon the few documentary examples in the eastern U.S. of rammed earth or unburnt brick construction during the two decades after 1850, the peak period for earthen wall popularity coincided with the 1840s. After 1870, there was no articulated rationale in the American architectural or agricultural press for earthen wall construction until after World War I. However, a discussion of American interest in adobe and its affiliated technologies during the twentieth century reaches beyond the scope of this paper.

Conclusion

Eastern North American adoption of rammed earth building methods derived most significantly from Henry Holland's 1797 translation of Francois Cointeraux's first two cahiers (1790-91), as published in the Communications of the British Board of Agriculture. Cointeraux, an adventurous rural architect, promoted a method of building indigenous to his native Lyon, because he saw the need for an economical, fireproof material that "the common man" could grasp and because no one had yet adequately explained how this could be done. On the American continent, Cointeraux's ideas, filtered at first through Holland and his American imitator, Stephen Johnson, took root quickly. Rural builders were anxious for an answer to the question of how to build a cheap, durable, and easy-to-erect structure.

But in the face of biting northern frosts and abundant rainfall, prejudice about "mud houses" persisted, despite the publicized successful experiments. The economy of such houses was also undermined by the increasing cheapness of other building materials that were made more accessible by canal and railroad expansion. The ease of earthen wall construction was likewise called into question by those who wanted homes without having to wait for a proper season to dry a specially-moulded brick, formed from a special recipe of sand, gravel, clay, or loam.

The safeguards that alleviated these problems provide lessons for today's conservationists who might confront an American rammed earth structure. Building a proper foundation was almost mandatory. Constructing eaves that flared sufficiently to throw water far enough from the wall and its base to prevent intrusion was another prerequisite. Joining the bricks carefully with wood joists, sills, lintels, sash, lath and rafters was also critical, as was finding the proper coating to apply over the particular kind of earth used to make the wall.

The diversity of technique, function, style, and material that characterized European and North American earthen wall construction from the late-eighteenth to the mid-nineteenth centuries, as depicted in the remarkable range of publications surveyed above, suggests that no single formula existed for earthen homes one might build. Fuller appreciation for the unique combinations that builders employed can be gained by examining the rammed earth or unburnt brick structures themselves. The several that survive attest to the durability of this building technology, even in a climate not normally conducive to the flourishing of adobe.

ENDNOTES

[1] Stephen W. Johnson, Rural Economy: Containing a Treatise on Pise Building (New Brunswick, N.J.: William Elliott, 1806).

[2] See, e.g., Vitruvius, Ten Books on Architecture (New York: Dover, 1960), 39; Plinius Secundus, Natural History (Cambridge, Mass.: Harvard University Press, 1952), 385; Marcus Varro, On Agriculture (Cambridge, Mass.: Harvard University Press, 1967), 217; and Sheppard Frere, "Excavations at Verulamium, 1956, Second Interim Report," Antiquaries' Journal 37, nos. 1,2 (January, April 1957): 1-15.

[3] Jean Dethier, Down to Earth (New York: Facts on File, Inc., 1983), 57; P. Doat, A. Hays, et al., Construire en Terre (Paris: Editions Alternatives, 1979), 13-29; Maurice Garden, Lyon et les Lyonnais au XVIIIe Siècle (Paris: Les Belles Lettres, 1970), 6-24; and René Abrard, Geologie de la France (Paris: Payot, 1948), 322-40.

[4] Georges-Claude Goiffon, "L'Art du Maçon Piseur," Introductions Aux Observations sur la Physique, sur l'Histoire Naturelle et sur les Arts, 1 (March 1772): 682-97; Denis Diderot, Supplément aux Dictionnaires des Sciences des Arts et des Metiers, Volume IV (Paris: Chez Panckoucke, Stoupe, Brunet, 1777); and C. Francois Boulard, "Pisé," in Abbé Francois Rozier, Cours Complet d'Agriculture, Volume VII (Paris: Rue et Hotel Serpente, 1786): 722-36.

[5] François Cointeraux, Ecole d'Architecture Rurale, Premier Cahier (Paris: Chez l'auteur, 1790).

[6] François Cointeraux, Ecole d'Architecture Rurale, Deuxième Cahier (Paris: Chez l'auteur, 1791), 10.

[7] François Cointeraux, Ecole d'Architecture Rurale, Premier Cahier (Paris: Chez l'auteur, 1790), 33-4.

[8] François Cointeraux, Ecole d'Architecture Rurale, Premier Cahier (Paris: Chez l'auteur, 1790), 38.

[9] Cointeraux's lamentations about the uncooperative way politicians treated him is found in his De la Distribution des Batiments de Pisé (Paris: Chez Vezard et le Normant, 1793), 6-7, and in La Méthode Facile et Economique de Reédifier les Eglises Paroissiales (Paris: Delaunay, 1816), n.p. Cointeraux sent "many copies" of his cahiers to Prussia, Sweden, Germany, England, Italy, Russia, Holland and North America. See André Bourde, Agronômes et Agronomistes en France au XVIIIe Siècle (Paris: S.E.V.P.E.N., 1967), Vol. 11, 946.

[10] The most notable are: in Italy, Giuseppe del Rosso, Dell' Economica Costruzione delle Case di Terra, Opuscolo Diretto Agli Industriosi Possidenti e Abitatori dell' Agro Toscano (Firenze: J.A. Bouchard, 1793); and in Germany, F. Cointeraux, Schule der Landbaukünst (Hilderberghaussen: n.p., 1793).

[11] Cointeraux mentioned his British experience in Méthode Facile, n.p. For Yorke, see Leslie Stephen and Sidney Lee, eds., Dictionary of National Biography (London: Oxford University Press, 1917), Vol. 21, 1268; and G.E. Cohayne et al, eds., The Complete Peerage (London: St. Catherine Press, 1926), Vol. 6, 307.

[12] The location of these experiments, none of which survived, was probably Scarsbrick Hall. See Robert Beatson, "On Cottages," Communications of the Board of Agriculture, or Subjects Relative to the Husbandry and Internal Improvements of the Country (London: W. Bulmer & Co., 1797), I, 111.

[13] The most complete description of this methodology is in The Quarterly Review 58, no. 116 (February/April 1837): 524-40. Also see Norman Davey, A History of Building Materials (New York: Drake Publishers, 1971), 19-20, and R.J. Brown, The English Country Cottage (London: Robert Hale, 1970), 147.

[14] John Plaw, Ferme Ornée; or Rural Improvements (London: I. and J. Taylor, 1795). For a proper context of Plaw's motives, see Sandra Blutman, "Books of Designs for Country Houses, 1780-1815," Architectural History 11 (1968): 25-33; J.M. Robinson, "Model Farm Buildings in the Age of Improvement," Architectural History 19 (1976): 17-23; and Georges Teyssot, "Cottage et Pittoresque: Les Origines du Logement Ouvrier en Angleterre, 1781-1818," Architecture, Mouvements, Continuité 34 (1974): 26-37.

[15] Robert Salmon, "Method of Constructing Commodious Houses with Earthen Walls," Transactions of the Society for the Encouragement of Arts, Manufactures and Commerce 27 (1809): 185-97. For Henry Holland and the Duke of Bedford, see Dorothy Stroud, Henry Holland: His Life and Architecture (South Brunswick, N.Y.: A.S. Barnes & Co., 1966) and Charles Drury, Important Hints and Discoveries in Agriculture; or, a New System of Farming in General (4th ed.; London: Sherwood, Neely & Jones, 1818), 214.

[16] In addition to Robert Salmon, see William Barber, Farm Buildings (London: J. Tyler, 1802); Joseph M. Gandy, Designs for Cottages, Cottage Farms, and Other Rural Buildings (London: John Harding, 1805); and The Society of Arts, "Rammed Earth Buildings," in The Complete Farmer; or the General Dictionary of Agriculture and Husbandry (5th ed.; London: W. Flint,

1807), Vol. II, n.p. Holland's contributions in this regard were best articulated by John B. Papworth, in his Rural Residences (London: J. Diggens, 1818), 15.

[17] American Farmer, 2, no. 28 (October 6, 1820): 224; 2, no. 36 (December 1, 1820): 288; 3, nos. 1-5 (March 31- April 27, 1821).

[18] The plantation buildings were placed on the National Register of Historic Places on March 23, 1972. The Church of the Holy Cross was designed by E.C. Jones. See unpublished 1926 report (located at Clemson University, South Carolina) by Thomas A.H. Miller, Associate Agricultural Engineer, Bureau of Public Roads, U.S. Department of Agriculture.

[19] For Anderson, see American Farmer 3, no. 22 (August 24, 1821): 176; 6, no. 1 (March 26, 1824): 6; Southern Agriculturist, 9 (April 1836): 188.

[20] S. Chase erected a two-story, whitewashed, "very firm" pise dwelling in Baltimore, as indicated in the American Farmer 2, no. 2 (April 6, 1821): 14. For the Maine patents by E. Mayo, T. Norcross and G. Pollard, see M.D. Leggett, comp., Subject Index of Patents for Inventions Issued by the U.S. Patent Office from 1790 to 1873 (Washington, D.C.: Government Printing Office, 1874), I, 139, 148.

[21] See Janet Bigbee Gritzner, "Tabby in the Coastal Southeast: the Culture History of an American Building Material" (Ph.D. diss., The Louisiana State University and Agricultural and Mechanical College, 1978).

[22] American Farmer, 8, no. 45 (January 26, 1827): 353; no. 49 (February 23, 1827): 391; Southern Agriculturist 3, no. 12 (December 1830): 617-24; 9, no. 1 (January 1836): ii; no. 8 (August 1836): 400; and no. 12 (December 1836): 641-44.

[23] For example, Benjamin Carroll recommended using one of three, nonlime stuccos: (1) a mixture of linseed oil, litharge (water-insoluble PbO), red lead (Pb3O4), and lead acetate; (2) turpentine gum boiled in salt water; or (3) tar mixed with hot water and salt. Southern Agriculturist, 9, no. 8 (August 1836): 406.

[24] Genesee Farmer, 4, no. 39 (September 27, 1834): 309; no. 44 (November 1, 1834): 345; 5, no. 5 (January 31, 1835): 34; 7, no. 6 (February 11, 1837): 42; and 8, no. 3 (August 4, 1838): 244.

[25] Annual Report of the Commissioner of Patents, 1843 (Washington, D.C.: U.S. Government, Senate Document 150, 28th Congress, First Session, House Document 177), 45-6, 98-101; Ibid., 1844 (Senate Document 75, 28th Congress, Second Session, House Document 78), 239-41; Ibid., 1845 (Senate Document 307, 29th Congress, First Session, House Document 140), 450-54.

[26] The 1844 and 1845 reports were reissued by Congress in printings of 15,000 and 50,000 respectively. See the New Genesee Farmer and Gardener's Journal 5, no. 6 (June 1844): 54 and the Ohio Cultivator 1, no. 5 (March 1, 1845): 36.

ABSTRACT

The explosive growth of the Mexico City Metropolitan Area, and the deep changes in the lifestyles of its inhabitants, have brought the use of traditional building methods in adobe practically to an end; adobe is now seldom used, but an enormous number of buildings of all types made of this material still exist. By breaking the metropolitan area into zones relating to soil types and environmental conditions, we have found that, within a general framework of building usage applicable for the whole area, adobe and its related building methods can be studied as the result of truly regional and even local developments, responding successfully to the requirements of these localities.

KEYWORDS

Adobe, Mexico City, geography, history, characteristics existents.

EL USO DEL ADOBE EN EDIFICIOS EN EL AREA METROPOLITANA DE LA CIUDAD DE MEXICO; EL PASADO, EL PRESENTE Y LAS EXPECTATIVAS PARA EL FUTURO.

Segismundo Engelking Keeling
Saúl Alcántara Onofre
Universidad Autónoma Metropolitana-Azcapotzalco
Av. San Pablo No.180
Col. Reynosa Tamaulipas
02200 Azcapotzalco, D.F.
México.

Introducción

Este trabajo es parte de una primera etapa de organización de un programa de investigación académica que se está realizando dentro del marco de las actividades docentes del Departamento del Medio Ambiente de la División de Ciencias y Artes para el Diseño, Universidad Autónoma Metropolitana. Estos trabajos se originan en nuestra preocupación por la constante destrucción de edificaciones realizadas en adobe, como producto del rápido crecimiento de la Ciudad de México y el consecuente olvido de las tecnologias de construcción en este material fundamental.

No comenzar su estudio ahora, implicará una cada vez mayor dificultad para su análisis desde el punto de vista estadístico.

La meta de este programa de estudios será establecer criterios para determinar la monumentalidad que los edificios de adobe pueden alcanzar en el contexto del medio construido existente en el país, y asignar juicios de valor que no necesariamente estén vinculados a la noción de que éste material se usa sólo en construcciones paupérrimas y despreciables.

El ámbito geográfico; condiciones físicas

En esta investigación nos hemos dedicado al estudio de la construcción de adobe existente en algunos poblados absorbidos por el crecimiento de la Ciudad de México y las áreas ribereñas de los antiguos Lagos de Chalco y Texcoco, incluyendo los Municipios de Atenco, Ecatepec, Texcoco, Chimalhuacán, Ixtapaluca y Chalco, y los Municipios de Tlalmanalco y Amecameca, que muestran una sección típica de la orografía y de las variaciones climáticas de flora y fauna, así como la composición geológica y de suelos que se pueden encontrar en la mayor parte del Valle de México. Estas áreas aun cuando conservan muchas de sus características rurales, se encuentran en un proceso de transición a formas de vida urbanas, incluyendo la adopción de métodos de construcción no tradicionales.

Caracteristicas geográficas del Valle de México

En el extremo sur de la Meseta Central ó Altiplano Mexicano, se encuentra, a una altura de unos 2240 m. sobre el nivel del mar, la depresión conocida tradicionalmente como el "Valle de México". Este término, que por razones de orden histórico y de uso generalizado seguiremos utilizando, en rigor no es correcto, pues debe ser definido como cuenca, dado que se encuentra rodeada por cadenas montañosas que, por su peculiar ordenación impiden la existencia de una línea de drenaje superficial que permite la erosión o modelado, característica de un Valle.

Dicha cuenca tiene una forma aproximadamente oval, cuyo eje mayor, de Noreste a Sureste es de unos 110 km, y el menor, de Este a Oeste de unos 80 km. (ver figura 1).

La cuenca de México debe su formación a procesos volcánicos y tectónicos que se han ido desarrollando en los últimos 50 millones de años como parte de la formación de la faja volcánica transmexicana.

El valle o cuenca se encuentra rodeado al Sureste por la Sierra de Rio Frío y por la Sierra Nevada, que incluye los volcanes Popocatepetl, con 5438 m. S.N.M. y el Iztaccihuatl, con 5286m. Esta se liga por el Sur con la cadena del Chichinautzin y la del Ajusco, constituyendo parte integral de la cordillera neovolcánica. Del Suroeste al Noroeste se extienden las Sierras de Tepozotlán y de Tezontlalpan, ligándose con la serranía de Pachuca. Por el Nororiente encontramos las Sierras de Chichicuautla, del Tepozán y Calpulalpan.

*ama

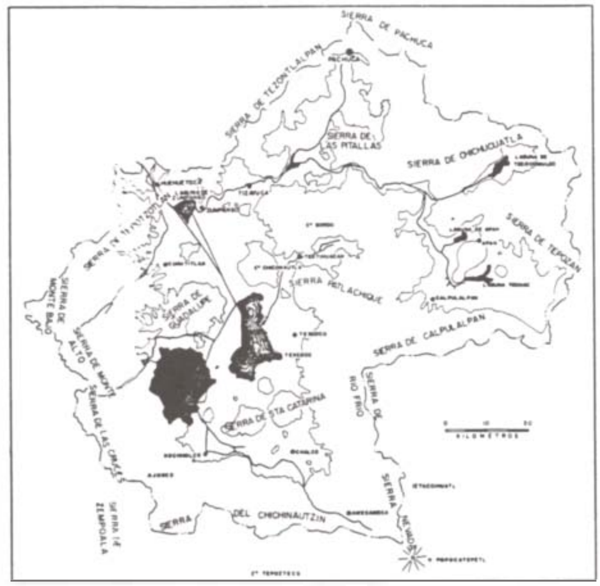


Figura 1. Las Sierras y Lagos del Valle de México.

Dentro de esta cuenca se encuentran otras formaciones menores, como la Sierra de Guadalupe, la de Santa Catalina y la de Caldera, al Oriente, así como eminencias aisladas, como el Cerro de la Estrella, el Peñón del Marqués y algunos otros.

Clima

Dadas las grandes variaciones orográficas, las características climaticas de las diversas zonas de la cuenca son igualmente variadas. En términos generales se encuentran dos regímenes climáticos establecidos: al Norte, según el sistema de Köppen para condiciones medias, existe un clima de tipo "seco estepario" con lluvias escasas. Al Sur, incluyendo la gran masa de la Ciudad de México, se tiene un tipo templado moderado lluvioso, con precipitaciones mayores a 750 mm. anuales, resultantes principalmente de los vientos alisios húmedos provenientes del Noreste. Por otra parte, hay una tendencia a tener una mayor precipitación en las faldas de las montañas que en las áreas planas. La temporada de lluvias se extiende en general, entre los meses de Mayo y Octubre.

La temperatura media anual para la cuenca es de 15°C.; la máxima a la sombra es de 31°C. y la mínima de 4°C a 6°C, con algunas heladas en invierno, aunque existen diferencias según alturas y cercanías a las montañas. Por otra parte, la temperatura ha aumentado en áreas como la Ciudad de México a 8°C, ó 10°C, debido al gran aumento en la contaminación ambiental.

Hidrología

La condición de cuenca del Valle de México determina que todas las corrientes superficiales provenientes de la serranias circundantes, fluyan hacia la depresión central, la cual, no teniendo salidas de descarga, ha formado una serie de lagos y lagunas, entre las que se pueden señalar como más importantes las de Texcoco, Chalco, Xochimilco, Zumpango, San Cristóbal y Xaltocan. De éstos poco existe ahora debido por una parte a la tala inmoderada en los bosques existentes y a la extracción de grandes volumenes de agua fuera de la cuenca desde el Siglo XVIII. Ultimamente, gran parte ha sido bombeada del subsuelo con la consiguiente deformación diferencial del mismo.

Geología

Las principales formaciones pétreas son de rocas ígneas extrusivas (andesicas, riolitícas y basálticas) del terciario y cuaternario, que yacen discordantemente sobre las rocas mesozoicas marinas, cubriendo la mayor parte de la cuenca; en las faldas de las serranías también existen rocas sedimentarias clásticas (areniscas y gravas) y arcillas, asociadas con piroclásticas (tobas). La mayor parte de la planicie de la cuenca está formada por arcillas lacustres, prácticamente impermeables, o con depósitos permeables o gravas y arenas, concentradas especialmente en las áreas de desembocaduras de ríos.

Suelos y flora

La complejidad litológica de la conformación del área ocupada por la zona metropolitana, determina que en ella se haya desarrollado una gran cantidad de tipos de suelo. Sin embargo, la relativa juventud de las formaciones geológicas explica la existencia de andosoles ricos en cenizas volcánicas, y litosoles con formaciones petreas aparentes, predominantes hacia el Sur y el Oeste, así como las grandes extensiones de regosoles y fluvisoles de origen aluvial volcánico, presentes en la vecindad de los volcanes Popocatepetl e Ixtaccihuatl. Por otra parte, hacia el Norte predominan formaciones como vertisoles, (Cuautitlán a Texcoco), muy arcillosos con concentraciones de calcio, y suelos feozem, ricos en materia orgánica y de gran productividad agrícola, denotando una mayor antiguedad. Finalmente se tienen suelos solonchac en los fondos de los antiguos lagos, complementados por histosoles y gleysoles en el antiguo lago de Chalco (Xochimilco y Mixquic), con altas concencentraciones de sales y cambiosoles húmidos en las áreas boscosas cercanas a los volcanes.

Los suelos mencionados definen ampliamente los tipos de vegetación existente: bosques de montañas, yendo de caducifolias a coníferas según la altura, pastizoles con matorral en las partes bajas,con algunas especies mayores como pirul, fresno, etc., y en las zonas más áridas existencia de plantas de tipo desértico, como nopales (opuntia sp.) y magueyes (agave sp.). En muchos lugares el crecimiento desorbitado de la mancha urbana ha deteriorado el balance ecológico en forma irreversible.

Desarrollo de la Ciudad de México y la presencia histórica del adobe

Al igual que en otras regiones del mundo, México ha conocido una larga historia en el uso del adobe. En "La Venta", Edo. de Tabasco, existen pirámides recubiertas de piedras y lodo, que datan del año 800 A.C. y en Cuicuilco, en el Valle de México, desde el año 600AC. se construyó el primer basamento de piedra de grandes dimensiones, en que se usó barro como aglutinante; en Comalcalco, Tabasco, ya en tiempos clásicos (c. 700 D.C.) los Mayas construyeron pirámides y templos en ladrillo crudo y quemado a falta de piedra en la zona.

En el año 1325 D.C., fecha tradicional de la fundación de la Ciudad de México-Tenochtitlan, el Valle de México se encontraba ya considerablemente poblado, con una economía basada tanto en agricultura de temporal, incluyendo agricultura por terrazas, como de chinampas en las áreas lacustres. Era generalizado el uso de técnicas de bajareque y de adobe para las construcciones de los macehuales (ciudadanos comunes) y aun de clases mas altas, como los comerciantes (pochteca); la construcción de mampostería con mortero de cal se reservaba principalmente para la nobleza o los templos.

Figura 2.

Tras la conquista de la Gran Tenochtitlán, los Españoles no tuvieron gran dificultad en entrenar a los indigenas en las técnicas de edificación europea para los trabajos de reconstrucción, puesto que muchas de ellas se utilizaban en México, entre ellas las de adobe.

Un buen ejemplo de adobe prehispánico fue encontrado en las excavaciones de salvamento efectuadas durante 1989 en la calle de Francisco González Bocanegra, Colonia Morelos, por las Arqueólogas María del Jesus Sánchez Vazquez, Margarita Carballal Staedtler y María Flores Hernández, Subdirección de Salvamento Arqueológico, I.N.A.H. La excavación, localizada en lo que aparentemente fue un barrio de nobles y pochtecas, descubrió restos de construcción habitacional correspondiente al postclásico tardío (1473-1521). Esta incluye cimientos de piedra basáltica y de tezontle de sólo 22 cm. de ancho y 3.8 cm. de altura, sobre los que desplantan muros de adobe de 47 cm. de largo, 22 cm. de ancho y 8 cm. de altura, evidenciando poca preocupación por los problemas de humedad ascendente y una cubierta necesariamente ligera, probablemente armazón de madera con paja, lo que se confirma por huellas de postes. (ver figuras 2 y 3).

Figura 3.

Durante el siglo XVI existió una clara diferencia entre la construcción española hecha en mampostería de piedra con argamasa de cal, en el centro de la Ciudad de México y otros poblados importantes, y las construcciones indígenas de la periferia, realizadas en su gran mayoría con adobe. Kubler (1) menciona que, según Cervantes de Salazar, los materiales de barro eran considerados viles,

Figura 4. Los lagos de la época diluvial.

A comienzo del Siglo XVI.

A comienzo del Siglo XIX y en el año 1889.

comparando con la piedra. Esta noción se mantuvo en todos los niveles sociales, incluyendo a los remanentes de la nobleza indígena que logró sobrevivir a los profundos cambios sociales promovidos por un progreso de colonización, mismo que dentro de sus posibilidades adopta las formas Españolas, incluyendo la construcción de casas de mampostería y mortero de cal con puertas, ventanas y cubiertas de viguería escuadrada.

Otra condicionante para la existencia de construcciones de adobe fue la vecindad del Lago de Texcoco y el constante peligro de inundación que presentaba si la precipitación pluvial era excesiva. Este fenómeno era conocido desde mucho antes de la conquista y era de considerable importancia, dada la gran dependencia de la economía de los habitantes del Valle con los Lagos. Se ha detectado desde tiempos preclásicos un constante cambio de ubicación de poblados ribereños a la relación de los cambios de nivel de las aguas.

Antes de la llegada de los Españoles hubo inundaciones importantes; la de 1449 (2) llevó a la construcción del albarradón de Netzahualcoyotl, que extendía desde el poblado de Ixtapalapa hasta Atzacoalco, cercano al cerro del Tepeyac. Los primeros años de la Colonia transcurrieron sin grandes incidentes, hasta 1555 en que la Ciudad de México y otros pueblos ribereños quedaron inundados con gran daño a las construcciones. Siguieron las inundaciones de 1579-1580, de 1604, 1607 y la de 1628, que continuó hasta 1633, obligando a las autoridades a buscar una solución al problema la que, tras mucho argumentar, fue dada por el ingeniero Alemán, Enrico Martínez. Esta consistió en desviar las aguas del Lago Zumpango, hacia el Río Tula, que queda fuera de la cuenca, por lo que se debía hacer un socavón de unas 14,850 varas (unos 11,880m)

A partir de estos trabajos y posteriormente con la apertura del tajo de Nochistongo, comenzado en 1798, el gran canal del desagüe realizado durante el siglo pasado, y los trabajos del sistema de drenaje profundo de la Ciudad de México, de realización reciente, los niveles de los lagos han ido bajando hasta hacerlos casi desaparecer (ver figura 4).

Las inundaciones producidas por los lagos y posteriores medidas de control trajeron dos resultados importantes para la construcción de adobe:

1a. Que es casi imposible encontrar edificios anteriores al año 1700 (y aun posteriormente), debido al peligro que se corre con construcciones de adobe en áreas inundables. Por lo tanto, se puede decir que prácticamente todos los edificios de adobe pertenecientes al período 1521-1700 se podrán encontrar en regiones tradicionalmente secas, como los antiguos poblados de Mixcoac, Tacubaya, Tlalpan, Huexotla, Texcoco, Tlalmanalco, Teotihuacán, Amecameca, Tlalnepantla, etc.

2a. Que, debido al drenado de los lagos a partir del Siglo XVIII se construyó mucho en adobe en las tierras ganadas. En términos generales se podría establecer una cronología de construcciones en base a su ubicación relativa a los niveles de secación alcanzados en fechas dadas, como en el caso de Chalco, en que encontramos un edificio con rasgos barrocos típicos de mediados del Siglo XVIII, pero con muros de adobe, o de los pueblos de Ixtacalco, Santa Anita Zacatlalmanco, y la Magdalena Mixhiuca, cercanos a la Ciudad, en que la construcción de adobe sería posterior a 1800, o Ayotla en que las construcciones son más recientes.

El principio del fin

El desarrollo de la construcción en adobe en el Valle de México en tiempos en que los cambios sociales, tecnológicos y económicos eran lentos y paulatinos garantizaron la supervivencia de tecnologías netamente tradicionales como el adobe. Pero con los tiempos de paz que a partir de 1921 se experimentan en la Ciudad de México, con el fin de la Revolución Mexicana, comienza un proceso de acelerado crecimiento en todos los órdenes.

La población del Distrito Federal, que en 1895 era de 426,804 habitantes, para 1900 era ya de 540,478. A partir de 1930 la población comienza a modificar con mayor rapidez todos los patrones tradicionales, incluyendo formas de construcción.

Como indicador claro se muestra el crecimiento de la población en la tabla I.

Figura 5-6. Ixtapaluca.

Tabla I: Crecimiento demográfico en la cuenca:

	Distrito Federal	Cuenca
1895	426 804	
1900	540 478	
1930	1 229 575	1 625 935
1940	1 757 530	2 225 000
1950	3 050 442	3 633 407
1960	4 870 876	5 807 232
1970	6 874 165	8 643 425
1980	9 639 800	12 600 000 (aprox.)

(fuente: censos de población 1895-1980)

Se estima que para este año la población ha llegado a los 18 ó 20 millones, que equivale al 20% del total del país. Tan rápido crecimiento sólo se puede atribuir a un fuerte proceso de inmigración, que es explicable si se considera que en la zona metropolitana existe más del 30% de la planta productiva.

Figura 7. Casa colonial en Chalco.

Las cifras anteriores se reflejan claramente en los tipos de construcción que se han detectado en los diferentes levantamientos censales. Los de 1950, 60, 70 y 80, muestran la tendencia irreversible a la desaparición de la técnica del adobe en el Valle de México. Para efectos comparativos la tabla II presenta los datos de vivienda total y las hechas en adobe, tabique o block de cemento, y madera, en el Distrito Federal.

Tabla II: Vivienda

	Total	en adobe	en tabique o block	en madera
1950	784 082	128 709	394 012	53 924
1960	902 083	191 314	618 962	44 466
1970	1 219 419	73 256	1 076 766	33 417
1980	1 747 102	46 144	1 637 070	16 438

(fuente: censos de población 1950-1980)

Estas cifras indican que, mientras el número de construcciones de adobe en sólo 30 años se ha reducido en un 60%, la construcción en tabique rojo o block de cemento con refuerzos de concreto armado ha crecido en mas de 400%, constituyendo mas del 93% del total.

Figura 8. Troje en Texcoco.

Características del adobe existente

Al respecto, hemos realizado una encuesta preparatoria de treinta construcciones en varios sitios del Valle, ya mencionados al principio de este trabajo. Se obtuvieron los siguientes resultados:

1. Período de construcción. Mas del 50% de las construcciones datan de finales del Siglo pasado y sólo el 15% son atribuibles a las primeras décadas del presente.

Otro 15% fue difícil de datar, por no incluir elementos estilísticos, pero tendería a corresponder al primer grupo. (ver figuras 5 y 6).

Se encontraron además tres construcciones coloniales de especial interes, (ver figuras 7,8 y 9). En todos los casos los constructores son anónimos.

Figura 9. Iglesia abandonada en Texcoco.

2. Usos, original y último. En el 85% de los casos el uso, original y último, es habitacional, con algunas variantes que incluyen establos o comercios, (ver figura 10). Sólo se encontró un caso en que el uso original era de caballeriza y troje y el actual es habitación. Dos de los tres ejemplos coloniales son atípicos: uno es una iglesia y otro un troje.

3. Cimientos. En todos los casos se encontraron cimientos hechos con piedra, de preferencia volcánica extrusiva, para evitar en lo posible la humedad ascendente. El aglutinante fue en el 40% de las veces mortero de cal. Sólo en dos ejemplos de lodo y el restante en mezcla de ambos. Siempre se construyeron sobre el nivel del suelo, variando entre 30 y 30 cm. con algunos ejemplos que pasan el metro.

Figura 10. Casa con establo. Gpe. Victoria, Ecatepec.

4. Adobes. Se encontraron en una gran diversidad de dimensiones. Se supone que el dimensionamiento se hacía por cuartas, u otras medidas corporales, variando entre los 35 y 50 cm. de largo, 30 y 40 cm. de ancho y 8 a 10 cm. de alto. Todos los ejemplos coloniales llegaban a mediar hasta 60 x 50 x 15 cm.

Las juntas varían igualmente entre 2.5 cm. y 4 cm. y algunas veces más, casi siempre con rajueleo de piedra o barro recocido para fijar aplanados.

5. Cubiertas. En casi todos los casos las cubiertas son planas con enladrillado y viguería, en correspondencia con las áreas planas del Valle. En las áreas altas como Tlalmanalco y Amecameca, hay una decidida preferencia por cubiertas a dos aguas, dada la mayor incidencia de heladas y probabilidad de nieve. Los elementos portantes son casi universalmente de viguería. Por otra

parte, es muy raro encontrar edificios de adobe en dos niveles, (ver figuras 11, 12, 13 y 14).

6. Acabados. El aplanado de cal es el mas usado, aunque en tiempos recien - tes se usa cemento por facilidad. También es común utilizar únicamente una lechada de cal, pintura casi universal.

En cuanto a la composición de los adobes, se encontró que en las partes planas del Valle hay una tendencia a mezclar material que ayude a dar adherencia tal como paja, estiércol de caballo y cenizas, especialmente en suelos feozem y solonchac cercanos al lago, a diferencia de los fluvisoles de Ameca - meca y áreas cercanas, donde ésto no parece ser necesario.

Conclusiones

En el Valle de México hubo una larga tradición en construcción de adobe con gran capacidad de adaptación a las condiciones naturales imperantes de composición de suelos, accidentes geológicos, variación climática y diversidad de vegetación. Este sistema constructivo hoy se encuentra en proceso de extinción ante la dificultad de adaptarse a los rápidos cambios que impone el desmesurado crecimiento de la zona metropolitana de la Ciudad de México, y, a su incapacidad para competir con ventaja ante materiales como el tabique recocido, el block de cemento y el concreto armado. Por tanto, es de gran importancia comenzar cuanto antes su estudio sistemático y la identificación de ejemplos rele - vantes para su conservación.

Notas

1. G. Kubler, Arquitectura Mexicana del Siglo XVI; México 1984, 174.

2. J. F. Ramírez, Memoria Acerca de las Obras e Inundaciones de la Ciudad de México; 1976, 34.

Bibliografía

V. J. Moya Rubio,"La Vivienda Indígena en México y el Mundo"; México 1982.

P. Gendrop, "Arte Prehispánico en Centro Mesoamérica"; México 1988.

Ch. Gibson, "Los Aztecas Bajo el Dominio Español, 1519-1810"; México 1983.

Depto. del Distrito Federal; "Memoria de las Obras del Sistema de Drenaje Profundo del Distrito Federal"; México 1975.

I.N.E.G.I. "Síntesis Geográfica Nomenclator y Anexo Cartográfico del Estado de México"; México 1987.

I.N.E.G.I. 4°, 5°, 6°, 7°, 8°, 9° Y 10° Censo General de Población.

Figura 11. Construcción típica de cubierta plana; Ayotla, Edo. de México, C. 1900.

Figura 12. Construcción a dos aguas con lamina Galvanizada, C. 1900. Tlalmanalco, Edo. de México.

Figura 13. Construcciones a dos aguas con teja plana, C 1900; Amecameca, Edo. de México.

Figura 14. Construcciones a dos aguas con teja plana, C 1900; Amecameca, Edo. de México.

ARQUITECTURA DE TIERRA EN ITALIA: DESDE LAS COLONIAS GRIEGAS HASTA LA DOMINACION ESPAÑOLA

Eugenio Galdieri
Via dell'Accademia Platonica 12
00147 ROMA, ITALY

ABSTRACT

This contribution does not claim to be a complete catalogue of all the mud brick architecture that has been built in Italy over a span of almost thirty centuries. Instead it aims to show that this ancient technique has a continuity of its own in Italy, too, and has produced good examples of building construction. It was not, however, a technique that ever became a practice with deep-rooted traditions and, consequently, it did not attain high levels of maturity.
The paper denounces the past responsibilities of archaeologists who, with their Classical, academic training that was directed towards the study of great monuments of Greek and Roman civilization, paid little attention to, or even destroyed, the evidence of buildings in mud brick, especially of the Etruscan period.
The article also emphasizes the fact that, in spite of the recent interest in this subject that has been recorded over the past twenty years in Italy, very little has been done by the competent authorities to gain better knowledge of, or to catalogue and conserve these numerous, important testimonies of our past.

KEYWORDS

ITALY'S HISTORICAL EARTHEN ARCHITECTURE

Hasta hace algunos años Italia no estaba incluída entre los países dignos de ser citados en el campo de las construcciones de tierra: uno de los primeros estudiosos de este fenómeno técnico, social y económico - el Prof. P. Vidal de la Blache - en su obra póstuma del año 1948 (1), ignora completamente Italia como lugar de "casas de tierra", así como lo ha ignorado la Exhibición de Paris en el año 1982. Estudios efectuados en los años treinta de geográfos como Baldacci (2), además de otras investigaciones más recientes efectuadas en los años ochenta (3), han permitido modificar sustancialmente este juicio negativo, poniendo a la luz un panorama bastante interesante, sea desde un punto de vista cuantitativo como cualitativo. Aunque de manera geográficamente discontinua (y ésto también por causa de la naturaleza del terreno en Italia) en vastas zonas del territorio peninsular e insular son muchas las pequeñas ciudades compuestas en gran parte por edificios de tierra y numerosas son las construcciones en el campo, aisladas o agrupadas en grupos homogéneos. Se puede afirmar que la práctica de la construcción de casas de tierra se llevó a cabo por lo menos hasta el año 1950, cuando, por motivos higiénicos, pero a través de leyes no escritas, las autoridades impidieron que se continuase construyendo con dicho método. Al estado actual de nuestros conocimientos- y a pesar de tener en cuenta las numerosas demoliciones y sustituciones de los últimos decenios - el patrimonio de las casas de tierra en Italia (entendemos referirnos a aquellas en normal y continuo uso civil) abarca a una decena de millares de edificios. Estos están distribuidos en el territorio de al menos setenta ayuntamientos, con las mayores concentraciones en las provincias de Alessandria (Piemonte), de Cagliari (Cerdeña) y de Catanzaro (Calabria). Una catalogación completa de tales núcleos de edificios, y de las respectivas tipologías se lleva actualmente a cabo en un proyecto que une algunas Universidades italianas y centros autónomos de investigación (4) . Pero el argumento que nos interesa tratar en este encuentro es de carácter histórico. Nos interesa efectivamente ver que hay detrás del notable número de construcciones todavía existentes; nos interesa, por lo tanto intentar entender si también en Italia se puede hablar de una tradición constructiva de la tierra. Ante todo hay que decir que nuestras investigaciones nos han llevado a dos conclusiones : la primera es que, no obstante la gran difusión de las casas de tierra (fenómeno mucho más extendido y rico de cuanto se haya imaginado hasta ahora), la técnica del adobe no ha logrado nunca en Italia , convertirse en una verdadera y radicada tradición. En consecuencia tal tecnología específica no se ha desarrollado más allá de un cierto límite, ya que han faltado los apoyos fundamentales de la creatividad y de la continuidad temporal. La segunda es que el uso de la tierra no ha sido casi nunca autóctono sino importado del exterior, a través de inmigraciones - más o menos pacíficas - de otras culturas. Si se quieren buscar los períodos y la naturaleza de estos aportes externos, sobre todo en lo que concierne la antigüedad, se pueden individuar cuatro rumbos principales: El púnico-fenicio desde el Sur, dirigido sobre todo hacia Cerdeña meridional; aquel proveniente de Asia Menor, en el cual pueden incluirse sea la corriente griega en el Sur y en las Islas, sea el etrusco, presente en Italia central y en el Véneto; el rumbo de Europa Oriental (los Balcanes islamizados), dirigido principalmente hacia las zonas adriáticas de Italia centro-meridional, hasta en el interior; por fin el rumbo español, dirigido hacia Cerdeña, las costas tirrénicas y, quizás, las zonas de tierra adentro de la Liguria. Para estas últimas áreas y para aquellas cercanas a la Francia meridional, se habla de una posible influencia de poblaciones islámicas expulsadas de España. Pero éste es un argumento que, no obstante me interese particularmente, tendrá que ser estudiado más profundamente.

Por lo menos cuatro, entonces, fueron las contribuciones externas al desarrollo de la arquitectura de tierra en Italia, dichas contribuciones comienzan en el siglo VIII a.C. (influencia púnico-fenicia) para llegar al siglo XVI con la ocupación española. En este lugar nos interesa examinar solamente los periodos más antiguos, para demostrar que, favorecida por las influencias exteriores que hemos individuado hace poco, la técnica de las construcciones de tierra en Italia tiene raíces muy remotas.

Como sería demasiado largo y de poca utilidad ocuparnos de todas las obras de edad antigua realizadas en tierra en Italia (muchas de ellas han sido en efecto reducidas a importantes pero míseros testimonios arqueológicos), será quizás más interesante concentrar nuestra atención sobre algunos ejemplos de mayor importancia histórica.

En Tuscania existe la gran instalación etrusco-romana de Roselle (VIII - III a.C.). Excavaciones recientes pero también descubrimientos casuales han puesto a la luz algunos edificios civiles del período arcaico (c. VII a.C.), formados por grandes ladrillos de tierra.

El hallazgo de los restos es importante sobre todo porque confirma la hipótesis de finales del siglo pasado (5), según la cual casi todas las construcciones civiles etruscas estaban hechas de tierra. De Tuscania pasamos a Lucania y precisamente a Elea (la moderna Velia). De esta colonia griego-iónica fundada por los focenses entre finales del siglo VI y la primera mitad del siglo V a.C., se conoce sobre todo la parte monumental de la Acrópolis. Pero en la zona casi llana, en la desembocadura del río Alento, los restos de la antigua instalación (aquella en la que enseñaron el filósofo Senófane y luego el mismo Parménides), muestran numerosos edificios civiles realizados en ladrillos de tierra (6). La técnica etrusca del ladrillo de tierra pasó directamente , como es sabido, a los constructores romanos. Es apenas el caso de recordar que buena parte de las habitaciones medio-bajas de Roma estaban construidas en pisé o en adobe (según Plinio y Varrone, el nombre de láteres indicaba exclusivamente los ladrillos de tierra) y que Octaviano Augusto en los años treinta a.C. se vanagloriaba de haber sustituido con piedras y mármoles aquellos barrios de Roma que habían sido construidos con arcilla cruda.

Más imponentes y de mayor impacto visivo son los tres ejemplos elegidos entre las murallas urbanas, que aquí describimos rápidamente:
En Gela, en la parte meridional de Sicilia , el general Corintio Timoleonte es obligado en el 340 a.C., a potenciar y a reparar las murallas de la ciudad, hechas con bloques de arenisca. La solución más rápida y económica fué la de subir las murallas (hoy quedan de ellas casi 350 metros, algunos puntos con una altura de más de 9 metros) con bloques de tierra de 40x40x8 cm.

Las murallas de Arezzo en Toscana , una de las más importantes de la confederación de doce ciudades etruscas, fueron construidas en el siglo III a.C. con ladrillos de unas dimensiones de 42x28x12 cm. de sólida arcilla roja; el examen de los restos de aquellas murallas dió lugar a la hipótesis que refiere la nota (5).

En Reghión, una de las más ricas colonias griegas de Italia meridional (la actual Reggio Calabria), el cerco de murallas urbanas tenía una longitud aproximada de 4 km en forma de anillo, con una parte de contacto con el mar y con otra opuesta sobre la llamada Colina de los Angeles, entre las cotas +100 y +200 . Hacia el final de los años sesenta fueron descubiertos y puestos a la luz más de 150 metros de la parte más alta de las murallas, datadas en el siglo III a.C.; éstas a diferencia del trecho hacia el mar, realizado con sólidos bloques de caliza, están realizados en ladrillos de tierra de unos 30x30x8 cm. Sobre uno de estos ladrillos por efecto del enarenado, se ha conservado afortunadamente una breve inscripción esgrafiada con el nombre del lugar PHΓIΩN (7)

Para terminar una curiosidad; justamente en el centro de Roma, durante las recientes excavaciones arqueológicas realizadas para liberar la Crypta Balbi, ha sido hallado y afortunadamente conservado un manufacto circular de unos 5,80 metros de diámetro y unos 4,00 metros de altura, posado directa - e inexplicablemente - sobre un mosaico de época romana; acerca de la fecha y de la función de esta singular estructura, realizada con sutiles y regulares ladrillos de arcilla clara y depurada. Los estudios se encuentran todavía en curso. Sin embargo, se puede atribuir la construcción a los siglos II o III de nuestra era. De los datos hasta ahora en nuestro poder podría individuarse el período antiguo más interesante, aquél etrusco y etrusco-romano, más o menos entre el V y el III siglo a.C. Acostumbrados como estamos a considerar la arquitectura etrusca ligada al uso de los bloques de toba o de nenfro o incluso a las obras excavadas, en negativo, en la roca; y aquella romana realizada en mármol, piedra o fuertes ladrillos cocidos, el estudio de una técnica tan diferente sería para nosotros de extrema importancia. Pero, por desgracia, de aquel período tenemos más citaciones literarias que testimonios concretos, más documentos que monumentos: la responsabilidad de tal hecho (y por consiguiente de la destrucción de muchos restos etruscos de tierra) recae en gran parte sobre la preparación académica de nuestros arqueólogos del siglo pasado (pero también de nuestros días...). Para ellos, un "monumento" era tal solamente, si estaba construido con materiales nobles, pues la atención científica que ellos prestaron a estructuras aparentemente inestables e informes fué muy escasa. El mismo fenómeno , por otra parte, se había verificado en los primeros tiempos en Oriente Medio, con la destrucción de aquellos que se confundían con pequeñas colinas de fango.

Esta es pues la situación en Italia; una situación que tiene que ser estudiada todavía en su totalidad, seguramente más rica y prometedora de cuanto se pueda imaginar. Pero se está llevando a cabo una furiosa lucha con el tiempo: por una parte nuestro deseo de descubrir, registrar, salvar; por otra el avanzar del cemento, el bienestar, el desinterés de las autoridades. Este último es el aspecto más preocupante del problema, no obstante el interés suscitado también en Italia en estos últimos años, las autoridades municipales y aquellas nacionales de tutela parece que no se dan cuenta que un patrimonio singular - no sólo aquel de valor histórico sino también aquel todavía hoy de uso normal y civil - está lentamente, pero inexorablemente yendo hacia la destrucción.

Termino aquí mi intervención pidiendo que en las recomendaciones finales del Convenio se haga un apelo explícito para la salvaguarda de todas las construcciones de tierra existentes en Italia.

NOTES

1. P. Vidal de la Blache, Principes de géographie humaine, (Paris: 1984).

2. O. Baldacci, "L'Ambiente geografico delle case di terra in Italia", Rivista Geografica Italiana, LXV (1958).

3. E. Galdieri, Le meraviglie dell'architettura in terra cruda, (Roma-Bari: 1982).

4. En particular, las Universidades de Pescara y Udine, y la Asociación "Later" de Roma. Una investigación de grande escala está también los futuros programas de la facultad de Ingeniería de Perugia.

5. G. Sordini, Vetulonia, Studi e Ricerche (Spoleto: 1984).

6. G. Greco, "Velia", Annali del Istituto Universitario Orientale di Napoli, IX (Napoli: 1987), 194.

7. F. Costabile, "Ricerche di topografia antica tra Motta S. Giovanni e Reggio Calabria", Rivista Storica Calabrese, n.s., anno I, nn. 1-2 (Reggio Calabria: 1980).

ABSTRACT

The use of adobe has had a long tradition in the arid regions of the American Southwest. The evolution of this tradition from 1848 to 1948 has produced three distinct construction systems (Indigenous, Victorian and Revival) and has left behind a wide variety of historical resources. Deterioration of adobe resources is often related to the misapplication of construction principles from one of these systems to another. The conservator of adobe buildings must understand the basic nature of these systems, the problems which arise when they are combined and how to approach preservation interventions by impacting the least significant element.

KEY WORDS

ADOBE CONSTRUCTION SYSTEMS
DETERIORATION INTERACTION
CONSERVATION PRINCIPLES
EARTHEN ARCHITECTURE

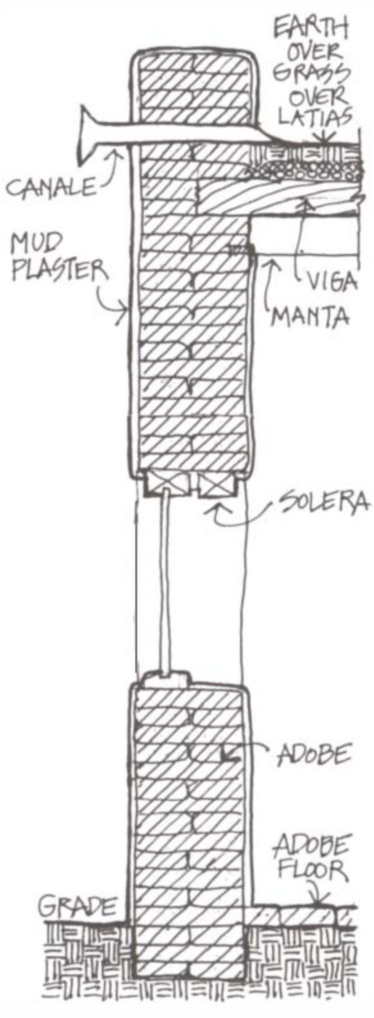


Figure 1
The Indigenous System
(1848-1881)

THE EVOLUTION OF ADOBE CONSTRUCTION SYSTEMS IN THE SOUTHWEST (USA) AND RELATED CONSERVATION ISSUES.

James W. Garrison, Historical Architect
JANUS ASSOCIATES INCORPORATED
602 North 7th Street
Phoenix, AZ 85006
U.S.A.

Introduction

With the signing of the Treaty of Guadalupe-Hidalgo in 1848 and the completion of the Gadsden Purchase in 1853, that area now known as the American Southwest came under the control of the United States. Imprinted over the natural topography of the region and the earlier Native American, Spanish Colonial and Mexican cultural traditions came American settlement patterns and architectural development. Adobe as a primary building material has had a long tradition within this pattern of regional development. Evolutionary in nature, the wide variety of adobe resources can be classified into three basic systems of construction: Indigenous (1848-1881), Victorian (1882-1914), and Revival (1915-1948). The timing of the primary use of each of these systems is tied to the development of the region's transportation, and industrial infrastructure. As the cultural acceptance of adobe rose and fell within this evolution the transition from one construction system to the next occurred. It is important to remember that each of these unique systems was balanced in its use of materials, detailing and method of reaction to the causes of deterioration.

Today many adobe resources constructed between 1848 and 1948 are considered historically or architecturally significant. At the same time most of these resources have undergone additions, repairs and rehabilitation measures; many times mixing together the three basic systems of construction. Conservation measures undertaken today on historic adobes must consider the basic nature of these construction systems and the significance of each building feature.

Historic Adobe Construction Systems in the Southwest

From 1848 to 1948 three separate adobe construction systems evolved in the American Southwest; the Indigenous System (1848-1881), the Victorian System (1882-1914) and the Revival System (1915-1948). Each of these systems is described below.

The Indigenous System (See Figure 1)

The Indigenous System of Construction, derived from Native American, Spanish Colonial, and Mexican Influences, maximizes the use of earth throughout the building. Thick adobe walls (46 to 61 cm/18 to 24 inches) rise directly from shallow trenches. Openings are small and framed with local wood lintels. Simple doors are usually batten while windows have shutters only. Floors are packed earth or adobe pavers. Roofs are flat having packed earth over a simple system of log beams (vigas) branches (latillas) and straw (or grass). Rainwater runs off the roof through wood or metal drains (canales). High ceilings ($\pm$ 4.27 m/14 feet) might have muslin linings (mantas). Fireplaces are usually of a bee-hive style, located in a corner of the room and built entirely of adobe. Walls are rendered inside and out with mud plaster similar to the adobes.

This system of construction reacts to storms like a sponge. The earthen materials soak up the rain water during intense downpours and dry out over a number of hours. Leaks were not uncommon but easily repaired. Maintenance was required more often but was simple in execution. The massive walls and small openings also tempered the hot-arid climate.

Although virtually every community developed its own variations of this system based upon the local climate, types of plants and trees available and the traditions of local craftsman; the basic approach, applying site-formed adobes with locally cut wood and branches, was constant. Details often varied by location with wood canales in many parts of New Mexico and metal canales in many parts of Arizona. In Tucson latillas were often made of Saguaro cactus ribs while in Yuma they used Arrowweed.

The Victorian System (See Figure 2)

As the U.S. Military established camps, posts and forts in the southwest and as railroads were constructed, Victorian age industrial products and processes arrived in the region. Two industrial structures changed the method of constructing adobe buildings, the sawmill and the limekiln. Using dimensioned lumber in place of logs and branches and lime as an exterior coating, adobe structures needed less maintenance. They could also pass as more traditional brick or stone Victorian structures through the use of gingerbread wood detailing and scoring of the lime stucco.

The Victorian Construction System of adobe retains the basic thick adobe walls, but they are constructed on continuous stone foundations. These foundations were used for two reasons; first, to reduce the potential for rising damp and, second, to support wood framed floors above an adequate crawl space. Windows have larger Victorian proportions with simple wood casement or double-hung windows. Lintels and casings are of dimensioned lumber. Doors are usually four panels with moldings. Rafters and ceiling joists are usually 5x10 cm (2x4 in) with spacing as wide as 76 cm (32 in) on center. Wood shingles are supported on 2.5x5 cm (1x4 in) spaced sheathing. Rain water falls directly from moderate eaves or is channelled away from the building through half-round gutters and round downspouts. Ceilings may still be cloth or 2.5x5 cm (1x4 cm) beaded tongue and groove fir or pine, but have been lowered 61 to 122 cm (2 to 4 ft).

Exterior walls are rendered with smooth lime plaster applied directly to the scored or raked adobe surface. The lime stucco is usually whitewashed and is often scored as stone or brick. Lime is also used for mortar in the stone foundation. Lime is rarely used as adobe mortar. Interior walls remain plastered with mud and either wallpapered or limewashed. Simple wood jigsaw details or moldings are often used. Metal is limited to hinges, hardware, fasteners, square nails (pre 1890) and anchor bolts. Fireplaces are most often constructed of fired common red brick, with midwall placement and detailed with Victorian mantels and overmantels.

The Victorian adobe also has many design variations. In New Mexico adobes with flat roofs and Victorian detailing are referred to as "Territorial" designs while in Arizona this term is most often applied to houses with square plans and pyramidal roofs. Stylistically most designs follow Gothic Revival, Queen Anne or Colonial Revival trends. The most visual change during this period is the shift from property line row house site placement to discrete detached and often set back site placement. Fired red brick is often found combined with adobe. It can be found in fireplaces, at openings, and along parapets as copings.

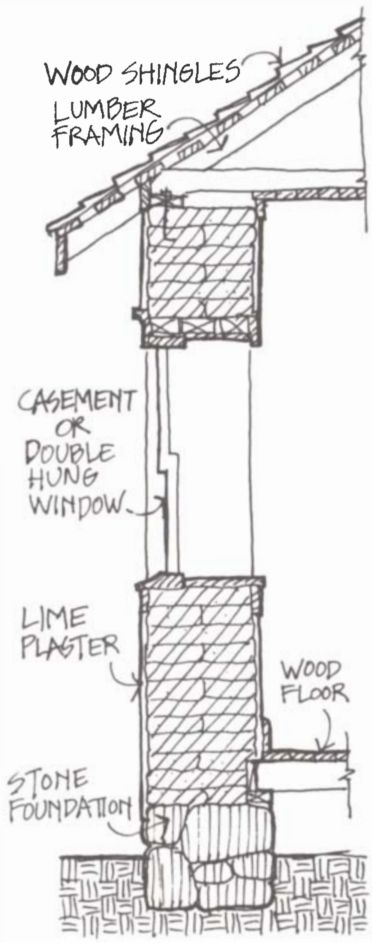


Figure 2
The Victorian System
(1882-1914)

The Revival System (See Figure 3)

When the settlers in the Southwest finally realized that sudo-Victorian designs from the East lacked regional climatic and cultural appropriateness, they spent a good deal of time looking at the Indigenous examples to develope Mission, Spanish Colonial and Pueblo Revival Architecture. Although based upon earlier examples these new designs are contemporary in function and construction method. Adobe, primarily found in Pueblo Revival buildings, is now found combined with Portland cement concrete and steel components.

The thick adobe walls are thinned to 25 or 30 cm (10 or 12 in). The natural sun-dried adobes are difficult to see, being totally encased in concrete. Reinforced concrete foundations are topped by a "damp proof course" of bitumen or metal. The adobes rise to concrete sills, steel lintels and reinforced concrete bond beams. The walls are plastered inside and out with Portland cement stucco attached to chicken wire or wire lath with nails driven into the adobe. Floors are also constructed of concrete using the "slab on grade" method. The slabs are often topped with very hard tinted and/or scored concrete. Windows feature steel sash usually using casement styles. Corner windows are used sparingly. Doors are most often batten with rustic wrought iron hardware and face mounted hinges.

The roofs are structured with telephone pole beams, heavy timber decking and composition built-up flat roofs behind parapets. Ceilings may be plastered or left natural wood. Mud mortar is still preferred when laying the adobes. Rounded corners, arched doorways and recessed nitches are often found. Fireplaces are more rustic but found in both corner and mid wall locations. Many buildings constructed during this time period are stylistically tied to earlier adobe styles, but have no actual adobes in them, being replaced by fired red brick or cast-in-place concrete.

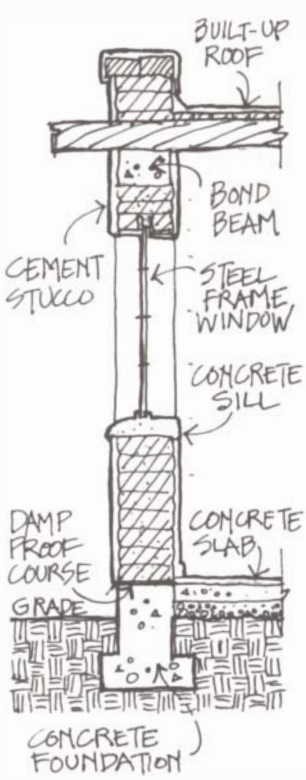


Figure 3
The Revival System
(1915-1948)

Deterioration Problems

It is important to fully understand how each of these discrete adobe systems was designed to react to the causes of deterioration and therefore the weaknesses in their design. But it is also important to realize that through time, repairs can have been made to adobes designed under one system with materials and techniques from another. The haphazard combination of construction systems has, in many cases, led to accelerated deterioration problems. At the same time combined elements may have become historically significant and therefore require unique preservation treatments in order to preserve incompatible details and materials together. A prime example of this process was the Victorianization of many of The Spanish Colonial churches in New Mexico. Currently many Victorian features, many over 100 years old are being removed for "aesthetic purity", without documented historical justification. The main deterioration problems of each system of construction and combinations of systems are described below.

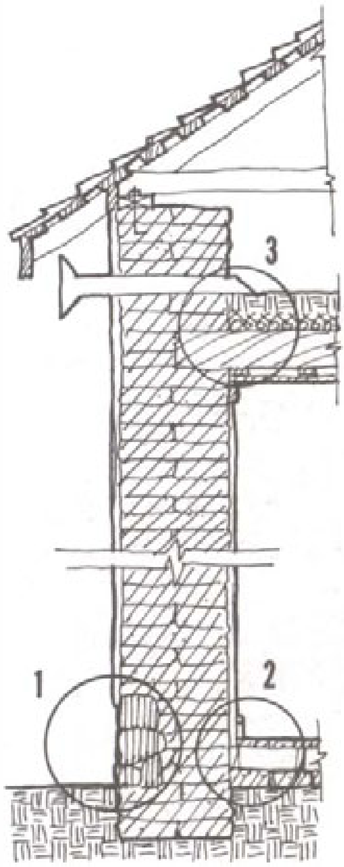


Figure 4
Indigenous/Victorian
Combination Problems

Indigenous System Deterioration Problems

1. Base wall erosion, caused from rising damp because the adobes extend directly into the ground.

2. Surface erosion and/or coating failure, caused by lack of maintenance.

3. Cracks or leaning walls, caused by ground movement and lack of any substantial foundation.

Victorian System Deterioration Problems

1. Base wall erosion, caused by the use of porous stone (sandstone or limestone) for the foundation, which allows rising damp.

2. Surface coating failure, caused by lack of a mechanical key between the lime plaster and the adobe.

3. Cracks or leaning caused by differential settlement of the stone foundation, or improper triangulation of the roof framing system.

Revival System Deterioration Problems

1. Moisture build-up in the adobes, caused by lack of a damp-proof course, cracks in the concrete stucco, or lack of proper roof drainage.

2. Surface coating failure, caused by the corrosion and rusting of metal elements including chicken wire, wire lath, nails and reinforcing bars.

3. Cracks, caused by the difference in expansion coeffencients between concrete and adobe.

4. Rotting of viga ends and other wooden elements, caused by the trapping of moisture behind the concrete stucco.

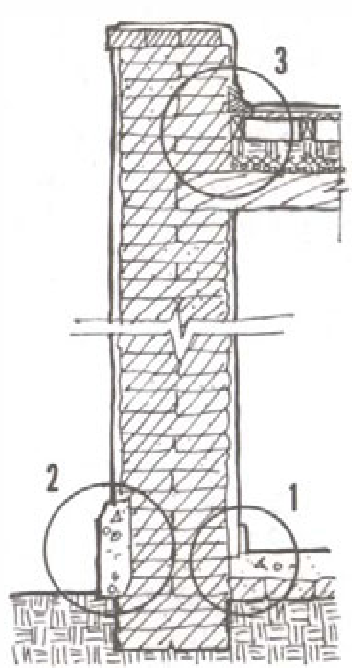


Figure 5
Indigenous/Revival
Combination Problems

Indigenous/Victorian Combination Problems (See Figure 4)

1. Stones used to repair base wall erosion rarely extend completely through the wall allowing rising damp to rise higher.

2. Wooden floors are installed directly on earlier earthen floors with little or no crawl space.

3. Frame gable roofs over earlier dirt roofs allow for potential increase in damage from insect or moisture damage to vigas and latillas by hiding formerly open areas.

Indigenous/Revival Combination Problems (See Figure 5)

1. Concrete floors poured into rooms over dirt floors force ground moisture into the surrounding adobe walls.

2. Concrete aprons or boots also trap ground moisture into the surrounding adobe walls.

3. Framed roofs over dirt roofs hide moisture and insect problems.

Victorian/Revival Combination Problems

1. Concrete floor slabs, often used for porches, allow moisture to build-up in the base of the walls.

2. Changing the surface coating to cement stucco increases damaged from nails and chicken wire corrosion and traps moisture in the walls.

3. Removing Victorian roof framing to create a flat roof causes a significent loss of historic fabric.

4. Placing mission tile on Victorian roof framing can severely overload the structural members sized for wood shingles.

Conservation Principles

When working on an historic adobe building the following principles should be followed:

1. Document all existing conditions especially the evidence and the sources of deterioration. Cosmetic repairs should be avoided.

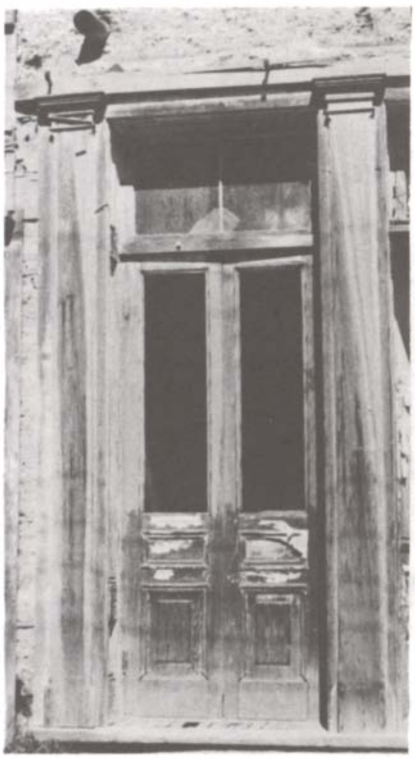
2. Fully understand the primary method of construction. Analyze both the materials used as well as all original details (ie. floor to wall connections, roof to wall connections, wall to opening connections, and wall to foundation connections.)

3. Evaluate the significance of all building elements. Based upon chronology, artistic value or historical association define which elements should be treated with the greatest sensitivity and highest conservation standards.

4. Make repairs based upon the primary method of construction. Avoid using hard materials to preserve soft materials. Remove as much concrete as possible from Indigenous or Victorian adobes. Explore the use of lime as a compromising measure on either Indigenous or Revival adobes.

5. Preserve and maintain the existing conditions, unless a less significant element is damaging a more significant element, then impact the less significant element.

6. Make repairs that are reversible wherever possible. The wrong intervention can often not be corrected by the next conservator.



Detail of a Victorian Adobe
TOMBSTONE, ARIZONA
Janus Associates Inc.

Conclusion

Many times the focus of adobe conservation is placed upon the material itself and those mechanical and chemical properties which cause the material to deteriorate. The focus of the above discussion has been to place adobe within a construction system or context, specifically three historic construction systems found in the Southwestern region of the United States. By understanding the nature of each system as well as their individual materials the conservator can make appropriate intervention decisions; and thereby, preserve adobe in its natural, original, aesthetic state.

ABSTRACT

From time immemorial, clay has played an important role in the building of houses in Germany. Its greatest importance lay in its utilisation as infilling material for walls and ceilings, for laying floors and as mortar. All of these techniques were common until the nineteenth century and were still occasionally employed in the twentieth century. Solid ("monolithic") clay structures, that is, buildings with load-bearing walls consisting only of clay, without timber or stone, have been in existence in Germany since the Middle Ages. Their number is considerably larger than had formerly been assumed and they are formally and technically interesting buildings. Few of these buildings have been placed under protection as historic monuments because the peculiarities of this building technique are on the whole unknown. There have been many attempts in Germany to revive clay architecture. The most important reasons for the use of clay as a building material were its incombustibility and the saving of wood and energy.

KEYWORDS

Clay architecture; Architectural history; Building techniques; Propagation of the use of clay as building material; Utopian architecture.

Fig. 1 Depicts a rammed-earth house.
(" Representat domum ex argilla contusam." Drawing by Ludovicus Reischl, Wien, 1780). [7]

ON THE HISTORY OF CLAY BUILDINGS IN GERMANY

Jochen Georg Güntzel
Department of Architecture and Interior Design
Fachhochschule Lippe
D-4930 Detmold, Bielefelderstraße 66
Federal Republic of Germany

Next to timber and stone, clay has been the most important building material used in Germany. It served as infilling material for walls and ceilings, as a sealant for crevices in log cabins, and was used for the construction of floors, vaults and ovens.

Most certainly, clay´s greatest importance lay in the realm of timber-framed buildings ("Fachwerkbau", see fig. 2) where it was used as a filling material. Incidentally, this type of work (daubing) was nearly always done by the owner himself, or with the help of his neighbours, and it is for this reason that it never developed into a professional craft and consequently seldom enjoyed high status.

However, this paper does not need to address the uses of clay in timber-framed architecture: The number of publications on this subject, always the favourite child of building historians and ethnologists, is legion. The problems of the restoration of framed buildings are not nearly as great as those of solid clay structures, since the framework of these buildings, the "primary structure" ("Primärstruktur"), is of timber. Instead this paper will focus on the history of solid ("monolithic") clay structures in Germany, in particular those buildings whose supporting walls consist solely of solid clay (See figs. 1, 3 and 4). Until recently, little was known about the history of these edifices, the special techniques used in their construction, their advantages and disadvantages, their number and the areas of their distribution. On the contrary, a great many misconceptions and prejudices about them are in existence. One can indeed maintain that there have been few types of architecture in the course of German history about which so many falsehoods have been propagated.

If a German art historian, architect or curator of public buildings were asked if he knew of any solid clay structures in Germany he would probably be unable even to name a few, let alone correctly to differentiate between the various building techniques. He is not likely to know the age and geographical distribution of these buildings or conditions of their construction. Yet the sheer number of them is impressive. It has been estimated that the solid clay structures in Germany originating in the eighteenth and nineteenth centuries number in tens of thousands and that those built in the twentieth century number somewhere between 30,000 and 40,000. Yet in Germany much more is known about clay structures in Africa, America or Asia. It is, after all, vastly more interesting--as the saying goes--to sweep in front of your neighbour´s door than in front of your own.

It is probable that the technique of building with solid clay has been used in Germany since the early Middle Ages: Several buildings excavated and dated by archaeologists were possibly constructed as early as the eighth or ninth century. However, it is also possible that these buildings date from a later medieval period; the archaeological evidence is unfortunately not always easy to interpret. In any case, more important than the question of exactly how long these solid clay structures have been in existence is the question of why it was decided to build in solid clay. Did this material make for more comfortable living quarters? Was it because clay was a safeguard against fire? Or did solid clay houses afford the owner higher prestige? Lack of timber was certainly not the reason, as this material was still abundantly available during the Middle Ages.

The oldest known buildings are in Saxony and Thuringia, where most existing clay buildings are to be found even today. When this type of construction aroused interest in the eighteenth century, it was reported to be very old even then, and one hundred- or two hundred-year-old buildings were not in the least a rarity.

Fortunately, there exists a very old written reference which we can use as evidence for this piece of research. Today we would call it a detective story. A peasant from a village near Leipzig testified in 1560 that the clay walls of his granary had been dug through for the purpose of stealing grain. He expressly referred to the thickness of his granary walls: they were one and a half ells thick, i.e. 87 cm [1]. Therefore we are certainly dealing with a solid clay wall, not a timber-framed one, which normally has a thickness of only about 20 cm.

The first solid clay structures were built of clay mixed in its wet state with plant material and then laid in several layers with pitchforks. Sometimes the walls were formed with the aid of a shuttering, although the clay was not rammed (the method used with the "pisé technique"). After drying, the walls were smoothed. This technique is well known in many countries of the world; in Great Britain it is usually called "cob". In England this type of building has been intensively studied [2]. There are a number of handsome cob buildings, such as the birthplace of Sir Walter Raleigh who pioneered the first (unsuccessful) English settlement on the coast of North America at Roanoke in 1585. Captain Cook (born 1728) is also reputed to have been born in a clay cottage. The latter is no longer in existence in situ: According to my information it has been transported to Melbourne, Australia. In addition to this "cob" technique, there were buildings constructed of unfired clay bricks called "clay lumps", made of clay mixed with straw, what in America is mostly called adobe (See fig. 3).

Fig. 2 Depicts a timber-framed house. ("Representat domum ex viminibus contextam." Drawing by Ludovicus Reischl, Wien, 1780). [7]

In Saxony and Thuringia the authorities began to express interest in this type of construction at a relatively early date. The motives for this interest are understandable as it offered a safeguard against fire in the city and the country (most buildings were very much endangered because of their thatched roofs, timber ceilings, etc.). One was also concerned with reducing the amount of wood used [3].

Since it is important to clarify this motive of limiting the use of wood, let me digress for a moment. I shall not lose sight of my goal, which is the exploration of the history of clay architecture.

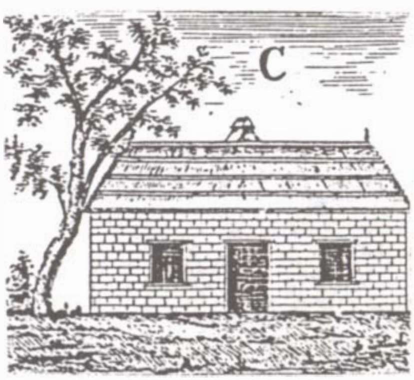


Fig. 3 Depicts a house built of unfired bricks ("Representat domum ex tegulis incoctis constructam." Drawing by Ludovicus Reischl, Wien 1780). [7]

Originally, the forest and its produce belonged to everyone in common. With increasing population and the claims of the nobility and clergy to more exclusive rights to the woods, the consumption of firewood and timber for building constantly increased. Until 1800, the consumption of wood in thickly populated areas was extraordinarily high due to the fact that it was practically the only fuel used in household heating, cooking and industry before coal became available. in quantity. Correspondingly, it was used in ever-increasing amounts in areas of growing industrial development. Many wooded areas were ruthlessly plundered and degenerated into heaths. This was true not only of the forests in densely populated areas, but also of the woodlands from which timber could be transported with relative ease, e.g., by raft. An immense amount of timber was used for the construction of commercial vessels and warships. For example in the eighteenth century about 2,000 oak trees were needed for a man of war of 64 guns. It was reported that rafts of immense proportions were floated down the Rhine and the Elbe. Gradually people were faced with an ecological catastrophe (had they known and used this term at that time), the depletion of wood supply. The danger was that soon there would be no more trees and the forest would be unable to fulfill its function of regulating the climate.

In Saxony, which had several industrially developed areas, the authorities tried to limit the use of wood as early as the end of the sixteenth century. Local ordinances permitted the use of timber for new buildings only if it was demonstrably impossible to construct them of clay. Other rulers of territories issued similar regulations, but often not until 200 years later.

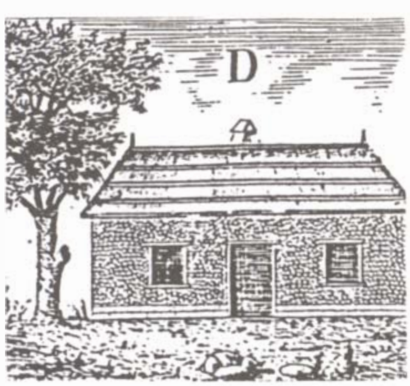


Fig. 4 Depicts a house built of wet clay lumps.("Representat domum ex glebis argillaceis confectam." Drawing by Ludovicus Reischl, Wien, 1780). [7]

A special feature of clay architecture in Germany, as opposed to those of her neighbours, is the fact that clay was assigned a particular role at the turn of the nineteenth century. Individuals as well as groups (notably the agricultural societies), were enthusiastic about this building material and praised it almost euphorically as being the one and only material suitable for the improvement of building technique. At the same time it was believed that clay could be utilized for the promotion and improvement of public housing. Thus the writings of Cointeraux describing the rammed earth technique became better known in Germany (and also in Switzerland, Denmark, and England) and received more attention in these countries than in the author's native France.

A girl moistening the clay.

(So called "Dünner-method", a method developed in the nineteen twenties). [6]

The first printed work on solid clay architecture identified by the present author was published anonymously in 1736 as a simple kind of pamphlet. It was a propaganda piece of sorts praising the virtues of solid clay architecture as an ideal method of improving the fire resistance of buildings. The author of this pamphlet was in all likelihood an architect by the name of Richter, who was prevented by illness from practicing his profession and therefore had the leisure to write little articles embellished with drawings on the improvement of daily life (see fig. 5). He had these printed at his own expense and distributed them among his friends. In his article on the "fireproof farmhouse," Richter suggested methods which must have been extremely radical for his day and age, and they have been propagated and put into practice on a large scale only in the present day. Richter not only suggested the use of solid clay wall and pillars instead of the usual timber-framing of his time, he went one step further: In order to avoid having even a flammable roof of wooden beams and thatching, he suggested that the farmhouse be vaulted. In addition, on top of the vault there was to be spread a layer of clay and soil, about one metre deep, which could be used for planting. Richter had also conceived an ingenious plan to make this roof garden accessible: A spiral stairway around a central newel, on top of which sat a cone-shaped hood which could be lowered to cover the stair-well in inclement weather.

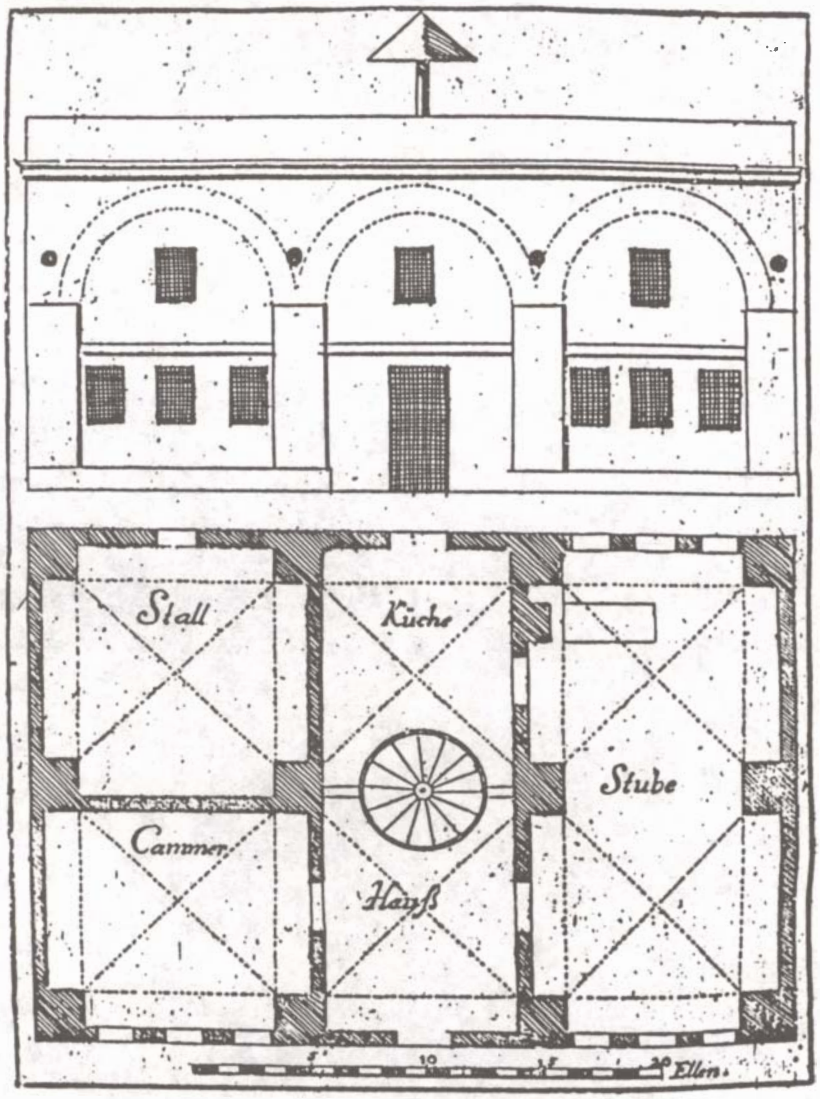


Fig. 5. Floor plan and elevation of a "fireproof farmhouse", as planned by the Saxon architect Richter in 1736. Walls and pillars were to be made of solid clay, the vaults of stone. The roof area was to be filled to a level of about one metre with clay and fertile soil and planted as a garden. The cone-shaped roof to the circular stairway was to have been mounted on the newel of a spiral staircase and could be lowered in inclement weather. [3] (Stube = lounge; Hauß = hall; Cammer = chamber; Stall = stable; Küche = kitchen).

Children helping to mix the clay by stamping it with their feet.

(So called "Dünner-method", a method developed in the nineteen twenties). [6]

This theoretical contribution of the Saxon Richter to the advancement of architecture is extraordinarily significant: The dwelling of man, who can only then justifiably be called "homo sapiens" when he is part of God´s creative order, is to be built mainly of clay. Clay structures need little energy for their construction; they are fire-resistant and enduring; and when they deteriorate they can also be creatively incorporated in the natural cycle of growth and decay. Seen from this point of view using the roof as a garden is also logical, since the land which is lost by construction of the building can be reclaimed as fertile land.

During the following decades many more suggestions were made for the improvement of architecture and housing with the aid of clay, but none went beyond those of Richter.

In her essay "Telling Lives: The Biographer´s Art" [4], the historian Barbara Tuchman states that biographies can arouse and grip the reader´s attention in major historical themes, since people are interested in other people and since the biographical form can illuminate general truths by means of the particular. What follows are a few biographical details meant to acquaint the reader with some ideas of certain little known thinkers and architects. In doing this, I have purposely chosen those thinkers and builders who are scarcely known today.

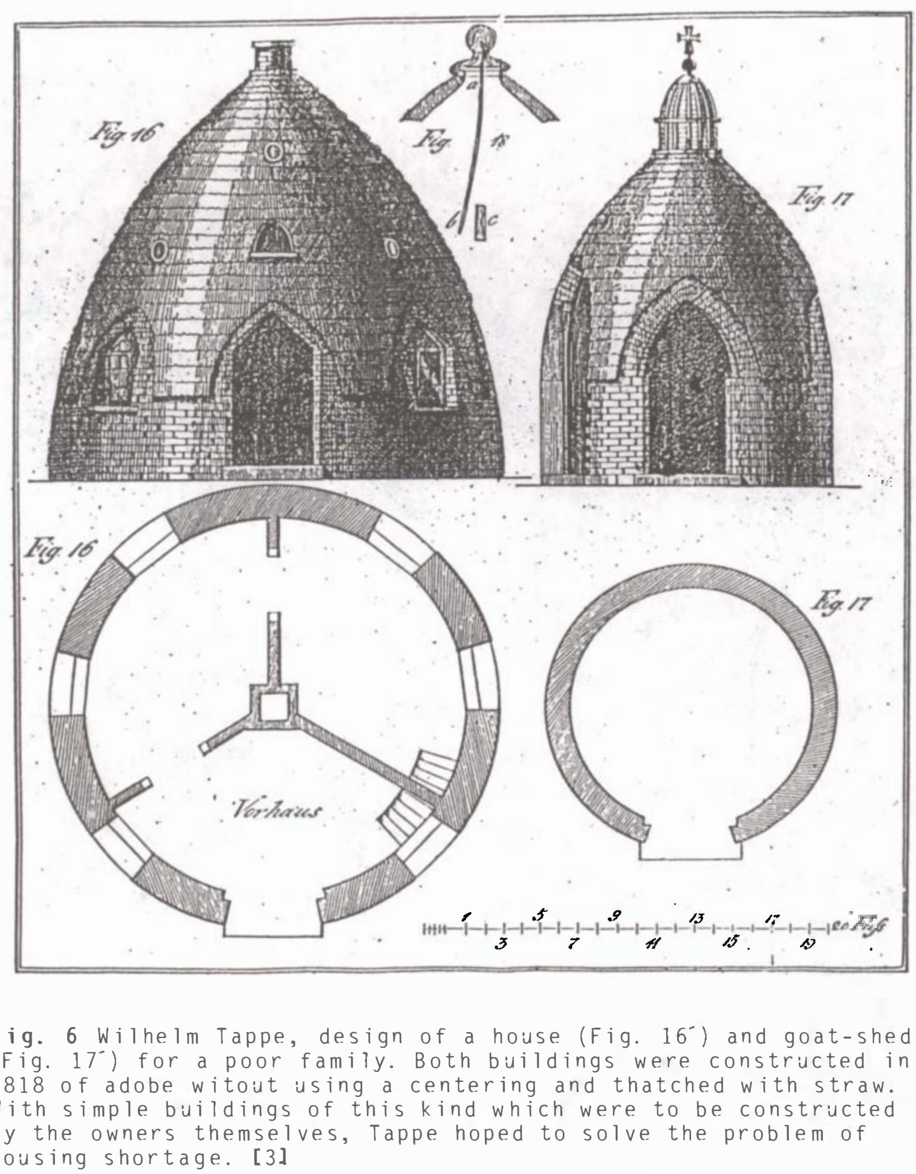


Fig. 6 Wilhelm Tappe, design of a house (Fig. 16´) and goat-shed (Fig. 17´) for a poor family. Both buildings were constructed in 1818 of adobe witout using a centering and thatched with straw. With simple buildings of this kind which were to be constructed by the owners themselves, Tappe hoped to solve the problem of housing shortage. [3]

Children helping to carry clay-loaves.

(So called "Dünner-method", a method developed in the nineteen twenties). [6]

One of those who was not well known in his own day and is practically unknown today, is Wilhelm Tappe (1769 to 1823). Tappe, a nineteenth century architectural theorist, artist, architect and poet, desired to set amazing things in motion with clay, that very economical building material. Above all, he hoped to solve the housing problems of the lower classes.

We know very little about Tappe´s training and development, mainly because a large part of his writings and designs are lost. Only a few of his printed works, which he had published at his own expense and of which he sold only a small number, are still in existence. He began his career as advertising expert and industrial designer and then became a teacher and inspector of draughtmanship in the schools. He later turned his attention to the field of architecture. It is impossible to establish with any certainty whether he had practical training or an academic and theoretical education.

From 1813 to 1819 Tappe was the chief architect of the small principality of Lippe, where he found a patroness in the person of Princess Pauline, a very progressive personality and one dedicated to the social welfare of her subjects. For example, she founded the first day-care center for poor children in 1802. It was here that he developed his unusual ideas for solving the pressing housing problems of his age. These ideas should have assured him a place among the most innovative thinkers in the realm of architecture, but he was simply forgotten. He wrote two books on historic buildings in the city of Soest, thus presenting us with the very first inventory of historic monuments in Westphalia. In addition he composed an ode to architecture ("Lied von der Baukunst").

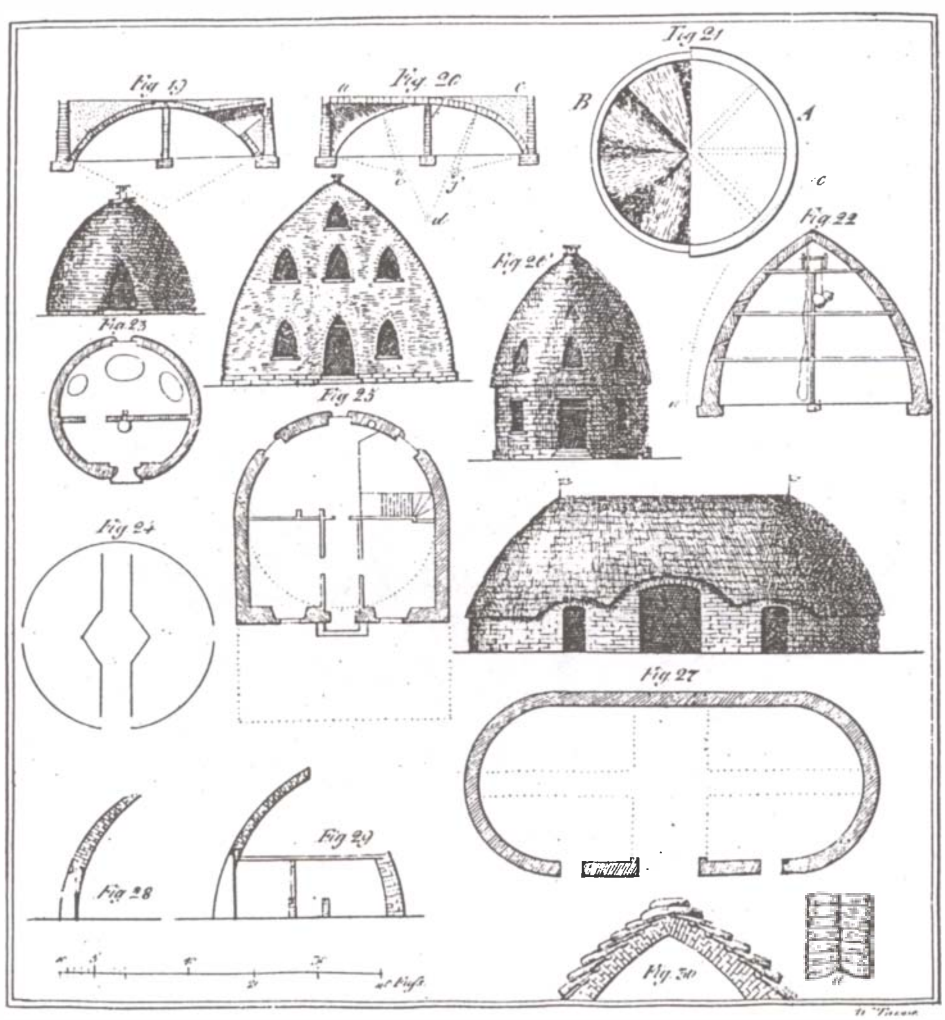


Fig. 7 Wilhelm Tappe´s designs for various buildings derived from the basic "hut shape". Cross-section of a granary with a pulley for grain sacks (Fig. 22´). Floor plan and a facade of a barn (Fig. 27´), living and working quarters for day-labourers (Fig. 25´), and a bath-house with three iron bathtubes (Fig. 23´). This structure (with heated anteroom) was very progressive for that time, as bathing was then considered to be reprehensible.

Women forming clay-loaves on a table.

(So called "Dünner-method", a method developed in the nineteen twenties). [6]

The extraordinary thing about Tappe´s ideas was that, unlike those of his contemporaries, they were not limited to the development of methods by which individual parts of a house, walls, ceilings, roofing, etc., could be replaced by the cheap and incombustible building material clay. Rather, he made the radical suggestion of having a circular floor plan and of making the houses dome-shaped, like half an egg, and of building them entirely of sod, turf or clay (see fig. 6). He decided on the round floor plan for aesthetic and economic reasons, and the dome shape because of its stability and endurance. The prototypes which he developed and--rather unhappily--named "huts", were adapted from almost forgotten architectural archetypes and were intended to solve the housing problems of the poorer classes. The houses could be built by the owner with the help of neighbours and with a minimum of expense, that is, without employing a professional craftsman. He had designed the shape and size in such a way that the vault could be constructed without a centering; he also developed an ingenious model for checking the vault´s shape.

Tappe had the opportunity of having one of his models actually built. The construction of the first adobe hut, which resembled a beehive with its straw thatching, was a veritable sensation. Curiosity seekers came from miles around. Unfortunately the building could be admired for only four years, as it had to be demolished because of permanent damage caused by dampness. The use of straw for thatching the roof proved to be completely inadequate because it could not dry and consequently rotted. Because of the curved shape, water had run into the wall openings and damaged the base. For this very reason it is said in England that clay houses should have a "broad-brimmed hat and dry feet". Another of his dome-shaped buildings made of adobe, a mill near a brook, survived for several decades. Here, tiles had wisely been used on the roof.

In his next seven booklets Tappe waxed ever more enthusiastic about the elliptical shape of buildings. He presented suggestions for the construction of churches, barracks, entire neighbourhoods, bridges, monuments and light-houses in this form (see fig. 7). These were, however, unlike the "hut" of the poor, to be built of stone and not of clay.

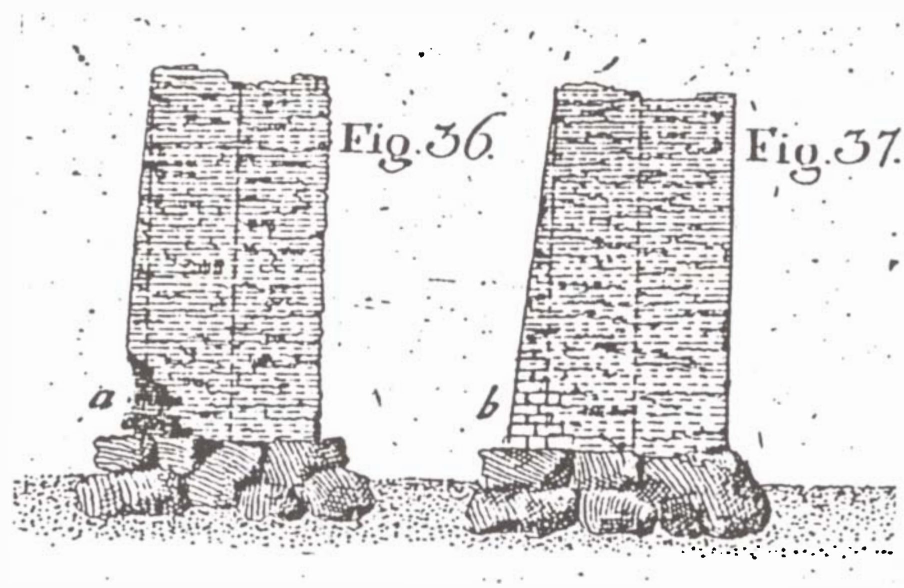


Fig. 8 Cross-section of the exterior wall of a cob building. As all of the participants of "Adobe 90" know, an important rule has been violated: The base should have been high enough to prevent water from splashing onto the vulnerable clay.
(Drawing by Joh. Gottfr. Lange, Breslau, 1779). [3]

Plastering a wall made of clay-loaves.

(So called "Dünner-method", a method developed in the nineteen twenties). [6]

Another innovative brain among those who euphorically praised clay as a means of improving the usual type of architecture, was that of the physician Christoph Bernhard Faust (1755-1842) one of the leading hygienists of the nineteenth century. Faust made a number of meaningful suggestions which--had they been consistently put into use--would have made some of the oral and written contributions to "Adobe 90" superfluous. For example, in an age in which this was by no means usual, he advised using two layers of impermeable tiles, glued together with pitch, as a horizontal barrier against rising moisture in the walls of buildings. In addition he suggested dissipating damp vapours rising from the earth by means of horizontal and vertical shafts in the walls. His idea of orientating the house to take the best possible advantage of the sunlight, of using double windows and doors, and of calculating the thickness of the walls so as to waste as little energy as possible make him one of the co-founders of the concept of the "Zero Energy House". The solar energy stored in the solid clay walls was to be used to raise flowers and fruit.

I am coming to the end of my article without having quoted anything from Vitruvius or Francois Cointeraux. And indeed, this is something that one could expect to read in a paper dealing with architecture in general and clay architecture in particular. It should be mentioned that in Renaissance Germany Vitruvius' comments on clay bricks were thoroughly misunderstood, because--and this is true even in the present day--several translators wrongly confused fired bricks with (unfired) adobe. In this way the use of clay was brought into discredit, in some cases perhaps even intentionally. The writings of the French architect Cointeraux, which recommended the ramming method and in general strongly contributed to the advancement of clay architecture, were probably read with greater interest in Germany and neighbouring countries than they were in France. Within the space of a few years, several translations and adaptations appeared. For several decades, pisé de terre was the fashionable technique. However, many of the buildings erected were for purposes of testing and demonstration.

In Germany, the man who, under the influence of Cointeraux, built the most enterprising rammed-earth structures was Jacob Wimpf (born 1767). Like many others who were enthusiastic about this method, he was not a professional builder but a lawyer and factory owner. Indeed, he had all of his factory buildings, some of which were of very respectable size, built of rammed earth because he recognized that clay walls were superior to stone in regard to such factors as thermal insulation and room climate. In 1837 he constructed the tallest clay building in Germany. It is a multiple-family dwelling in Weilburg, built on a steep mountainside (see fig. 9). There are three storeys on the side facing the mountain and five on the side facing the valley. This house still looks as if it had been built only a short time ago.

It has remained the tallest clay structure in Germany; later on the building authorities ruled to restrict clay buildings to one and two storeys. About 1970 the regulations governing clay architecture were withdrawn, so that today solid clay architecture is no longer permitted. And this after some 100,000 to 200,000 clay buildings, erected without any official regulations, had proven their worth! Jacob Wimpf had, in addition, a very special faith in the rammed earth method. To him is attributed the statement "... I would dare to build a tower as high as the Straßburg Minster (142 m). The cohesion which the earth receives through this method of ramming is far greater than that of a stone wall." [3]

Wimpf also believed that living conditions in the New World could be improved if immigrants brought their knowledge of building with clay to their new homeland. What he did not know was that in 1806 an American or British citizen named S.W. Johnson in New Brunswick, New York, had concerned himself with the advancement of clay architecture and dedicated his publication to the American President who was himself a talented architect, Thomas Jefferson. [5]

In the nineteenth century, when Germany was evolving from an agricultural to an industrial society, solid clay architecture as well as timber-framed architecture was gradually replaced by (fired) brick buildings. After the First World War, when the scarcity of energy and transport caused a renewal of interest in this building material which could be obtained and processed practically without fuel, there were hardly any people left who were conversant with the techniques of its use. Nonetheless, many thousands of buildings were erected during this time. After the devastation of the Second World War, clay was used in the construction of about 30,000 to 40,000 buildings. Unfortunately, this type of architecture was considered old-fashioned and inferior because hardly anyone was willing to consider its special qualities. It is necessary to revise this judgement. Now that we have recognised that clay is part of the natural life cycle and can be obtained and processed without wasting energy, there has been a revival of interest in clay building in Germany during the past few years.

The forming of clay-loaves.

(So called "Dünner-method", a method developed in the nineteen twenties). [6]

Conclusions

Clay architecture had a much greater significance in Germany than has previously been assumed. Its greatest importance, however, is to be found not in the structures themselves, but rather in the innovative impulses issuing from the buildings and the literature concerning them.

As a glance at their history will reveal, the opportunities offered by the use of clay in building have by no means been exhausted. If we succeed in abolishing all the well-tended prejudices which exist regarding its use in architecture, then we will have the best chance of creating those conditions necessary for the preservation of numerous historic buildings in Germany, ranging from the dwellings of the humble cottagers up to the level of palaces of the ruling class.

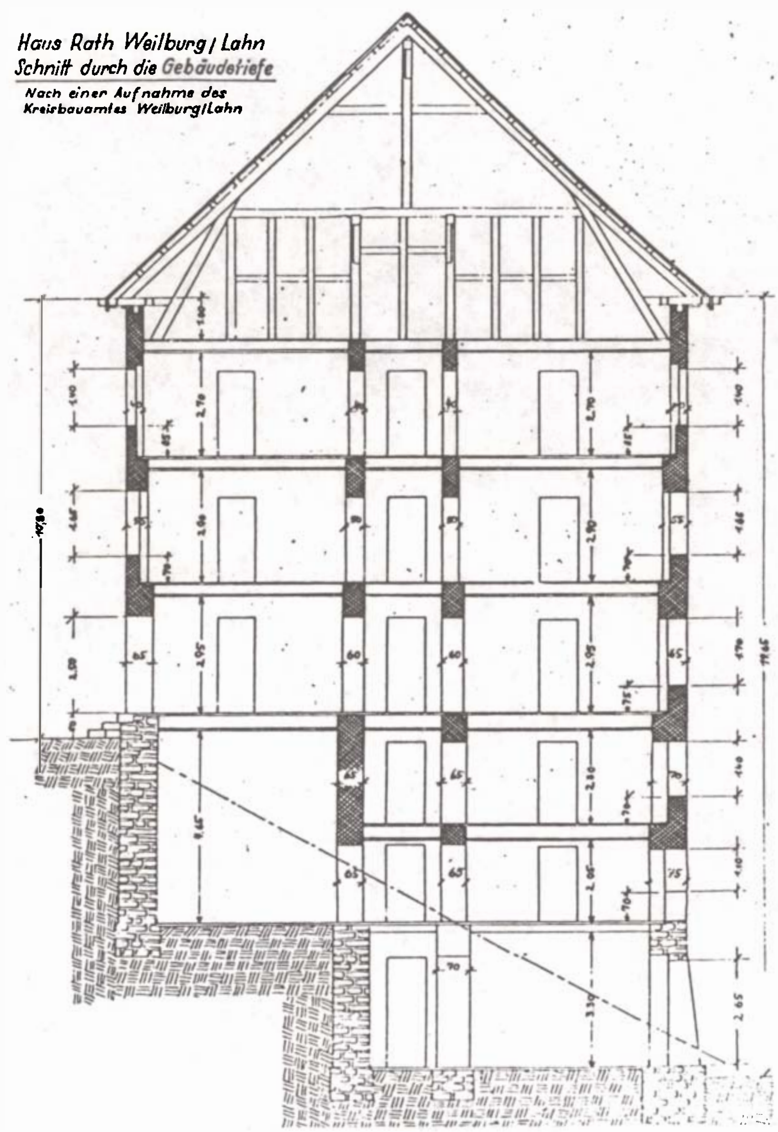


Fig. 9 Cross-section of "Haus Rath", built by Jacob Wimpf in 1837 in Weilburg/Lahn. Built of rammed earth and with five storeys on the valley side, it is the highest clay building in Germany. [3]

A house built of clay-loaves.

(So called "Dünner-method", a method developed in the nineteen twenties). [6]

NOTES

[1] Werner Emmerich, "Flurpläne aus der Zeit des sächsischen Kurfürsten Friedrich August I. im Leipziger Stadtarchiv," Jahrbuch für Geschichte Mittel- und Ostdeutschlands 11 (1962), 111-133.

[2] John McCann, Clay and Cob Buildings, (Aylesbury, Bucks.,: Shire Publications Ltd., 1983).

[3] Jochen Georg Güntzel, Zur Geschichte des Lehmbaus in Deutschland, (Staufen: Ökobuch-Verlag, 1988; ISBN 3 - 922 964 - 99 - 0). The paper here submitted is based on this book. All of the references - about 1.600 titles - are listed in the book´s bibliography and have not been specifically referred to here.

[4] Barbara Tuchman, Die Biographie - ein Prisma der Geschichte (Telling Lives: The Biographer´s Art), in: In Geschichte denken, Essays, B. Tuchman (Düsseldorf: Claasen, 1982), 94-106.

[5] S.W. Johnson, Rural Economy: Containing a Treatise on Pise Building (New Brunswick, New Jork, 1806).

[6] Jochen Georg Güntzel, Bauen mit Lehm: Das "Dünner Lehmbroteverfahren", Schriftenreihe Lehrgebiet Baukonstruktionslehre (Detmold: Fachhochschule Lippe, 1982).

[7] Franz Griselini, Versuch einer politischen und natürlichen Geschichte des Temeswarer Banats in Briefen an Standespersonen und Gelehrte (Wien, 1780).

Fig. 10 Princely hotel built of rammed earth 1811 in Fürstenlager near Auerbach-Bensheim. [3]

THE "SLOW" METHOD OF CONSTRUCTION OF TRADITIONAL WET MIXED AND PLACED MASS SUB-SOIL WALLING IN BRITAIN

J R Harrison
English Heritage
Keysign House
429 Oxford Street
London W1R 2HD
Great Britain

ABSTRACT

This study is intended to offer some background support, analysis and, by implication, lines of action, for those seeking to revive the craft of "mud-walling" in Britain. It is based on documentary research and fieldwork and confirms the tradition as of relative complexity and sophistication with many correspondences in international practice. It is dedicated to Alfred Howard, Devon master-builder and conservationist.

KEYWORDS

Britain, mud walls, construction, historical practice.

Introduction

The use of sub-soils in building is a large subject and it is important to confirm the limits of this paper, which concentrates on the now largely defunct British tradition of wet mixed and placed mass sub-soil walling. The parallel and related practices of continuous wet mud building, shuttered mud and mud brick - techniques once also known in Britain - are excluded. An understanding of the basic principles involved is assumed in the reader (1) but some specifically British terminology requires explanation. The terms "cob", "clay" and "mud" were all once used in Britain to describe material prepared for wet-placed mass sub-soil walling. Here 'mud' is used to refer to wet clay-based, and "chalk-mud" to wet chalk-based, mixes. The traditional East Anglian terms "lump" and "clay-lump" refer to unbaked mud brick. The paper is divided into sections describing individual operations within the wall building process or elements relevant to the process at particular stages. Some sections also offer a gloss on the purpose and benefits of the activities and elements described. A few amplify previously made points. All are prefaced by a traditional or modern phrase descriptive of what follows. The study opens with a note on aggregate which, through mix-balancing, offered the builders one way of modifying strongly shrinking "as found" sub-soil, and continues through the other types of mix-modifying additives. The various stages in preparation of the material are then considered and this is followed by an introduction to alternative course building methods and the tools used. Further sections examine the detail of course, and over all wall, construction. "Paring-down", the last phase in the main building process, closes the investigation, leaving matters of building and drying-out time, finishes and overall structural context, to another occasion.

Aggregate

Some sub-soils contained ingredients whose natural balance suited them to wall building "as found". With less reliable sub-soils extra aggregate might have to be added while, over a certain size, it might have to be removed. Large stones were a hazard during mixing and might 'blow' at the wall face and they were therefore invariably removed. Stones above the size of a walnut were picked out by some 'lump' makers, to ensure homogeneity. Where a wall has been left unrendered, aggregate shape and size can be seen to affect weathering performance to a greater or lesser degree.

Mix balancing

As noted above, some sub-soils required no amendment before use. With others, sand, gravel or small stones were added to bulk out the material in order to reduce the 'strength' of the clay element present. 'Dirt, Gravel and Compas' were in use in walling in Leicestershire 200 years ago (2). This practice, in the form of 'stream gravel' added to the mix was still utilised in the County in the 1960's. Pit gravel had been employed sixty years earlier by the squatter builders of the New Forest (3). In Devon, as in Britanny, where a sub-soil was too 'strong', small stones or gravel were added (4). A Cornish ratio was two parts of 'clay' to one of 'shilf' (small, flat slaty material) (5), the same ingredients being mixed together also in Pembrokeshire (6). In Suffolk in 1849 'clay' dug from a pit for lump manufacture was mixed with 'as much sand as it will carry to remain tenacious, say one yard of clay to half a ton of sand' (7). Buckinghamshire "wichert" shows that naturally occurring mixes of clay and chalk can produce very good walling. A well known recipe of 1843 advises that clay-marl is 'best' for building (8). If this is unobtainable, chalk and grit should be added to the clay. In the early 19th century three parts of chalk to one of clay was a common mix in parts of Hampshire and the Isle of Wight (9), while lime is known to have sometimes been added to Devon cob, south country chalk-mud and Irish mud.

Animal organics

The use of dung is so extensively quoted that there can be no question about its value with clay-based preparations. There is no record of its employment with chalk-based mixes. It may have helped to plasticise refractory, and therefore potentially useful, clays and soils low in clay content as well as flocculating soils with an over-expansive clay fraction. All the other common animal organics were well enough known to broad vernacular building tradition but were not extensively used with mud walling.

Vegetable fibre

Fibre of all kinds, was usually but not invariably, added. Sometimes it was pre-soaked but more often it seems to have been added dry to the mix. Where a preference is expressed it is always for barley straw, probably because it was both 'tough' and 'soft'. Before it was added, fibre might be chopped into short lengths or it might merely be 'pulled abroad and bruised with the hands' (10). For binding purposes within the wall - one of a number of functions performed by the fibre - the longer the material the better. Uncut barley straw presumably had the advantages of 'softness' for mixing, handling and placing, and length when laid in the wall course. Some mud was laid with little or no fibre content; some chalk-mud mixes are a case in point while certain Midland iron-bearing sub-soils harden without additions of any sort. Such hardening must represent a one-way chemical set, preventing the re-use of the material, in contrast with what may be a mechanical and therefore possibly reversible set found with some Devon cob claimed as fibreless. The quantity of fibre required in a mud mix is proportional to the 'strength' of the clay element and the quantity of aggregate and water used. One modern West Country builder states that 'the straw makes the cob less sticky. You should add water and straw to the material gradually. Too much straw and the cob gets weak, like dung' (11). In Britain, as elsewhere, 'local custom as to the composition and preparation of the mixture will generally be found to have adjusted itself to the peculiarities of the soil' (12), and localised standard measures such as that at Bridstow, Devon, in 1813 where 'eight bundles or one horse load of straw is mixed and tempered' with nine cart loads of clay to make $4^1/2$ perches ($16^1/2$' (4.950 m) x 2' (600 mm) x 1' (300 mm) high) of cob, ruled (13). Even with mix balancing and the use of fibre, large scale course-confined 'unit' or 'block' drying cracking sometimes occurred, as for instance with walling in the New Forest and Buckinghamshire "wichert". The effects of block contraction were taken in their stride by the builders; some of the most highly performing mud walling in Britain is found in Buckinghamshire.

Weathering the raw material

Weathering the excavated sub-soil over the winter in the open so that rain and frost could act on it was, and still is in places, common practice in brickyards, yet the record suggests that the builder in clay-based mud made little use of the process. Occasionally however, the raw material was 'raised' in the autumn for use the following spring. The practice is known for both Devon and Norfolk 'clay'. It seems by contrast to have been considered a wise precaution with chalk-mud, and was employed if there was time. There is good reason for this - getting newly excavated chalk rubble down to an acceptable aggregate size could be a back-breaking and lengthy task.

'Soaking' the raw material

This process has affinities with weathering but is less time consuming. Henry Best, the 17th century Yorkshire Wolds farmer and diarist recommends it for the preparation of mud mortar for thatching but his principle stands for wider use, 'Mortar neaver doeth well unlesse it bee .... well watered and tewed; it is accounted soe much the better if it bee watered over night, and have nights time to steepe in ..... water it and tewe it well, till it bee soe soft that it will allmost runne; then lett it stande a while till the water sattle somethinge from it, and it will bee very good mortar' (14). Soaking allows water to split down the clay particles and increases plasticity. It compresses them under their own weight and brings them into maximum association with the fine aggregates in the mix, bringing strength - or this at least should be the result once 'soaked' material is mixed and turned over prior to placing. In the New Forest after 'puddling' (mixing), the material was worked to a 'slurry' and then left to drain before use (15). Draining would presumably have removed the finest and most unstable part of the clay fraction. In the western Scots Borders in 1810 it was noted that mud builders first worked the "common clay" with water into good mortar and then let it lie to get more consistency (16). One authority has it that 'wichert', the natural chalk and clay mix, was soaked before use (17). It was certainly thought an advantage to pre-soak chalk-mud. During the recent experimental rebuilding of a chalk-mud boundary wall it was found that a lesser amount of water standing in the chalk-mud mix over a longer period is of greater benefit than a larger amount of water added just before use. The material is more easily worked and laid, and shrinkage cracking arising from drying-out is reduced with the lesser quantity of water (18).

Souring

An Irish survey mentions that after wet-mixing with fibre, mud might be left to 'temper' or 'sour' for several days, being turned over or re-kneaded occasionally (19). In contrast to the mechanical action of soaking, souring changes alkalinity to acidity through bacterial action and promotes flocculation in the clay. It seems that the British mud waller rarely sought to bring about deliberate souring though the writer has personal experience of its being achieved accidentally with a re-used daub mix. However, the adding of organic matter such as dung would, in the right circumstances have some potential for encouraging flocculation, as noted earlier.

Tempering or Puddling

These were the terms for mixing, descriptive of the process. Hand mixing persisted to the end, work that would 'pull the ribs out of a man'. The term 'treading' was often used for the actual process of mixing. Hardy says of Dorset that women were sometimes put to treading, an echo of ancient tradition. The work might be done barefoot, but heavy boots, sometimes shod with irons, were needed for stoney mixes. The correctness of Ellis's description of central Devon mixing methods is borne out by more recent practice. Moving inward from the perimeter and treading down the mud as they go, the circular heap is turned over and trampled down once by a couple of men while barley straw and water are sprinkled on. The process is repeated and then the cob is ready for use (20). Such speedy preparation helps to bear out the claim that Dunsford cob is among the best in the West of England. At the other extreme chalk-mud builders in Wiltshire are said to have needed an hour or two to produce a reasonable amount of useable material (21). In the light of this, their now-lost mudwallers' song chanted while they toiled, was a very necessary adjunct to the operation as was, and still is, the liberal consumption of cider. In Cumberland and Dumfriesshire whole communities still came together at the end of the 18th century to make short work of mixing - and the remainder of the job. Tempering by driving domestic hoofed animals through the mud is known from Ireland, north east Scotland, north west Wales, the West Country and East Anglia. Oxen were originally preferred to horses for the work because of the cloven hoof. A 'sandwich' of three successive layers each of 'soil, hay and water' round which horses or oxen were driven is described for Devon in 1810, and 'as the cattle in treading it cause it to spread, a labourer with a three pronged fork throws it up again ...' (22). For a watered and straw-spread bed trampled by horses in Essex in 1843 it was noted that the mud '... can hardly be too much trodden. The clay-dauber's joke is, "You spoil it if you tread it too much"' (23).

Compression while mixing

The 'clay-dauber's joke' confirms a deeply held traditional view of the value of treading, beating and chopping of mortars, both lime and clay based. After soaking, further compaction of the mud took place while it was trodden and turned. A hint at more serious efforts at compression at this stage can be found in the former use in Devon of a mud beater - described as a semi-circular iron hoop whose base was attached to a wooden handle by a flail type joint.

Wet built, unshuttered, mud, slow method

The raw material was prepared fairly stiff and was picked up either in bare hands or on a fork in amounts called 'clats' in Devon, placed on the wall, beaten down and built up to form a course, often a couple of feet high. This had to reach a certain level of dryness before the next course could be superimposed. Courses were known alternatively as rases, scars, rearings and berries. Ellis refers to them as lifts. Where the fork was used there were two ways of raising individual courses; these are described below.

Hand placed mud walling

Only one example of this technique is recorded - by Deas in Norfolk in 1938 - but this stands as a pattern for innumerable similar structures long ago razed and swept away, '... the clay was moist when laid; the builder simply gathered up a quantity of clay and pressed it into shape to facilitate handling and make it conform to the wall thickness ...' (24). Here we are in the presence of widespread and ancient practice. The method allowed construction to the finished wall thickness from the outset, an advantage for the self-builder with limited resources of time and effort available.

The fork

The use of tools allowed the worker to keep relatively clean, to extend the reach of his arm and to improve compaction through beating as he worked. From north-east Scotland through the Borders to Lands End, the fork was the prime instrument of construction with both dung and hay forks featuring largely in the oral tradition. So identified was the tool with the technique that mud walling in Norfolk was known as 'forked clay'. As late as the 1920's, an observer of New Forest methods complained that there were those who '.. could not build a wall with a "mud prong" but trusted to board "clamps", and thus this serviceable walling material has been discredited, most unfairly' (25). The term 'mud prong', as also 'mud' or 'cob, pick', suggests a specialised tool and there was indeed such an implement. Known recently from Cornwall to Buckinghamshire this took the form of a small trident. Ellis accurately illustrates the type. The prongs were set at an angle to the haft to allow for a scoop action and the small size of the head underlines the need to keep to the minimum the weight of each 'clat' moved. Strain on the worker was reduced since material was taken in small packets, while many small packets consolidated better in the wall than fewer, larger, ones.

Using the fork

Compression continued during the mud moving and placing stages. After mixing, a 19th century Devon labourer is described as taking his 'three pronged and somewhat flatted' fork and 'striking the soil therewith until it lies like a cake' - a modern Devon builder does exactly the same - 'he takes it up with the fork and lays it on the wall, striking it there repeatedly at top and sides until he has packed it close' (26). Once the wall reached any height two men were needed, one standing on, or next to, the wall head. For this stage as recorded in Buckinghamshire, 'One man then stands on the stone grumpling (wall base) and holds the fork in front of him with its tines resting on the grumpling. Another man ... digs a forkful of wichert and smacks it down on the fork of the builder, who immediately turns it over and, with a smart pat, puts it in position' (27). Each 'pat' brings further, if minor, compression. Beating the material on the wall was common practice, with the back of a spade or more usually the fork; it was sometimes combined with treading. Ellis confirms the use of treading, noting that the heels should be well used. Latterly scaffolding was little used and only then in certain specific circumstances. Rose says that when wall height became 'greater than a man can pitch to, a third man is needed, who stands on a raised stage, also with a fork, taking the wichert from the first man and passing it up to the builder'. Recent practice in Devon follows the same approach; elsewhere carts might be used as pitching levels. Comment above relates to average 2'0" (600 mm) to 2'6" (750 mm) thick walling for buildings - for the thinner boundary walling, down to 1'0" (300 mm) thick or less it is hard to see how staging could be avoided.

Course building by diagonal layering

Ellis notes that under the system he examined cob was laid and trodden in diagonal layers to a course height of about two feet (600 mm) (28), an approach also seen outside Devon. The method has parallels with the herringbone effect seen in some masonry as well as in peat block and sod work. It allowed each succeeding layer of angled wet mud to bond with the previous one, producing a continually advancing ramped face against which it was easy to work. The builder took his stand on the hardened top of the course below. He moved backwards, away from the advancing mud work, convenience perhaps dictating that course height would be the level to which the 'boot heel' could easily reach.

Course building by horizontal layering

This approach used thin layers, a number of which made up a full course height. A Devon report says that successive layers were about 6" (150 mm) deep, were coated with long straw and were then trodden down. A few layers were done at one mixing and then left to harden (29). Much thinner layers have been observed in walls in other parts of the country. It was normal for workers to stand on the wet material. A Devon eyewitness notes that straw was spread on the top of a 12" (300 mm) to 18" (450 mm) high course and well trodden in. In Ireland, with courses of similar height, a light person or child might be given this task (30). In Devon in 1980 one of Alfred Howard's workers had to operate on top of the wet material of a small cob structure in a constructionally awkward situation, a gable peak, and this was managed without undue difficulty.

Course height

For those aiming for maximum course height, performance depended primarily on physical matters and especially the amount of water present, while by contrast the course height possible for a self-builder might be limited by the time available to him in the evenings. The number of thin horizontal layers going to make up a course was controlled by wall thickness, wetness, overhang of the wet material at each side and the inherent properties of the sub-soil involved when mixed with fibre and perhaps dung, all this following compaction. Courses ranging between 18" (450 mm) and 30" (750 mm) high are very common with clay and chalk based mud. Sometimes a lesser range of between 12" (300 mm) and 18" (450 mm) was preferred.

Course joints

Though generally formed without mechanical connections, occasionally attempts to 'pin' courses together with pegs between lifts have been observed - a reminder of the close relationship between mass-mud and daubing. Sometimes straw laid across the wall forms a physical course-break. A Devon tradesman believes that such layers prevented the upper, wet, course from destabilising the lower, hardened, course, and if so this would also prevent the new work losing moisture content at too quick a rate into the old. However, a recent practitioner wets the top of the hardened layer before placing the next to help courses "knit" together (31). The straw bed here may relate to the "treading down" stage in the lower course, not to overall structural or constructional requirements.

Paring down

The mud-work was always initially built overhanging the (stone) plinth. In one area late walling has a permanent overhang but usually the face of the mud was brought into line with the base by paring. Paring was known as "dressing" or "facing". Various tools were used, commonly the fork or spade but also mattocks, hay knives and even axes. It was done either from the side or from the wall head, depending on the tool employed. Initial overhang varied somewhat with the raw material. In Ireland paring could either be by course or on full height completion (32). In the New Forest by contrast it was done by course (33). Nationally both approaches were used, choice being partly influenced by the nature of the material involved. Good chalk-mud for instance proves extremely hard when allowed to go fully off, as was found during the rebuilding experiment mentioned earlier. Paring down by the course could thus be seen as the logical approach with this particular material.

Conclusion

It is hoped that this brief and incomplete survey has demonstrated the variety - and incidentally the extent - of one part of the former tradition of the use of "mud" in building in Britain. This was a tradition - now generally, but not entirely, disregarded - bearing a deep understanding of the potential of the material, an understanding nicely displayed in the words of Henry Best on the subject of flooring-clay, "when a floore is decayed, that there are holes worne, they usually leade as many coupe loades of redde clay, or else of clottes from the faugh (fallow) field, as will serve, but they must leade their clottes from such places where the clay is not mixed with sand" (34).

NOTES

1. For background to the nature of the method and its distribution in England in recent times see J. R. Harrison, "The mud wall in England at the close of the vernacular era," Transactions of the Ancient Monuments Society N.S., 28 (1984): 154-74.

2. M. V. J. Seaborne, "Cob cottages in Northamptonshire," Northamptonshire Past and Present, Vol. 3, Part 5 (1964): 218-19.

3. Personal communication, Mr J. James, Sway, Hampshire.

4. C. Williams-Ellis, Cottage Building in Cob, Pise, Chalk and Clay (London: Country Life, 1920), 51.

5. J. L. Manson, "Cob walls," Building in Cob and Pise de Terre, Building Research Board Special Report No 5 (London: H.M.S.O. 1922), 6.

6. Personal communication, Mr E. Wiliam, Keeper, Dept., of Buildings and Domestic Life, Welsh Folk Museum.

7. W. Raynbird and H. Raynbird, Agriculture of Suffolk (1849), 283-84.

8. Copinger-Hill, "On the Construction of Cottages," Journal of the Royal Agricultural Society, XXVI (1843): 359.

9. Vancouver, General View of the Agriculture of Hampshire including the Isle of Wight (London: 1810), 67.

10. C. H. Laycock, "The Old Devon Farmhouse, Appendix 2, Cob walling," Transactions of the Devonshire Society Vol. 52 (1920): 179.

11. Personal communication, Mr A. Howard, Morchard Road, Devon.

12. Williams-Ellis, "Cottage Building in Cob, Pise, Chalk and Clay," 36.

13. Vancouver, General View of the Agriculture of Devon (London: 1813), 94.

14. Surtees Society, Rural Economy in Yorkshire in 1641, being the Farming and Account Books of Henry Best (Durham: 1857), 145.

15. Personal communication, Mr J. James, based on an interview in 1980 with Mr C. Broomfield, retired builder, born 1909.

16. Information contained in an unpublished letter from his Factor to the Earl of Mansfield, dated 1810, Mansfield Muniments N.R.A. (S), 0776.

17. Personal communication, Mr M. Andrew, based on an interview with Mr J. Nelms, builder, of Haddenham, Buckinghamshire.

18. G. Pearson, "Report on the rebuilding of the chalk boundary wall to the staff car park at Andover, Cricklade College" (Unpublished Report, The County Architect, Winchester, Hampshire, 1984), 14.

19. C. O. Danachair, "Materials and methods in Irish traditional building," Journal of the Royal Society of Antiquaries of Ireland (1957): 66.

20. Williams-Ellis, "Cottage Building in Cob, Pise, Chalk and Clay," 37.

21. R. Whitlock, Folklore of Wiltshire (London: 1967), 87.

22. S. W. Johnson, Rural Economy: containing a Treatise on Pise Building etc (New York: 1806), 78.

23. Copinger-Hill, "On the Construction of Cottages," 359.

24. J. H. Deas, "Building in Norfolk" (R.I.B.A. thesis, 1939), 41-47.

25. H. Sumner, A Guide to the New Forest (1923): 62.

26. Johnson, "Rural Economy: containing a Treatise on Pise Building etc.," 78-79.

27. Harman, "Appendix, Method of Wichert Construction," Buckinghamshire Dialect (1929), 165-168.

28. Williams-Ellis, "Cottage Building in Cob, Pise, Chalk and Clay," 38-39.

29. Rex Gardiner, "Extract from a short talk on the repair of cob buildings," given to the Society for the Protection of Ancient Buildings: undated.

30. C. O. Danachair, "Materials and methods in Irish traditional building," 66.

31. Personal communication, Mr A. Howard, Morchard Road, Devon.

32. C. O. Danachair, "Materials and methods in Irish traditional building," 66-67.

33. Personal communication, Mr J. James, interview with Mr C. Broomfield.

34. Surtees Society, "Rural Economy in Yorkshire in 1641, being the Farming and Account Books of Henry Best," 107.

ABSTRACT

The technique of earth construction has a long history of 6000 years, and reached maturity in China by the time of Qin Dynasty (221 B.C). The earthen cave-dwellings in the reaches of Huanghe river valley are an embodiment of Huanghe valley culture. The Great Wall (6350km in length) was rebuilt repeatedly from 476 B.C. to A.D. 1344. The ancient cities of Gaochang and Jiaohe of Tang dynasty (618—907) on the Silk Road have a history of 1500 years, and their historical & cultural value must be protected. The present engineering conservation of the Xian city wall is a prime example of the need to protect rammed earth architecture.

KEYWORDS

Banpo Village, Cave-dwelling, Adobe, Terraces, Huanghe River Valley Culture, Jiaohe and Gao Chang, Rammed Earth

NOTE:

* Yangshao culture is a culture of the Neolithic period in the reaches of Huanghe river valley in China. Because potteries with colour patterns were discovered in the remains, so it is also called Painted Pottery Cuture. The painted pottery is the index of civilization during the Neolithic period in China to a certain extent.

* * These are scripts on tortoise shells or animal bones, the original of Chinese pictogrphic character.

EARTH · CULTURE · ARCHITECTURE

—— The Protection and Development of Rammed Earth and Adobe Architecture in China

Professor Hou Jiyao and Master Jia Weitung
Department of Architecture
Xian Institute of Metallurgy and Construction Engineering
Xian, Shaanxi Province
People's Republic Of China

Vice Chairman of The Cave Dwellings and Earth Architecture Institute of China

A Background

A—1 A Long History of Earth Construction in China

For over 6000 years,the Chinese people in the Banpo Village have used the technique of earth construction to build villages, caves and semi-cave dwellings. Dwellings were circular or square in plan (see Fig 1). In order to meet the needs of life, the technique of making pottery was developed. As exemplified by archaeological findings, the painted potteries * have good shapes and painted patterns (see Fig.2).

China has recorded history since the Xia Dynasty (2100 B.C—1600 B.C) , the first slave system regime. This culture was formed in the middle reaches of Huanghe River valley during the Chinese Bronze Age. The houses and palaces were built on the rammed terraces, according to some Chinese characters from the Shang Dynasty (16th Cent.B.C), for example, 宅、京、高* *. The earth-ramming and wooden Shuttering rammins techniques were used to build walls, according to other shang dynasty characters, 圃* *(see Fig.3).

Many earth dwellings, cave-dwellings, palaces and rammed earth and adobe terrace architecture were constructed in big cities during the Warring States (475 B.C) period. Seven States built defensive walls competitively. Then the Qin Dynasty conquered the other states and established the first centralized feudal society in Chinese history and built the unified Great Wall. The technique of earth construction in China had reached maturity.

A—2 Cave Dwellings In The Area Of Huanghe River Valley And The Huanghe Valley Culture.

The area of Huanghe River valley is the cradle of Huanghe valley culture, Located in the northwest China loess plateau region. Our ancestors made full use of the physical qualities of loess —— its plasticity, thermal insulation and easy workability. Simple tools were used to excavate cave-dwellings. By combining expertise in site selection, space organization and the technique of earth construction, cave dwellings with rich Chinese cultural charteristics were created. For example, Mangshan, in the suburb of Luoyang, Henan Province, is a wonder among cave-dwelling villages, a treasure of human culture and also the crystallization of Chinese Huanghe valley civilization, which urgently awaits preservation and development (see Fig.4).

A—3 The Great Wall And Chinese Culture

The Great Wall in China is one of the greatest engineering constructions on our earth

The construction of the Great Wall started 2200 years ago. From the period of the Warring States (476 B.C) to Ming and Qing dynasties (1368—1911), efforts were made time and again to extend and strengthen it. As a result, its full length exceeds 6350 kilometres. The Qin, Han and Ming dynasties mostly built with rammed earth and adobe. At the time of the Qin dynasty (221 B.C.), the Great Wall, starting from Lin Zhao of Gansu Province to the east of Liaoning Province, required 300,000 people and 10 years to complete by A.D.213.

The portion of Great Wall in the suburb of Beijing was rebuilt in Ming dynasty over a period of 100 years. The Great Wall, a great military construction, is the crystallization of the ancient Chinese people's labor and intelligence and is the pride of ancient Huanghe River valley culture (see Fig.5).

B. The Protection And Development Of Earth Defense Ramparts In China

B—1 The Ancient Cities Of Gaochang And Jiaohe In Tang Dynasty (618—907)

The ancient city of Gao Chang built during the Tang dynasty is located in Turfan district of the Xinjiang Province. It had been the capital of the Gaochang Empire for 1500 years, and was the only one of 5 states on the Silk Road in Han dynasty. Remains of city wall built with rammed earth still exist. The area is 200 square km with a 5 km perimeter, and is divided into 3 sections — the palace, the inner and the outer city, with ramains of adobe architecture scattered over a wide area. An intact temple still exists in the southwest corner of city, with an area of 10000m², Its gates, squares, chambers and pagoda are still visible. There is an earthen pagoda, 15m in height, in the inner city. All constructions within the city were built with rammed earth and adobe. There is a great adobe dome-shaped roof in the temple with an amazingly high level of building technique (see Fig.6).

The ancient city of Jiaohe is located 10km away from Turfan county. The city is built alongside an earth precipice without a city wall. It is 1000m long from north to south, and 300m wide from east to west. There were gates and a road leading to the centre of the city. The road is 350m long and 3m wide. There are high and thick rammed earth walls on the side of the road, and the buildings behind the walls are divided by lanes into 3 sections. The northwest section are mostly sites of temples with pagodas which house Buddha images in niches. The northeast section is a residential zone where court-type houses are densely clustered, most of which are well preserved. The southeast

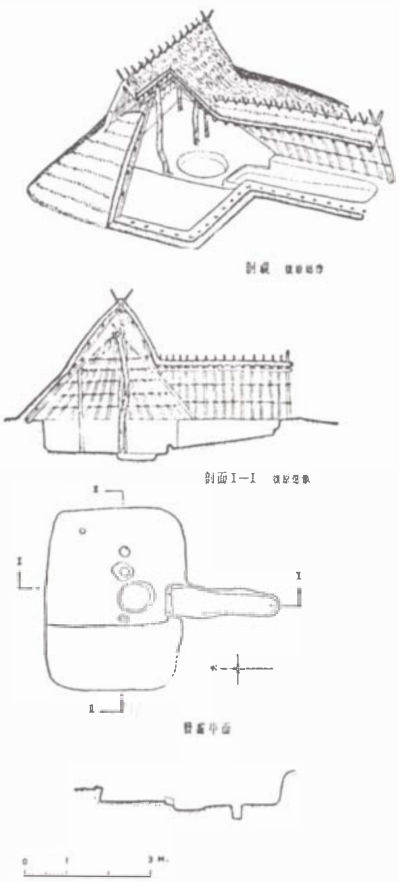


Fig.1 Square Earthen House In Banpo Village, Xian ShaanXi

Section I-I
Section II - II
Plan

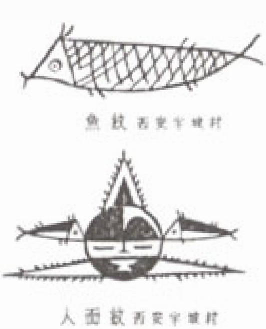


Fig.2 A Painted Patterns On A Colour Pottery In The Epoch Of Yangshao Culture

Fig.4(a) The Bird's-eye View Of Pit Cove Dwellings Village In Mang shan

Modern Chinese	Script on Animal Bones	English
宅		House
京		Capital
高		High
囿		Hunting Field

Fig.3

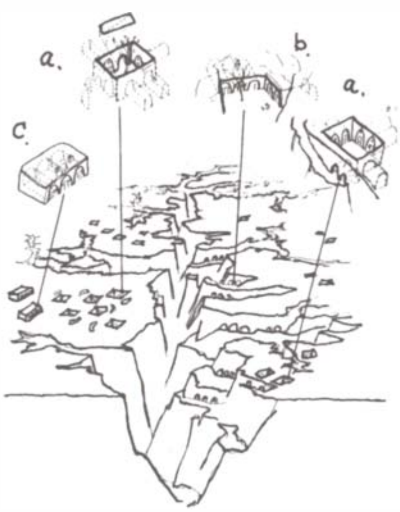
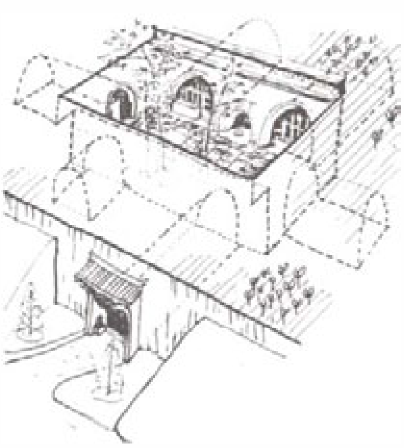


Fig.4(b) Types Of Cave Dwellings In The Northwest China Loess Plateau Region

a. Pit Cave Dwelling
b. Cliff Cave Dwelling
c. Earth Sheltered Dwelling



section buidings are mostly ruined, except for a large edifice with chambers, courtyard, steps and widing corrider; This area of the city is possibly political centre. On the north termination of the road is an edifice built with brick and tiles. The eave tiles have the Tang dynasty lotus pattern. Jiahe flourished more than 1865 years from Han Dynasty to Yuan Dynasty (1272—1368) (see Fig.7).

These two ancient cities were important cities along the ancient Silk Road. Because of the dry climate, it is a architectural wonder that their adobe and rammed earth structures are so intact.

B-2 City Wall in Ming Dynasty (1368-1644) — The Protection And Development Of Xian City Wall

The city wall of Xian was constructed during the Ming Dynasty. It is 13. 7km in perimeter, and lies 4.2km long from south to north and 2.65km wide from east to west. The wall is 12m high, 15-18m wide at the bottom, 12-14m at the top. Its rammed earth core is encased with bricks. There are 98 combat quarters in a 10×12m area along the wall. Bricks are paved along the top of the wall. On the outside of the wall there are concave crenels spaced at 2.36m interval; the parapet walls inside are 0.75m high.

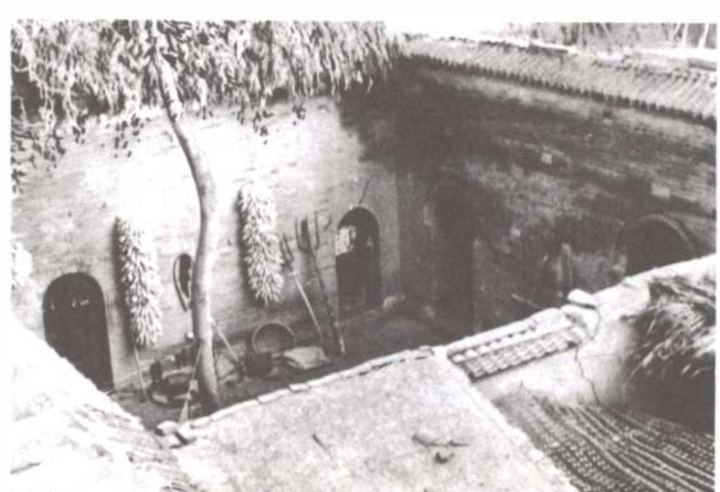
There are gates on each side of the city, with a main tower, embrasured watchtower and locktower at each gate. The city canal is around the city wall, and is 14.6km long and 14-24m wide. There is also a suspended bridge under the locktower.

Zhu Shuang, the son of Zhu Yuanzhang (first emperor in Ming Dynasty) established his palace in Xian and began to build the Xian city wall, which was built on the base of the Feng Yan city of the Yuan Dynasty (1271-1368) and extended the area by 1/4. From then on the wall had been rebuilt many times. It was first built by the rammed earth method and was then enclosed with brick in 1558. During the Qing Dynasty (1781), the city wall was heavily repaired, and a sewer system was constructed. In 1983, the city wall was protected and developed a third time by the committee of city wall conservation in Xian.

From the time of the construction of Daxing city in the Sui Dynasty (581-618) to that of Changan city in the Tang Dynasty, the Xian city has a history of 1400 years, it is the crystallization of the Chinese labourer's intelligence and labor. The section of Xian city where there is evidence of the king's palace, has rammed earth walls dating from the Sui and Tang Dynasties which are 4600m in length. A very precious historical and cultural relic, the Xian city wall was the first cultural relic to be protected by the government in 1961 (see Figs.8,9.).

Because of war, lack of maintenance and erosion by wind and rain, the

Fig.4(c) Pit Cave Dwellings



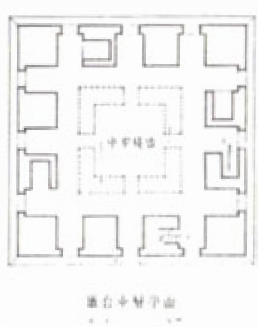
Xian city was ruined severely after the Qing Dynasty. In 1983, the state council allocated a special fund of 53 million yuan (RMB¥) to assist in the conservation of Xian city. A committee of city wall conservation in Xian was founded; the project goals were to restore and renovate the city wall, transform the woods around the city wall, bring the old city canal under control and open the road enclosing the city wall. The construction budget for forty—four main projects was 135 million yuan (RMB¥) and utilized labor of 8 million volunteers. Before the rain season in 1985, the conservation of the city wall and canal were mostly finished and has benefitted society and the environment. It is an important milestone in Chinese architectural history.

C Conclusion:

China is one of the five ancient countries in the world with a long continuous history. Rammed earth and adobe were the first materals used for architectural construction. From the prehistoric age through slave and feudal societies, nearly all of the construction in the world depended on the earth technique. In the reaches of Huanghe river valley, there are still 40 million people who live in the cave-dwellings and other earth architecture. Consequently, the history of adobe and rammed earth architecture and the site of Great Wall built with rammed earth embody the course of Huanghe culture. It should be recorded in the treasure home of human culture, and compared with such constructions as the pyramids in Eygpt.

The ancient wars stimulated the building of defense ramparts, and the activities of building city walls advanced the technique of adobe and rammed earth. The Great Wall, the ancient cities of Gaochang and Jiaohe and other remains are like all the rare cultural relics in the world, worthy of protection and restoration.

The good example of developing and protecting the ancient city in China is the conservation engineering of Xian city wall. Now, through the renovation by Xian people, It has been the main relic in Xian and has benefitted society and economy for 3 years.



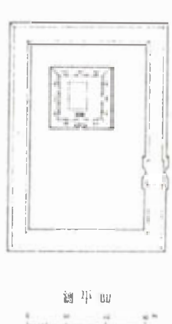


Fig.5(b) A Combatting Quarter Of The Great Wall

Plan

General Plan

MAIN REFERENCE

1. Zhang Yuhuan, Research and Survey of Ancient Architectures. (Jiangsu Press, 1988)
2. Zhang Jingfei, The Present Construction of Xian City Wall (Shaanxi Press, 1988)
3. Dictionary of Chinese Relics (Management Bureau of Fhanghai Cultural Relics, 1981)

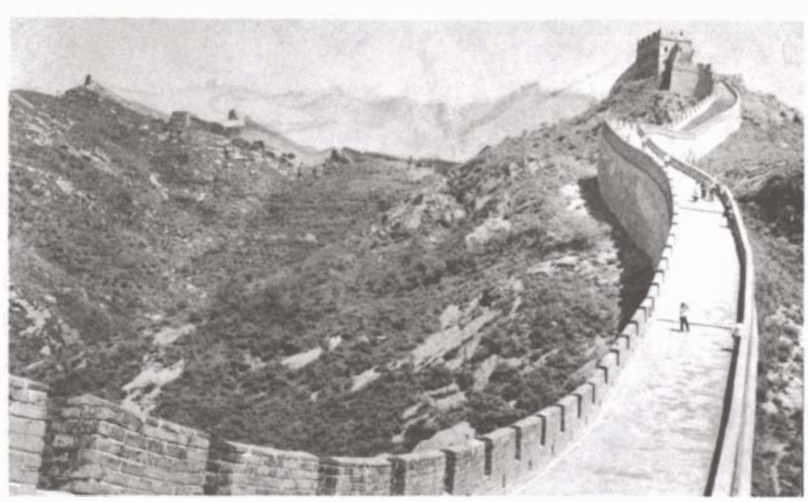


Fig.5(a)
The View Of The Great Wall In Badaling, Beijing.

4. Liu Dunzhen, History of Ancient Architecture In China (Chinese Construction Engineering Press, 1984)
5. Hou Jiyao, Cave-Dwelling (Chinese Construction Engineering Press, 1989)
6. Ren Zhenying, The Spring of 40 million People Living In Cave-Dwelling In China (The Report for UIA, 1989)

Fig.6
The View Of Ancient City Of Gaochang

Fig.7
The Full View Of The Ancient City Of Jiaohe

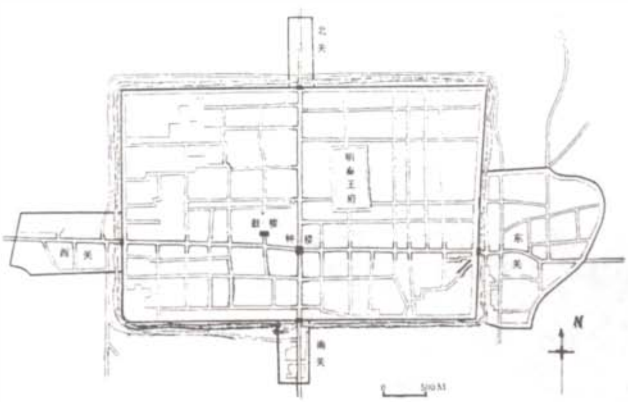


Fig.8(b)
The Plan Of Xian City Wall In Ming Dynasty

Fig.8(a)
The View Of Maintenance Of Xian City Wall

Fig.(9)
The View Of Xian City Wall Which Renovated by Xian People

CYCLICAL MAINTENANCE OF EARTHEN ARCHITECTURE AS A FUTURE POLICY IN TANZANIA

Donatius Msobwe Kamana Kamamba
Ministry of Labour, Culture and Social Welfare
Department of Antiquities
P.O. Box 2280
DAR ES SALAAM

ABSTRACT

In spite of the fact that the conservation of cultural heritage is a concern of the world today, the heterogeneity of this heritage has caused conflicting conservation philosophies among policymakers and professionals who do not agree on common solutions to common problems. Conservation philosophies and practices become difficult when talking of architectural conservation, as one is dealing with structures exposed to all the environmental hazards and much worse when dealing with earthen structures, built of a material described as poor, fragile, archaic, and primitive.

It is obvious that in developing countries like Tanzania both policymakers and professionals have been promoting and advocating the use of modern building materials and consigning the vernacular architecture, earth structures included, to village museums.

The actual fact is that modern building techniques are beyond the reach of the general rural population in Tanzania, as it is in some other developing countries. Regardless of the above fact, policymakers and professionals are encouraging and promoting the use of modern building techniques. Despite this conflict between the ideals of policymakers and actual reality, it must be understood that the heritage has to be passed over to the next generation. I am of the opinion that cyclical maintenance and conservation of the earthen architecture could be a compromise in our country. Techniques of traditional earthen architecture should be perpetuated and yet adapted to changing conditions.

KEYWORDS

Cyclical maintenance, traditional crafts, legislation, training, improved designs, dissemination of information, conservation within a rural built environment.

Introduction

Despite prejudices that have continued to flourish under many guises, condemning earth as poor, fragile, archaic, and primitive, evidence from all over the world points in precisely the opposite direction: earth is a versatile and durable building material with many qualities to justify its use today.

Supporting the use of earth as a building material, Dr. Julius Nyerere, President of the Republic of Tanzania, declared in 1977:

> People refuse to build a house of burned bricks and tiles, they insist on waiting for a tin roof and "European soil" - cement. If we want to progress more rapidly in the future we must overcome at least some of these mental blocks. [1]

And Mrs Indira Gandhi, Prime Minister of India, stated in 1980:

> All the new houses are built for energy consumption. They are hot in summer and cold in winter, whereas our old houses are not. So we have not only to have new technology, but look a bit to the old technology. There is much sense in what people have evolved over the years to suit their climate, their environment, their way of living. You can't keep all of it, because our way of life has changed, but I think a lot of it can be adapted and made efficient. [2]

Archaeological research has revealed that earthen architecture was in use during the ninth century A.D. along the East African coast, especially in Kilwa Kisiwani and probably much earlier in some inland areas. It is a heritage to be proud of, a symbol and identity of our architectural development. Today, this type of building dominates the vernacular architecture in the country.

The International Charter for the conservation and restoration of monuments and sites - The Venice Charter - which was adopted by the Second International Congress of Architects and Technicians of Historic Monuments (at its meeting in Venice from May 25th to 31st 1964), explicitly states:

> Imbued with a message from the past, the historic monuments of generations of people remain to the present day as living witnesses of their age-old traditions. People are becoming more and more conscious of the unity of human values and regard ancient monuments as a common heritage. The common responsibility to safeguard them for future generations is recognised. It is our duty to hand them on in the full richness of their authenticity. [3]

While President Nyerere and Mrs Indira Gandhi have encouraged the use of earth as the best way of developing our building industry, the International Charter too, advocates the handing over of a country's architectural heritage to succeeding generations in the full richness of its authenticity. This is a clear indication of the need to conserve this architecture in every possible way. But it is obvious that culture is never static and so conservation of earthen architecture has to take into consideration not only the conservative and scientific way of architectural conservation but also the social and economic factors which necessitate the idea of cyclical maintenance.

Historical Background

Earthen architecture is still a living art in Tanzania, as well as elsewhere in the world. It has been used for thousands of years, not only in rural housing, but also for monuments that reflect the material and spiritual development of communities: warehouses, aqueducts, pyramids, religious buildings, and defensive walls. Earth is one of the most practical and viable building materials as it is an ecological resource the use of which is based on regionally derived techniques. "Earth structures, built of local materials by local people, do not demand a high level of technology. They are not built to scientific principles nor are precise quantities and mixes used. Each new generation had to reassert the way and pass on the method to the next generation." [4]

In Tanzania, traditional building construction in rural areas was always a highly cooperative venture. It was a major social occasion in which both men and women cooperated. There was very little division of labour and everybody was supposed to know everything. Given these considerations - very little division of labour, the need to use essentially voluntary manpower, and the uniformity of the structures - one would think that construction techniques would have to be extremely simple. In fact getting any sort of earthen dwelling to stand up requires a good deal of skill and the use of techniques developed conscientiously over a long period of time. These techniques involve choosing the soil, preparing the soil for building, and selecting admixtures and finishes. The durability of these structures depends very much on their maintenance. They can survive nicely as long as they are in use.

Types of Earthen Architecture

There are three main types of earthen architecture in Tanzania. Buildings are mainly curvilinear or rectilinear in plan. Roofs are either flat, conical, pyramidal, or beehive type, usually supported by a central pole and made of closely spaced, heavy rafters tied together to form a strong support for thatch. Thatch may be tucked into the framework or applied in layers fastened to the framework and tied together by means of thin reeds and sticks. Floors are made by beating mud with a wooden beater while it sets. The mud is mixed with charcoal, small aggregate, or cow dung and then smeared with ashes, clay or cow dung. Mud floors can become almost as hard as cement and quite smooth.

The most popular type of earthen architecture is wattle and daub which is found in both rural and urban areas. Walls of buildings are made of upright wood posts to which horizontals are tied in parallel pairs. This framework is filled with mud and plastered on the inside and outside with cow dung, ashes, or clay. The plaster, which acts as a protective layer, is usually applied in several coats, and in some cases vegetable oils are added to create a kind of water repellant. The rigidity of the structure depends very much on how deep the posts are planted in the ground. The mud which is used for both framework filling and plastering is prepared by digging a pit and discarding the top soil. Then the red soil is broken into clods while wet, puddled by stamping and then applied by hands.

Another principal type of earthen architecture is made of sun-dried clay bricks. This type is used widely and is probably of a recent development. Clay bricks are shaped in moulds, dried in the sun (preferably under shade), and then used to build walls. These walls are usually built on stone foundations, but in some cases a foundation trench is excavated and the wall built up from it. The soil is prepared in the same way as the wattle-and-daub construction, usually without admixtures. Much care is needed in the selection of soils for these bricks, so as to avoid cracks and shrinking.

A third type is rammed earth, which is limited to very few areas in the country. A building is erected in courses of about 30 cm^2, which are left to harden before the next course is applied. Soils are prepared in the same way as the other examples and usually a 30-cm wide trench is dug in which the wall construction starts. The walls are plastered only on the interior, using cow dung, ashes, or various types of clay.

Existing Conservation Strategies

Archaeological Sites

Earthen architecture has survived in archaeological sites and in very old settlements in Tanzania and elsewhere in Africa. It is this heritage that must be handed over to the next generations in its authentic form. Experience has shown that earthen structures will not survive if they are subjected to environmental hazards: in other words, unexcavated archaeological sites stand a better chance of survival.

The conservation of these archaeological remains - for science, culture, and tourism is in its infancy in Tanzania, not only because of the lack of expertise and funding, but also, to a great extent, due to lack of will. Both the government and the general public are complacent about the conservation of these sites and the preservation of the skills and techniques that could save them. The existing legislation only covers the conservation of structures built before 1863, but does not include (or recognize) the skills and techniques used to build these structures. Thus, with time, they will vanish, and it may become difficult or impossible to conserve structures using traditional materials and skills. This will then open the way for the use of expensive synthetic materials.

These earth structures, which have been standing for thousands of years, may inspire little interest in and of themselves. What is interesting is how these structures could have survived for so long in such conditions; and what is even more interesting are the techniques and skills that have allowed these structures to go on through centuries in such a satisfactory manner.

The Building Research Unit, a Department in the Ministry of Local Government, Community Development, Cooperatives and Marketing in Tanzania, has been undertaking scientific research to find out the secret to the earth structures' durability. These superficial research findings have resulted in treatments that are not only expensive but also cumbersome to use and control. They need special expertise, exotic admixtures, and maintenance. I have called this research superficial because, with the architecture still extant, it seems such studies should have concentrated on the traditional skills and techniques and, if need be, then improvements could be taken as a supplement.

In Tanzania, conservation legislation is geared towards the selection, listing, or scheduling of buildings that are of historic or architectural significance as historic or national monuments. This legal provision is deemed adequate for securing the protection and preservation of monumental remains of past cultures or civilizations - archaeological sites - which in most cases are either ruined or situated in abandoned settlements. However, when we talk of conserving the character, technique, skill, or craft, which are the backbone of this heritage, such legislation is inadequate since it does not address these issues.

Museum Conservation Approach

Tanzania has established a village museum in Dar es Salaam, at Kijitonyama, where examples of the country's vernacular architecture, earthen architecture included, have been recreated for display and conservation purposes. The establishment of such museums has in most cases been influenced by the European open-air museum concept without a critical analysis of the rationale for such types of museums. "Whereas earth architecture in Europe is generally speaking a phenomenon of the past, in Africa it is still a living reality providing housing for the majority of the rural inhabitants, about 85% of the population." [5] It still dominates the rural built environment and the basic problem is not the preservation of the dying tradition or even an extinct one, but how best to achieve rational and planned development of such architecture.

It is fallacious and ridiculous to start reconstructing buildings in village museums for display and conservation when such buildings are widespread in the country. It is absurd not to understand that in a country like Tanzania - where this architecture is varied in terms of materials, construction skills and techniques, and design and spatial arrangements - the reconstruction or assembling of a representative sample is a gargantuan undertaking. It is also contrary to conservation philosophy because such museums are out of context, and it is not possible to recreate the environment in which the buildings were conceived, developed, and lived in.

Of course, bringing together all these different buildings simplifies their management and conservation, but what is forgotten is the environmental influence so important in architectural development. It is practical and logical to build an earthen flat-roof building in Dodoma where it doesn't rain very much, but not to build the same in Dar es Salaam where it rains heavily for most of the year.

Future Policy

It is evident that existing conservation policy in Tanzania, as well as in other African countries south of the Sahara, needs to develop new perceptions and targets. In the formulation of policies and the planning of programmes there is a need to foster a concept of conservation which - without abandoning the traditional listing, scheduling, and preserving of monuments according to their archaeological, historical, and artistic significance - will have a wide scope to embrace the conservation of skills, crafts, and traditional techniques. This concurs well with what Dr. Julius Nyerere declared in 1977 and Mrs Indira Gandhi in 1980, as quoted earlier in this paper, who were emphasizing the use of local and traditional resources in our building industry. Thus local and traditional resources, especially earth, with proper planning and management can contribute both to the building industry and to the socioeconomic development of the communities which created them and so to the nation at large.

Earthen architecture is still a living entity in Tanzania, as well as in other countries. This does not mean that its future is unassailable or unthreatened. On the contrary, its future is very insecure, and modern development policies represent a major threat. Urban development has not yet reached a point where it is fast destroying the rural areas, but the attitude of the policymakers, planners, professionals, and building material industrial managers make the future of earthen architecture uncertain. This tendency has been pertinently described by Jean Dethier:

> Although unbaked earth no longer needs any real justification on technical or material grounds, resistance to it persists from quarters whose economic, psychological, cultural, institutional and political well-being is threatened by it. Such opposition is sometimes calculatingly self-interested, for the economic systems characteristic of earth construction might injure influential interest-groups. Industrial corporations and multi-nationals which

> produce building materials, as well as the technical consultants responsible for employing them, occasionally seek to discredit unbaked earth in order to protect their own market. [6]

Thus it is upon the policymakers, planners, and professionals in the field of architectural conservation to come forward with conservation legislation, conservation programmes, and training opportunities that offer the possibility of preserving the architectural character, skills, techniques, and crafts through training, dissemination of information, and designation of conservation areas within the rural environment. Training could take a form of formal education in both secondary schools and institutions of higher learning, apprenticeship, on-the-job training, workshops, refresher courses, and seminars. These people have to be assured of job opportunities and market demand for their products, otherwise such programmes will never attract them. Such problems could be reduced by starting big government housing schemes using earth as a building material in different parts of the country, especially in rural areas.

Conclusion

The success of cyclical maintenance of earthen building can be possible if most of the population has the necessary skills, techniques, and will to live in those buildings. Therefore it should be the duty of the professionals, not only to record and document the heritage, but also to study in detail the soil as a building material, its construction techniques, and the socioeconomic and cultural patterns associated with this heritage. These studies should be made easily available and the country's training institutions should teach these techniques, skills, and crafts so that people living in these earthen buildings can understand their structures in a better and scientific way. This understanding should help them to do the construction, repair, and maintenance of their houses, a tradition which is now disappearing rapidly.

People have to understand not only the value of earth as a building material but also the comfort and pleasure of living in such buildings, an aspect which calls for improved design and finishes. The buildings have to meet today's needs and functions in order to provide a comfortable environment. As said above, this has to be done through training. Young people must be trained to design and use earth as a building material, a subject which now is never taught in architectural training institutions. However, it is agreed that earthen structures, just as any other structures, are important in terms of function, science, and culture, and this is why the world is concerned with their conservation.

Whereas a lot of research and studies have been done in the industrialized world and a lot of training is also available, often this information is not disseminated to places where it might be useful. The use of modern building materials in the developing world is promoted without considering that the economy and expertise do not allow the use of such materials in most rural areas.

In addition to the research training and dissemination of the findings, such a heritage could be protected and preserved within the rural built environment in clearly demarcated conservation areas which should be integrated with the village planning and development process. This, as opposed to the museum approach, is rooted in reality since the buildings keep their original set up and function and receive care, repair and maintenance from the owner. Cyclical maintenance by the owner reduces the financial commitment from government and addresses itself to functional requirements of the people who use the buildings.

Notes

1. Julius Nyerere, The Arusha Declaration : Ten Years After. (Dar es Salaam: Tanzania Publishing House, 1977).

2. "Taking an all-round Attitude to Science : Interview with Indira Gandhi," Nature, vol. 285, no. 5761 London, (1980).

3. International Congress of the Architects and Technicians of Historic Monuments – Decisions and Resolutions Venezia (1964), 2.

4. Susan Denyer, African Traditional Architecture (London: Heinemann, 1978).

5. Amini Mturi, "The conservation of the African architectural heritage II," Monumentum, vol. 27, no. 4 (London: Butterworths, 1984) 276.

6. Jean Dethier, Down to Earth : Mud architecture (London: Thames and Hudson Ltd, 1982), 10.

ABSTRACT

Earth is one of the most common traditional building materials of Britain. It occurs as mortar, plaster (on a mesh frame), in mass and block form. Its technology though has not developed and has now fallen into disuse. The material does not command the respect and consequent protection that other materials of historic buildings do. Its conservation is becoming critical.

KEYWORDS

TYPE, DISTRIBUTION, HISTORY, REPAIR.

SOME NOTES ON EARTH BUILDING IN BRITAIN

Shawn R H Kholucy BSc(hons) Arch Dip Arch

Earthen buildings abound in Britain. They are found as a) the principal element in timber-framed buildings (the weather protection infill panels; b) monolithic structures without special foundations; c) monolithic earth laid between shuttering supported on special foundations; and d) earth block construction on special foundations.

Particular types of construction are usually associated with specific areas of the country. Type a) is the most common and is found throughout the country wherever timber building was used (generally widespread). Type b) is concentrated particularly in the southwest part of the country (Cornwall, Devon, Somerset) but is not uncommon further east (Wiltshire, Oxfordshire, Hampshire). Type c) is found in the eastern part of the country (and is commonly encountered in specific parts of Norfolk, Suffolk, Essex and Cambridgeshire). Because in the eighteenth century, instructions as to its manufacture and construction were published for and distributed among embrionic non-conformist church congregations, planning to build their churches, chapels are found of the material throughout the south part of Britain. I do not know of any in the north. Type d) is largely confined to the same areas as type c), and in those areas is far more commonplace. (See the distributions maps in Brunskill's Vernacular Architecture (London Boston, Faber 1971) 190-192).

The earliest attributable surviving examples of earth used as a building material in Britain (other than as mortar) date from the Roman occupation (before 400 AD). Examples of Roman earth walls are Norwich Castle and Hadrian's Wall. These were in block or shuttered construction[1]. But it is likely that it was used long before that, and examples may well exist unknown.

The type of timber-framed work which employs earth infill (called wattle-and-daub), type a) above, is accepted from wide spread examples throughout Britain to date from the twelfth century. But as earlier timber-framing exists the daub panels may well be earlier too.

The monolithic, unfounded type described as b) above, certainly survives in the south-west peninsula from the fifteenth century and probably much earlier too. Intermittent construction has continued until today when its use has diminished greatly, limited to the southwest part of the country.

In both the above cases the uncertainty as to the date of origin is due to the lack of a typology or records for the types of relevant buildings. Timber-framed buildings have traditionally interested historians and archaeologists and typologies of their frame form exist but are now found to be defective in their attributed date (the typology ocassionally suggests the building is younger than other considerations would direct). The daub has not been the subject of historical analysis.

Monolithic buildings formed with the use of shuttering (type c) are thought to date from the mid-eighteenth century to the mid-nineteenth. This is substantiated by estate maps and records as well as roof typology. They are founded on flint or brick plinths.

Earth block buildings (type d), apart from the few Roman fragments, are now thought (also from estate maps, records and comparitive typology) to largely date from the mid-eighteenth to the mid-nineteenth centuries. There was a brief resurgence of earthen construction at the beginning of this century, especially in the areas which had an existing earth building tradition, but also in unexpected ones too. They tend to be issolated examples rather than high consentrations. They are founded on flint or brick plinths. Twentieth century earthen structures often have slate or bitumen damp proof courses, earlier ones do not. In one Norfolk village the bottom three courses are bedded in lime mortar. This has not been noticed elsewhere. A clay slurry is otherwise used for bedding.

The method of construction of timber framed panels varies slightly in the construction of the wattle in different parts of the country. Broadly, frames in the west are divided into half or third storey squares, filled by wattles of thin wooden slats arranged in a 'basket weave' pattern. Those in the east, where the divisions are closely spaced uprights of one or two storey height with a panel width of about 300 mm - 600 mm, the wattle may be nothing more than vertical hazel branches wedged between the cross beams. Sometimes intermediate shaped cross bars hold these in place. Irrespective of the wattle, the daub (sand, clay, straw, dung mix) was then thrown on from both sides in one coat (per side) to the face of the adjacent timbers (about 100 mm - 150 mm in total thickness). The whole would then be limewahed (including the timbers). Sometimes a thin lime render may have been skimmed across the surface for a smoother finish. Decay of the wattle is usual but is not greatly significant to the life of the panel as once the daub has set then its job is largely finished. Domestic buildings from the Royal Palaces downwards were built of this material. The use of daub died out during the seventeenth century.

1. Pitchford Hall, a fifteenth century timber and earth renaissance mansion in Shropshire.

Monolithic construction used the same materials as for daub. The mix, having been thoroughly trampled (usually by cows or bullocks) is simply piled on itself. The resulting mass is then pared to form straight sides. The walls of the buildings are usually about 500 mm - 1000 mm thick and taper slightly to the top. The corners are usually rounded. Such devices as bread ovens are formed within the thickness of the walls and therefore are expressed architecturally. The walls are usually lime rendered and limewashed. Any domestic and allied (i.e. out-house) building can be found in this material, grand houses as well as hovels.

2. A nineteenth century basic monolithic cottage near Christchurch, Hampshire (now demolished).
(Photograph reproduced courtesy of the Hampshire Museums Service)

3. Pulham Manor Farm is a mediaeval timber and earth building with a nineteenth century earth block addition.

Monolithic work using shuttering is known for its straight vertical sides and sharp corners. Wall thicknesses can be 225 mm - 500 mm. The shutter lifts are usually about 600 mm - 900 mm. They were held by two rows of staggered through bolts, and the scars left from the later filling of these is the tell-tale sign this type of construction. They too were usually covered with a two-coat lime and/or clay render and limewashed. Often they were also tared. Recipes for limewashing and taring together, in one operation, exist. Naturally this method lends itself to repetition of type. Chapels and barns are the most commonly found structures .

Block buildings of the eighteenth and nineteenth centuries are generally composed of 450 mm x 225 mm x 225 mm blocks, making 225 mm thick walls. Small variations do occur. They are always two-coat rendered and tared and/or limewashed. It is thought that they supplanted the shuttered work. Chimneys are built of brick. Sometimes bonding timbers are found at the corners. This method was used primarily for cottages, farm and garden buildings. Orchard walls against which peach trees were grown made use of the material's thermal capacity even in areas where itnot otherwise common. Excluding the twentieth-century work, the writer knows of only one piece of 'architecture' (an eighteenth century 'Gothic' folly) built of block.

A resurgence of interest in building in types c) and d) was engineered by the government after the first world war to cope with the need for the great number of houses which were then needed by the soldiers returning, to be built quickly and without expensive fuel. A similar but lesser resurgence occured after the second[2]. These had only limited success due to the speed of recovery of the established brick and later concrete block production, and the newly imposed bureaucracy which limited available building sites.

The base material for all the above is the same, the variation is in the percentage of clay to sand or chalk and whether straw is added or not. Generally daub has a clay content below 5 per cent while monolithic and block has a clay content above 5 per cent.

Visual analysis and sedimentation[3] testing of the block and monolithic work (types c) and d) above) of samples collected from one representative village in Cambridgeshire, Suffolk, and Norfolk respectively has revealed the following:

SAMPLE (site)	% CLAY	SILT	SAND	GRAVEL
Ltle. Shelford	5-10	30-35	30	30
Hoxne	15	25	25	35
Gt. Hockham	15	35	15	35

The clay content is interestingly low in comparision to the following samples from elsewhere in the world[4]:

SAMPLE (site)	% CLAY	SILT	SAND	GRAVEL
Tumacacori	46	26	24	2
Escalante	27	55	18	
Samarra	26	12	62	
Ur	15	68	17	
Choche	34	59	7	
Aqar Quf	28	58	14	
Tell Omar	19	49	32	

The straw content in our samples varied from 'none' to 'a good deal'. Alva and Teutonico report that it is assumed that where the straw is not found it has already decayed. We have made and laid new blocks with and without straw and have not yet noticed any difference in their performance. In daub work the straw helps spread the shrinkage - not a problem in lump work - but reducing the clay content reduces the overall shrinkage far more satisfactorily.

The material is named as follows according to region

Type a) Called 'daub' throughout Britain

b) 'cob' from Cornwall to Hampshire.
'chalk mud' from Wiltshire to Berkshire.
'wichert' in Buckinghamshire.
'clay daubins' in Cumbria.

c) no traditional name. Pisé, and cob are used in the area where c) is found but they are modern names.

d) 'clay lump' in Norfolk, to Essex.
'clay bat' in Cambridgeshire.

Daub is only infrequently repaired, replacement with alterative materials has become commonplace. Repair is uncomplicated and simple to achieve once the host surface has been made receptive. The other materials were repaired by piecing in brick or concrete block or filling voids with mass concrete. This is usually destructive of the ancient fabric[5] and so now attempts to repair with reconstituted 'cob', 'clay lump' etc. or remaking it to marry with the host material is now being pursued.

CONCLUSION

Britain has been slow to respect its earthen buildings. Although its history here is regularly punctuated with periods of interest in its capabilities, these have not been sustained.

The water proofing qualities of daub and limewash are now seen to be more protective to ancient frames than the modern substitutes that have been used. Concrete blocks have not yet equalled the popular approval for thermal ability that earthen ones have.

The repair of the material has highlighted the need for greater care and respect. At the moment this is an aspect that has not been addressed adequately. Knowledge and practical application of successful repair techniques in Britain lags far behind that for the other traditional building materials.

NOTES

1. John McCann, Clay and Cob Buildings (Aylesbury, Shire 1983) 13-14.
2. Department of Scientific and Industrial Research, Building in Cob and Pisé de Terre, (London, HMSO, 1922 and 1949)
3. John and Nicola Ashurst, Practical Building Conservation, Volume 2, (Aldershot, Gower 1988) 94-97.
4. Alejandro Alva Balderrama and Jean Marie Teutonico, Notes on the Manufacture of Adobe Blocks for the Restoration of Earthen Architecture (Rome, ICCROM, 1983) 8-9.
5. Philip Hughes, The Need for Old Buildings to Breathe. Information Sheet 4 (London, SPAB, 1985).

PREHISTORIC MOGOLLON AND ANASAZI EARTHEN ARCHITECTURE OF THE SOUTHWESTERN UNITED STATES

David Teal Kirkpatrick
Human Systems Research
3201 Linden Avenue
Las Cruces, NM 88005
U.S.A.

ABSTRACT

Between A.D. 1150 and 1400, Mogollon peoples of the Chihuahuan Desert in the American Southwest built pueblos (settlements) using puddled adobe construction techniques. The ruins of these pueblos are found across southern New Mexico and west Texas. Smaller pueblos had one or more linear room blocks, while 50-room or larger pueblos were generally U-shaped or enclosed a plaza. Large, melted adobe mounds may indicate the remains of multistory room blocks.

Archaeologists have excavated and studied prehistoric Mogollon adobe structures over the past 50 years. The architectural details of these structures are described and compared with prehistoric Anasazi adobe sites in northern New Mexico of Pindi and Pot Creek pueblos and with the large prehistoric site of Pacquime, Casas Grandes, Chihuahua, northern Mexico.

KEYWORDS

Prehistoric; United States; Jornada Mogollon; Puddled; New Mexico; Earthen Architecture.

Figure 1. Site Locations

1. Chaco Canyon
2. Mesa Verde
3. Keystone Dam
4. Los Tules
5. Bradfield Site and Condron Field Pueblo
6. Alamogordo Sites 1 and 2
7. McGregor Site
8. Pindi Pueblo
9. Pot Creek Pueblo
10. Paquime

Introduction

Shelter can be simple or complex--a brush hut, a shallow cave, an adobe pueblo, or a steel apartment building. As prehistoric peoples across the world moved into new, unsettled areas, a primary concern was to provide shelter for their families. They built short term occupation structures using hides, tree limbs and branches, dirt and mud, and other locally obtained materials. With increased sedentism, these peoples used other materials to build more permanent structures, including large trees, rocks, and native soil.

The people of the southwestern United States between 5500 B.C. and 300 B.C. were highly mobile, moving across the landscape, hunting small mammals, and gathering native plant foods. About 3,000 years ago these peoples began planting corn, and later, beans and squash, eventually becoming full-time, sedentary agriculturalists by A.D. 500. They developed their own distinctive cultures, recognized today by the distinctive remains of their architecture and pottery. The Anasazi of the northern Southwest uplands are characterized by gray ware pottery and well-built masonry pueblos, such as those at Chaco Canyon, New Mexico, and at Mesa Verde, Colorado (see fig. 1). The Mogollon of the southern Southwest occupied regions of well-watered uplands and desert lowlands. Their culture is characterized by brown ware pottery and masonry architecture in the uplands and puddled adobe structures in the desert lowlands.

The Hohokam of southcentral Arizona lived along major rivers and in adjacent arid regions. Their culture is characterized by brown ware pottery, extensive irrigation canal networks, monumental architecture, and surface earthen structures. All of these surface architecture traditions evolved from pit structures or pithouses.

The topic of this paper is the mud or earthen architecture of the desert Mogollon peoples, with comparisons to earthen architecture of the Anasazi of northern New Mexico, of the Hohokam of southern Arizona, and at Casas Grandes, Mexico.

Archaic Architecture (6000 B.C.-A.D. 400)

The Archaic hunters and gatherers--who lived in southern New Mexico, southwestern Texas, southeastern Arizona, and northern Mexico--are the ancestors of the later peoples that archaeologists called the Jornada Mogollon. The earliest evidence of Archaic architecture in the southern lowland desert was found during archaeological excavations at Keystone Dam in northwest El Paso, Texas (1). Remains of 23 to 41 houses were identified during excavation and soil core sampling. Radiocarbon dates are between 4450 and 3750 BP (years before present). The structural remains are shallow depressions averaging approximately 3 m in diameter and 10 cm deep at the center. The unplastered floors are loose to slightly compacted native sand. The data on the roof structure is very minimal. Possible post holes are present around the exterior edges of three house depressions. The tapered holes range from 5 to 14 cm in diameter and from 7 to 14 cm deep. No post holes were found in the interiors of the house depressions. The superstructure may have been limbs leaning together, which were then covered with smaller branches, rushes, and grass. Fire-hardened clay fragments have been recovered from the remains. A clay mud was probably placed over the grass to form a weatherproof roof, as impressions of grass and reeds were found in the roof remains. Hearths are the only interior feature found in these structures, informal shallow depressions filled with charcoal. Entryway locations are inferred by erosional patterns on the east and southeast sides of the structures.

The inferred construction sequence (2) starts with excavation of a shallow, saucer-shaped depression. Leaners (poles placed at an angle from the perimeter of the depression to the center of the depression above the floor at an unknown height) were placed around the exterior edge of the depression, possibly in holes or sockets, to help support the roof. Small branches on the leaners were covered with reeds and grass. The superstructure was then covered with a thin clay layer. The houses were probably not occupied on a permanent basis but may have used for relatively long periods of time, such as over a winter.

Early Jornada Mogollon Architecture, Mesilla Phase (A.D. 400-1200)

The Archaic peoples added corn to their diet around 2000 B.P. (50 B.C.), starting their shift from nomadic collectors of wild foods to sedentary producers of domesticated agricultural foods. With increased sedentism came the need for more permanent shelter. This culture is known today as the Mesilla phase of the Jornada Mogollon (3). The type site is Los Tules, on the west bank of the Rio Grande, just west of La Mesilla, New Mexico. These people lived in pithouses that were slightly deeper than the Archaic-age, saucer-shaped depressions, with vertical walls. Two types of pithouses were originally described by Lehmer (4). The first is rectangular with ramp entrances to the east and southeast. The second is circular with a roof entrance. Mesilla phase sites in the El Paso area are similar in shape and size but have plastered walls and floors (5). The roof construction is poorly known. Post holes are found around the edge of the pit and in the center of the floor. Unlike the Archaic pit structures, no dried mud roofing material has been found in the excavation of the Mesilla phase pithouses. In the Hueco Bolson east of El Paso, the structures are similar, with shallow hearth features located just inside the structure, past the rampway (6).

Late Mogollon Achitecture, El Paso Phase (A.D. 1200-1400)

The El Paso phase represents an established, sedentary lifeway based on full-scale agricultural practices. The basic architectural shift, as in other parts of the Southwest, is from a pitstructure to a surface room unit (7, 8). The El Paso phase Mogollon (A.D. 1200 to 1400) sites are recognized by their earthen architecture and brown ware pottery. These peoples used puddled earth construction techniques to build their homes. Puddled earth is wet soil that contains sufficient calcium carbonate so that the soil dries to a hard mass capable of supporting the weight of the additional upper walls. The walls were built in courses. Wet earth was usually placed in a foundation trench and shaped by hand into a linear course that extended slightly above ground. When this earth dried, another layer of wet earth was placed on top, shaped into place by hand, and allowed to dry. The process was repeated to achieve the desired wall height. In cross-section, each layer of the wall can be identified by a drying crack at the bottom and top of the course.

No evidence of roof structures remains in the Jornada Mogollon area. The two large post holes often found inside the north and south walls indicate large supports for north-south beams; these may have held smaller east-west posts, which rested on the walls. These were probably covered with branches and grass and dirt for insulation. The roofs may have been covered with mud.

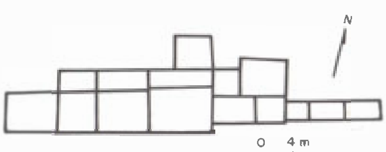


Figure 2. Bradfield Site (after Lehmer 1948:fig. 14)

The ruins of smaller pueblos have one or more linear room blocks with 3 to 20 rooms for a family or an extended family unit. Larger pueblo ruins are U-shaped, with enclosed plazas and 50 or more rooms. The very large ruins of extensive, melted adobe mounds may represent the remains of multistory room blocks. These larger communities probably housed several extended family units. In the following section, I present descriptions of El Paso phase architecture found at selected excavated archaeological sites. All of these sites are located in the Tularosa Basin east of Las Cruces and north of El Paso, Texas.

Bradfield Site

The Bradfield Site was excavated by Lehmer (9) in 1940 after portions of the 16-room pueblo were dug into by pothunters. The east-west linear room block measures 25 m (north-south) by 95 m (east-west) (see fig. 2). A study of wall abutments determined the growth of the pueblo. The walls were started in foundation trenches 20 to 25 cm below floor level. No stones were used in the foundation trenches or in the walls. Walls were built first and then the roof, followed by the plastering of the floors. The walls average 25 cm in width, with a range between 10 to 60 cm. The wet-laid courses were 20 to 35 cm high. The excavated wall remains were no higher than 75 cm, indicating a severe amount of erosion occurred after the abandonment of the pueblo over 600 years ago. Vertical and horizontal drying cracks marked individual courses. Mud floors ranged from 5 to 15 cm thick, based on the number of replastering events. The first floor was laid over native soil. Room features include hearths and post holes; however, it is thought that roof beams were laid from wall to wall, with the posts in the rooms used as secondary supports. Roof beams were probably covered with smaller beams and brush, then with a layer of dirt. Entry was probably through the roof, although some evidence for doorways in walls was present.

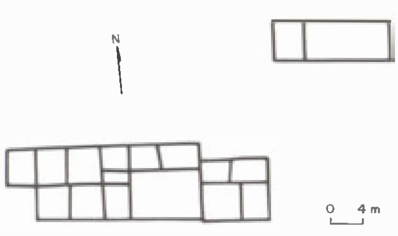


Figure 3. Alamogordo Site 1, House 1 (after Lehmer 1948:fig. 16)

Alamogordo Site 1, Houses 1 and 2

The excavations were conducted at Alamogordo Site 1 by Wesley Bradfield in 1929 and by Stanley Stubbs in 1930 (10). House 1 is an east-west room block measuring 10 m (north-south) by 45 m (east-west) (see fig. 3). The 15 rooms are laid out two rooms deep. The walls were set in foundation trenches 20-25 cm below the surface. Bradfield did not record wall measurements in his notes, although he noted the presence of coursed lumps of dried mud that were part of the wall. Fire pits were located near the center of the rooms. Severe erosion of the walls removed evidence of possible doorways. Roof construction is thought to be similar to that at the Bradfield Site.

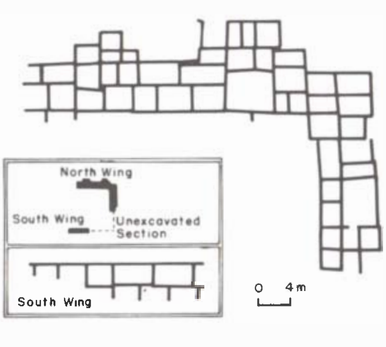


Figure 4. Alamogordo Site 1, House 2 (after Lehmer 1948:fig. 23)

House 2, located approximately 230 m from House 1, is a room block built around the three sides of a plaza that opens to the west (see fig. 4). The

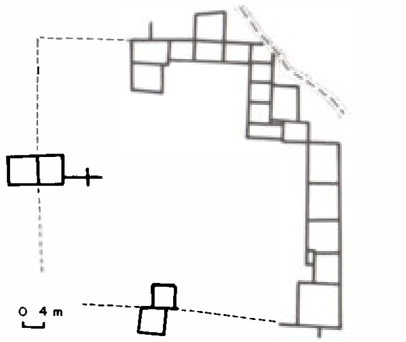


Figure 5. Alamogordo Site 2, House 1 (after Lehmer 1948:fig. 24)

room block measures 85 m (north-south) by 80 m (east-west). Fifty-sixe room were excavated, with an estimated total of 75 to 100 rooms. Rooms averaged 3.5 by 4 m, ranging from 2.5 by 3 m to 8 by 9 m. Wall foundation trenches were 25-30 cm below floor surfaces with stone slabs lining some trenches. The walls were made of irregular courses of mud, 25-30 cm thick and of unknown height. Floor features are primarily shallow hearth pits and roof support post holes. Roofs were constructed of horizontal poles measuring 2.5 to 10 cm in diameter and spaced 30 cm apart, often laid from the walls to a central beam. The poles were covered with reeds, grass, cornstalks, and brush and were topped with dirt.

Alamogordo Site 2, House 1

This site, located southeast of Alamogordo (11), consists of a rectangular room block enclosing a plaza (see fig. 5). The exterior walls measure 60 by 60 m. Twenty-two of the estimated 60 rooms have been excavated. The rooms average 3.5 by 4.5 m, ranging from 3 by 3.5 m to 7 by 8 m. The dried earthen walls, which average 45 cm thick, often had large stones (up to 25-30 cm in diameter) incorporated into the. Wall foundation trenches had stone slab floors. Roof construction was similar to that at Alamogordo Site 1. During excavations, Bradfield and Stubbs noted the presence of earlier, eroded wall foundations and wall remains.

Condron Field Pueblo

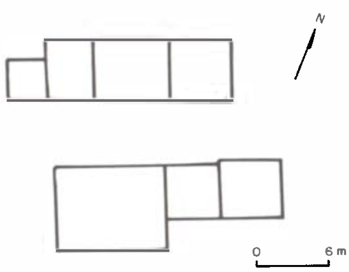


Figure 6. Condron Field Pueblo (after Hammack 1962:fig. 1)

The remains of Condron Field Pueblo are located under the airport for White Sands Missile Range, just south of the Post Headquarters. The site, excavated in 1960 (12) and 1970 (13), consisted of two linear room blocks with a total of seven rooms (see fig. 6). The wall thickness averaged 20 cm. No evidence of a foundation trench was found. The rooms ranged in size from 3.3 by 3.5 m to 7.5 by 10 m. Hearths were present in all rooms near the center of the south wall. Post holes were random. The floors were finished with hard-packed clay over sterile soil and were often replastered. No evidence of doorways was found. Some of the smaller post holes in the floors may be sockets for ladders associated with roof entrys.

The McGregor Site

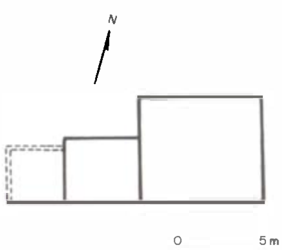


Figure 7. McGregor Site (after Brook 1966:map 2)

The McGregor Site is located on Ft. Bliss northeast of El Paso. Excavations conducted in 1964 (14) revealed a small, three-room site (see fig. 7). A foundation trench was present 30 cm below floor level. The wall stubs showed vertical and horizontal cracking. Wall thickness averaged 20 cm. Caliche (poreous calcium carbonate) was used to plaster the walls, which were then painted; they were replastered and painted as necessary. Puddled earth/mud steps were present along the interior of the south wall in two rooms. The floors were built by covering native soil with puddled earth/mud, followed by a caliche-based plaster. Repair patches were evident. Two major post holes for roof support posts were placed just off center on the west and east walls. These probably supported a central beam, which supported smaller limbs. No evidence of roof materials was found. Hearths were located about 1 m off the south wall and equidistant from the west and east walls. The room block, which probably housed a small family, was constructed as a single unit with the southern wall (oriented east-west) laid first and the remaining walls abutting against it.

Anasazi Earthen Architecture

The prehistoric Anasazi occupied the Four Corners area of the southwestern United States (the shared state corners of New Mexico, Colorado, Arizona, and Utah), extending eastward to the Rio Grande region of central New Mexico. Anasazi architecture is typically masonry with mud mortar, the best known examples are the pueblo ruins at Mesa Verde and Chaco Canyon. In some areas of northern New Mexico, earth was used if suitable rock was not available. Puddled-mud pueblos have been recorded in the Chama Valley (15), the Taos area (16), and the Santa Fe area (17).

Pindi Pueblo

Pindi Pueblo, located south of Santa Fe on the banks of the Santa Fe River, is one of these prehistoric puddled mud ruins. Pindi Pueblo was excavated in 1932-1933. The pueblo was occupied in the A.D. 1200s. The construction started by digging foundation trenches a few centimeters to 60 cm deep and slightly wider than the average wall thickness of 22 cm. Only 10 of the 200 rooms had stones in the trenches. Adobe mud was gathered from mixing pits located outside the pueblo, as well as some that were inside rooms. Later, these interior pits were filled in, and floors were built. The mud courses showed impressions of hands and fingers along the walls and on the tops of courses. Impressions of grass and brush are also preserved. No evidence of forms, such as parallel lines in the dried mud of the walls, were found during the excavations or during the analysis of construction techniques. Horizontal and vertical cracks were common, suggesting short segments of adobe were laid, but it appears that each course was as long as the wall. The individual courses averaged 49-59 cm high, although some were only a few centimeters and others were nearly a meter thick.

Room-block construction was irregular; rooms were apparently added as necessary. A long wall was often built and numerous walls abutted it to create several smaller rooms, which were then enclosed with one long or several short walls. The highest excavated walls were 2.2 m tall; these lacked roof beam sockets, indicating the walls were probably taller than 2.4 m. The pueblo may have been two or three stories high, based on the numbers of collapsed floors found in the stratified deposits in several of the rooms. One section of the pueblo may have been four stories high. The rectangular rooms averaged 2 by 2.7 m, with prepared floors 3 cm thick over native soil and, rarely, over flat river rocks. Hearths were shallow, plastered basins in the center of the room or against a wall. Evidence of roof construction methods is lacking. Stubbs and Stallings (19) suggest the roof construction was similar to that at Picuris Pueblo, near Taos, New Mexico. A center post supported a primary center beam across which secondary beams or vigas were laid and were covered with smaller materials and soil (see fig. 8).

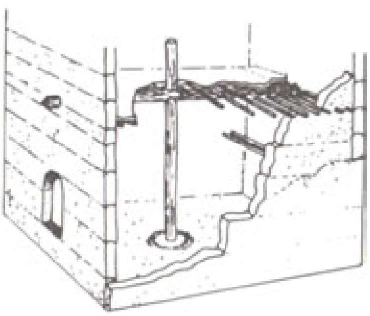


Figure 8. Room details (after Wetherington 1968:fig. 16)

Pot Creek Pueblo

The ruins of this large pueblo lie on the banks (see fig. 9) of Pot Creek about 22.5 miles south of Taos (20). Excavations began in 1957 and continue to the present. The site was first occupied ca. A.D. 1000 by the Anasazi, who built shallow square pithouse with walls made of coursed mud and floors of puddled mud. Later surface earthen rooms date into the A.D. 1300s. About A.D. 1200, construction of multiroom and multistory coursed mud room blocks began. The described architectural details are from rooms built between A.D. 1250 and A.D. 1350, which are very similar to those at Pindi Pueblo.

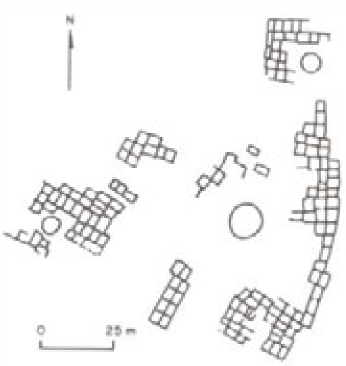


Figure 9. Pot Creek Pueblo (after Crown 1990:fig. 3 [23])

Foundation trenches were dug at varying depths but not deeper than about 30 cm. These were the same width as or slightly wider than the coursed mud walls. No reinforcing stones were found in the trenches. The courses were 27 to 40 cm thick, 45 to 55 cm high, and of unspecified length, presumably the length of the room. Finger- and handprints were common, and no evidence of molds was found. Some walls consisted of two individual courses that supposedly supported the weight of upper-story rooms.

Remains of center support posts were found in the majority of the ground-floor rooms. The posts were placed in holes dug into native soil. In trash-filled rooms, the post hole was dug to the old floor, and a stone was often placed at the bottom prior to setting the post. The beam supported a main rafter, which supported secondary vigas (see fig. 10). Remains of second- and third-story floors provided evidence of upper-level, central post support systems (see fig. 8). At Pot Creek and Picuris Pueblo (21) circular floor basins were placed around the center support post, a trait unique to the Taos region. Hearths were placed between the post and the wall.

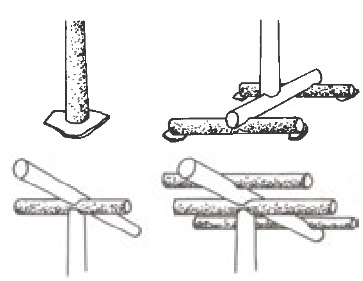


Figure 10. Central post support system (after Wetherington 1968:fig. 16)

Room floors were built over native soil or in leveled trash deposits of previous occupations. Puddled mud was poured over the soil or a foundation layer of sandstone slabs and cobbles. Entryways (open and sealed) were found in ground-floor rooms, the door bases being the tops of the first course of puddled mud. Doors were 30 to 60 cm wide, but their height is unknown, as no lintels or complete entryways were found. Entry to most rooms was probably through roof hatchways.

Adobe Architecture of Paquime, Casas Grandes, Mexico

The prehistoric pueblo of Paquime, Casas Grandes, Mexico, is about 320 km southwest of El Paso, Texas. Di Peso (22) has provided an excellent, definitive study of Paquime and its peoples. The earthen architecture of Paquime differs from that of the Mogollon and the Rio Grande Anasazi, because forms were used to contain the puddled mud for each course added to the wall. The use of forms indicates a greater labor commitment--procuring materials to create forms, using and maintaining the forms, and replacing the wornout forms--in addition to the auxillary materials, such as ropes, hammers, cutting and shaping tools, and associated labor costs for these.

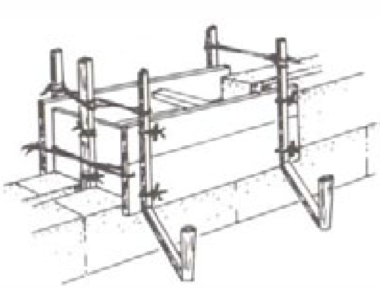


Figure 11. Form details (after Di Peso 1974:fig. 149-4)

Wall construction started with the excavation of foundation trenches, ranging 15-47 cm deep (average 18 cm). Trenches were as wide as the wall. The trench floor had clean gravel and a red clay laid for the wall base. The puddled mud walls of Paquime were formed by pouring mud into plank forms supported by stakes and braces (see fig. 11). After each course of mud dried, the form was removed and adjusted for the next pour. The use of the dropped key technique plus roughened contact joints strengthened the walls. Evidence of forms include adobe walls with cast impressions, evidence of slipped forms, and preplanned, squared space (rather than curvilinear space) for vigas (roof beams). Also, postholes for bracing stakes remain parallel to the walls. The use of forms allowed walls to be thicker, averaging 52 to 74 cm for single story rooms and 77 to 92 cm for additional, load-bearing walls. Roof construction techniques were similar to Mogollon and Anasazi techniques. Primary beams supported secondary beams, which were covered with brush and grass and were sealed with a poured puddled mud floor. In general, the architectural features of Paquime was more complex than those of the Mogollon and Anasazi pueblos.

Discussion

Prehistoric earthen architecture has a long tradition in arid areas of the Mogollon and a short tradition in the temperate areas of the Anasazi. In the Mogollon region, puddled mud structures were typically small, single story, and spatially dispersed across the landscape. This reflects low population density. The larger, multistory pueblos are situated in better-watered areas with access to upland timber resources. Studies of wall and roof construction techniques are hindered by the poor preservation caused by severe wind and water erosion. Studies of earthen construction material is needed to help understand differential preservation between Mogollon and Anasazi ruins. In the upland Anasazi areas, some of the ruins are better preserved, with taller walls remaining. All that remains of Mogollon structures after 600 years is short wall stubs and floors, which have been protected by accimulated soil. In areas of severe erosion, only foundation rocks or cimientos remain. An occasional mound may indicate an unexcavated, multistory structure. In both areas, adobe walls were built by hand without the use of forms. The walls average 20-30 cm thick, with ground-floor wall thickness limiting the construction of upper-story rooms. The use of forms at Paquime allowed puddled mud walls to be built up to 1 m thick for load-bearing walls. This resulted in construction of an extensive, yet compact pueblo. In all three regions, adobe architecture was successfully used by prehistoric peoples to construct shelters in areas lacking suitable timber and masonry construction materials.

The main goal of the majority of excavation projects is to study prehistoric lifeways, not to excavate and develop a ruin into a public park that would require conservation management. The conservation of these earthen ruins is very limited, with the exception of Paquime, where a major effort is ongoing to preserve and protect the ruin for visitors. During excavation, rapid deterioration of the Mogollon earthen structures probably accounts for very poorly preserved walls and floors. The excavation of these ruins or portions of the ruin is usually done in a few weeks so that the wall stubs and floors are exposed a short time. Large tarps are used to protect the features during rain storms. After excavation, the ruins are covered with dirt. The excavtion of Anasazi sites are conducted in a similar manner, with the wall and floor remains protected by tarps during storms. Overhead shelters are not used during the excavations of Mogollon and Anasazi sites, primarily because the short-term exposure of the ruins.

REFERENCES

1. Thomas C. O'Laughlin, The Keystone Dam Site and Other Archaic and Formative Sites in Northwest El Paso, Texas, Publications in Anthropology No. 8 (El Paso: University of Texas, 1980).

2. Ibid., 144.

3. Donald J. Lehmer, The Jornada Branch of the Mogollon, Social Science Bulletin No. 17 (Tucson: University of Arizona, 1948).

4. Ibid., 76.

5. O'Laughlin, "The Keystone Dam Site," 146.

6. Michael E. Whalen, Special Studies in the Archaeology of the Hueco Bolson, Publications in Anthropology No. 9, The Centennial Museum (El Paso: University of Texas, 1980), 54.

7. M.E. Whalen, "Cultural-Ecological Aspects of the Pithouse-to-Pueblo Transition in a Portion of the Southwest," American Antiquity, 46, no.1 (1981): 75-92.

8. Hiroshi Daifuku, Jeddito 264, Papers of the Peabody Museum of American Archaeology and Ethnology, 31, no. 1, (Cambridge: Harvard University, 1961).

9. Lehmer, "The Jornada Branch of the Mogollon," 38-46.

10. Ibid., 54-57.

11. Ibid., 57-58.

12. Laurens C. Hammack, Missile Range Archaeology, Laboratory of Anthropology Note 1 (Santa Fe: Museum of New Mexico, 1962).

13. H.C. Morrow, "Condron Field Site Salvage Excavations on White Sands Missile Range: A Preliminary Report," (Unpublished manuscript on file at El Paso Centennial Museum, University of Texas at El Paso, El Paso, Texas, September 30, 1970).

14. V.R. Brook, "The McGregor Site (32:106:16:4; E.P.A.S. 4)," The Artifact 4, no. 4 (1966): 1-21.

15. Jean A. Jeancon, Excavations in the Chama Valley, New Mexico, Bulletin No. 81 (Washington, D.C.: Bureau of American Ethnology, 1923).

16. Ronald K. Wetherington, Excavations at Pot Creek Pueblo, Publication No. 6, (Taos: Fort Burgwin Research Center, 1968).

17. Stanley A. Stubbs and W.S. Stallings, Jr., The Excavation of Pindi Pueblo, New Mexico, Monographs of the School of American Research No. 18, (Santa Fe: School of American Research, 1953).

18. Ibid., 25-28.

19. Ibid., 28.

20. Wetherington, "Excavations at Pot Creek Pueblo," 19-36.

21. Ibid., 30-32.

22. Charles C. Di Peso, Medio Period Architecture, Casas Grandes, Vol. 4, No. 9 of the Amerind Foundation, Inc. Series (Dragoon: Amerind Foundation, Inc., 1974), pp. 211-221.

23. Patricia Crown, "The Chronology of the Taos Area Anasazi," Clues to the Past; Papers in Honor of William M. Sundt, edited by Meliha S. Duran and David T. Kirkpatrick, Papers No. 16 (The Archaeological Society of New Mexico, 1990), pp. 63-74.

OF TAQ AND DHAJJI DWARI: THE EARTHQUAKE RESISTANT MUD AND BRICK ARCHITECTURE OF KASHMIR

Randolph Langenbach
Assistant Professor
Department of Architecture
University of California, Berkeley
Berkeley, California, 94720

Abstract

The vernacular mud mortar, brick and timber multi-story houses in Kashmir, India are interesting not only because of their architecture, but also because of their seismically resistive construction. The masonry piers and walls are held together at each floor level and above the windows with layers of heavy timber laid directly in the walls.

There are two variations, one known locally as *Taq* with horizontal timbers only, and the second with vertical as well as horizontal timbers, known as *Dhajji-Dwari*. Although of weak construction, these buildings have resisted earthquakes because of their flexibility.

Kashmir has been relatively insulated from the West and from the defusion of modern construction technology and ways of life, and thus has preserved this building tradition until very recently. Now, with the money brought by tourism, new reinforced concrete houses are rapidly replacing these traditional mud houses.

KEYWORDS

Earthquake resistant construction, Mud-brick construction, Mud mortar, Historic Preservation, *Dhajji-Dwari*, *Taq*.

Kashmir, India, Yugoslavia, Greece.

Above: *A narrow lane in Srinagar which is also one of the city's principal thoroughfares. Now many of these lanes are being widened by demolishing the buildings along one side.*

Upper right: *The Rainawari Canal, Srinagar. Canal boats used to be the main means of transportation through the city. Now one short stretch of this canal is reminiscent of the magical scene which used to exist where an ancient canal once penetrated the densest section of Srinagar until filled in during the 1970's (see p5.)*

During recent months the news has been increasingly filled with reports of the conflicts in Kashmir. The images of men in traditional dress standing in front of the timber and brick houses, surrounded by tanks and jeeps, recall the pictures of Afghanistan. Here it is, yet another religious and ethnic conflict which might turn into a civil war. The problem is that such conflicts cannot be easily resolved once they are started, and regardless of the outcome, in their wake often lies the ruination of the traditional culture, way of life, and the fabric of the historic built environment.

Both the traditional architecture and the ways of life are very fragile in Kashmir. It is a land of breathtaking beauty but few resources, a land where the economy depends for basic survival on subsistence farming, traditional handicrafts, and tourism. A protracted conflict will wipe out tourism and thus the market for most handicrafts. This will bring renewed hardship to the population, and has the potential of destroying many buildings in what is one of the most interesting, if not magical, settlements left on the planet.

In this paper I take a closer look at the buildings which make up this city - not the mosques, temples, palaces or other monuments - but the ordinary houses constructed of mud, straw, timber, brick, sod, and (more recently) galvanized steel. These buildings provide an opportunity to study the linkage between traditional construction technology, vernacular design, and a traditional way of life. These particular buildings also are significant because they have an inherent resistance to earthquakes.

Srinagar, a "Medieval" City

Entering Srinagar, in Kashmir, is like going back in time. The houses appear to be ancient and timeless, with much evidence of wear and tear. V. S. Naipaul made the observation in 1964:

> It was a medieval town, and it might have been medieval Europe. It was a town of smells: of bodies and picturesque costumes...; a town...of disregarded beauty...a town of narrow lanes and dark shops and choked courtyards [1]

Srinagar is a densely packed city full of houses. In the oldest portions the residences are mixed together with shops and even small manufacturing industries, such as carpet weaving and metalworking. The view of this dense development and teeming activity is like a scene out of the pages of Dickens or from the canvas of Brüegal. The houses themselves are what form the essential backdrop for this remarkable scene. They appear rickety and insubstantial, almost as if they were deliberately built only as a stage set for the human pageant which takes place around them.

A single house is usually occupied by a joint family, with the grandparents living together with the families of each of their sons. The houses were clustered into small districts, known as *mohallas*. Until the present strife, the families of each *mohalla* formed a tightly knit neighborhood of both Muslim and Hindu families who, regardless of their religious differences, were very close. [2] Often a temple, mosques, a *madrassa* (a muslim religious school), a school, and a few shops, form part of the *mohalla*.

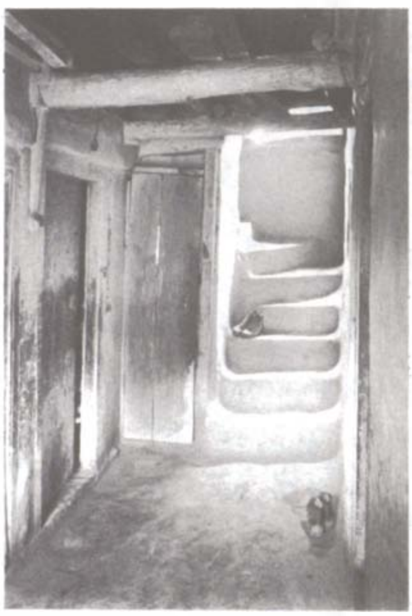
The Jalli shutters showing, on the left, the remains of the paper attached for winter protection.

The entrance to the typical house would be through a door in a wall separating a small paved private court from the street. The W.C. is usually detached from the house, and set in the corner of the front court, while the bathroom usually consists of a small room next to the hot water tap behind the kitchen stove.

The houses are mostly square in plan, with windows on all sides. In the densest areas, the houses are attached to their neighbors with common walls, but rarely did they line up in even rows. The windows are traditionally closed only with two sets of shutters, the inside set being of solid wood, and the outside with a *jalli* - an open filigree of carved wood. Glass has only recently come into general use in Kashmir. Traditionally oiled newspaper was glued onto the *jalli* shutters to admit light into the houses during the winter.

The living room and the kitchen were always located on the ground floor, with the bedrooms located on the second and third floors. The top level of the house was usually enclosed only with timber. It was usually one single large room with many windows. The family traditionally moved to this room during the summer in order to take advantage of the cool breeze and also, in moist areas, to move away from the mosquitos. This room was also used at times for gatherings and social events. In winter it was used mostly for storage.

Before the recent introduction of corrugated galvanized steel sheeting, the roofs of the houses were most frequently covered with mud laid on an underlayment of bark. In the spring the soil roof became covered with grasses and wildflowers. In the spring, the blossoming of the tulips and lilies on the roofs of the dense mass of houses in Srinagar was famous until most of the mud roofs had disappeared in favor of the corrugated steel.



The entrance lobby of a typical traditional house showing the timber and mud interior finishes. This front lobby, located at the center of the house, is considered to be the safest place to go to during an earthquake. (Running out of the house is more dangerous.)

The Aseismic Attributes of Traditional Construction in Kashmir

Earthquakes in Kashmir have occurred with regularity over the centuries, and the Kashmiri houses reflect an adaptation to this threat through the interlacing of heavy timber within the plane of the exterior walls of the masonry buildings.[3] In Kashmir, as in most countries, wood and nails are simply too precious to be used for more than what is absolutely necessary, so masonry is the primary building material Most of the traditional buildings in Srinagar can be divided into two basic systems of construction. The first system, sometimes referred to as "*Taq*,[4]" consists of load-bearing masonry piers and infill walls, with wood "runners" at each floor level used to tie the walls together with the floors. The second system, known as *Dhajji-Dewari*[5] construction, consists of a braced timber frame with masonry infill.

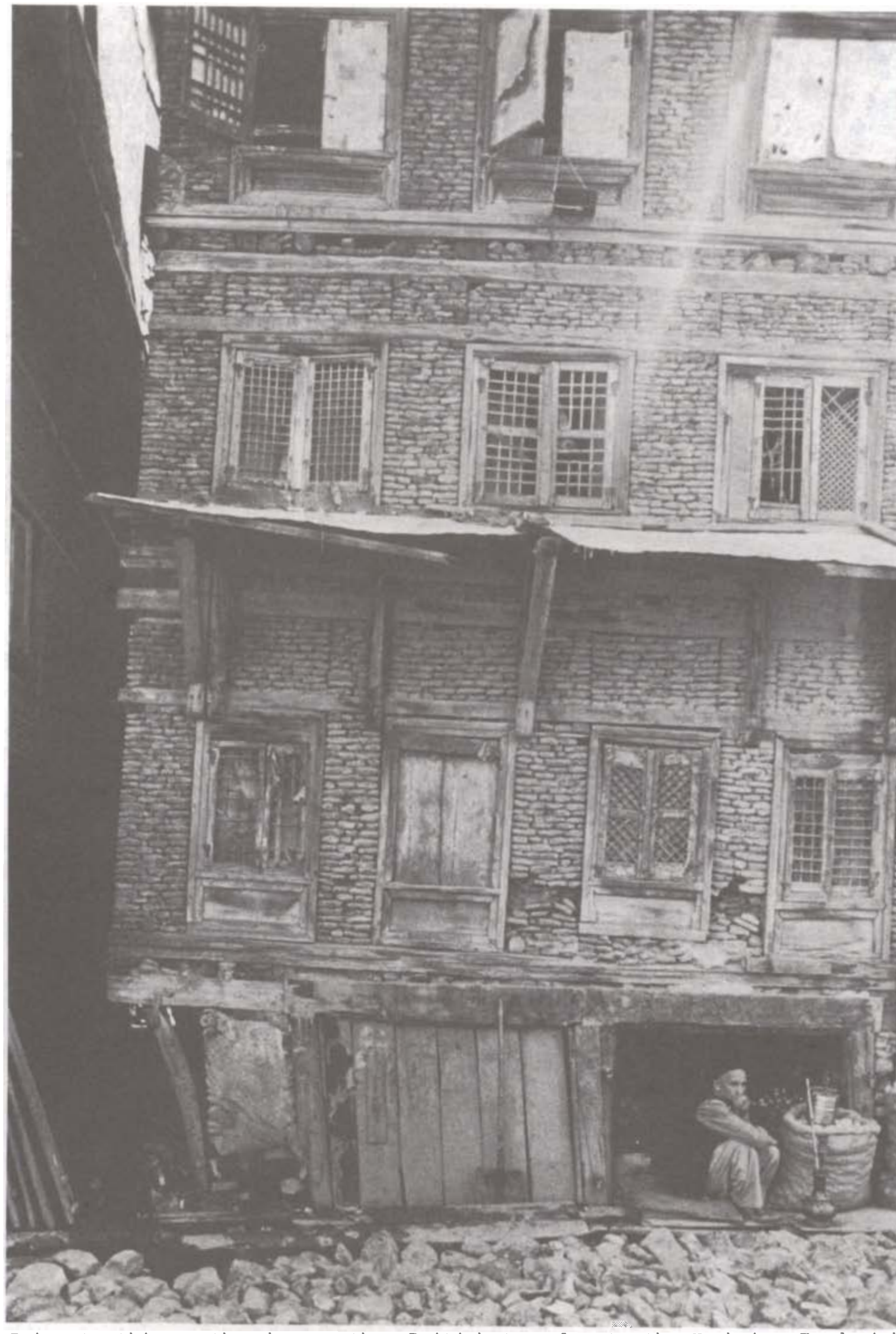
The houses were almost always raised on a plinth made up of stone masonry laced with heavy timbers measuring at least one meter in height. Above this stone the exterior walls were constructed of a mixture of brick and rubble stone set into a thick bed of mud mortar (*Taq*), or with a single layer of modern size brick surrounded by heavy timber (*Dhajji-Dewari*). The *Taq* houses were usually faced with a layer of small, very hard, hand made clinker bricks, known as *Maharaji bricks,* which give the houses their distinctive appearance.[6]

The mud, brick and timber construction was usually left uncovered by any plaster on the exterior. The interior was plastered with a mixture of clay, straw, and other ingredients. This layer of mud plaster provided insulation in summer and winter. The internal plaster was renewed by the application of a coat of a thin mixture of clay and water over the existing surface about every two weeks, a process referred to in Kashmiri as *livun*. When this dryed, the undulating mud walls were left with an unblemished beige clay surface.

The *Taq* System. The timber beams in the *Taq* buildings do not constitute complete frames. Instead, large timbers "runners" rest along the load bearing masonry walls, with the floor beams and the "runners" for the cross walls lapping over them. The wood serves to tie the walls of the structure together with the floors. The weight of the masonry serves to "prestress" the wall, contributing to its resistance to lateral forces.[7]

The construction practices used for these buildings in Kashmir which stand in contrast to the codes and commonly accepted practices today, include (1) the use of mortar of negligible strength, (2) the lack of any bonding between the infill walls and the piers, (3) the weakness of the bond between the wythes of the masonry in the walls, and (4) the frequent (historical) use of heavy sod roofs. It is just such buildings that were observed almost a century earlier by Arthur Neve, a British visitor to Kashmir who witnessed the 1885 Kashmir earthquake:

> To a European traveler, the city of Srinagar looks tumbledown and dilapidated to a degree; very many of the houses are out of the perpendicular, and others, semi-ruinous. But the general construction in the city of Srinagar is suitable for an earthquake country; wood is freely used, and well jointed; clay is employed instead of mortar, and gives a somewhat elastic bonding to the bricks, which are often arranged in thick square pillars, with thinner filling in. If well built in this style the whole house, even if three or four stories high, sways together, whereas more heavy rigid buildings would split and fall...Part of the Palace and some other massive old buildings collapsed...[but] it was remarkable how few houses fell....[8]



Above: A masonry pier resting on a timber cantilever bracket on a ca. 18th century house. The beams extend across the width of the house, tying it together, while the weight of the masonry holds the wood in place in an earthquake.

Upper right: A ca. 18th century Taq system house showing the horizontal runner beams and the masonry piers between the windows. Notice that in this unusual case the piers do not even line up.

Prior to this earthquake, another British traveler to the Kashmir, Frederick Drew noted that these houses were locally recognized for their aseismic attributes, "these mixed modes of construction are said to be better as against earthquakes (which in this country occur with severity) than more solid masonry, which would crack." [9] More recently, two Indian engineers, N. Gosain and A. S. Arya ascribed the damage from a 1967 earthquake to the different types of traditional and modern construction in Kashmir:

> The timber runners...tie the short wall to the long wall and also bind the pier and the infill to some extent. Perhaps the greatest advantage gained from such runners is that they impart *ductility* to an otherwise very brittle structure. An increase in ductility augments the energy absorbing capacity of the structure, thereby increasing its chances of survival during the course of an earthquake shock. This was substantiated by the observation that "*dhajji-dwaris*" [sic] in which a larger volume of timber was used were comparatively safer. [10]

Gosain and Ayra note that during the 1967 Kashmir earthquake buildings of three to five stories survived relatively undamaged. According to Arya, one of the most important reasons for this was the damping of the motion of the building caused by the friction induced in the masonry of the *Taq* walls when it begins to crack and move along the mortar joints. Internal damping "may be in the order of 20%, compared to 4% in uncracked modern masonry (brick with Portland cement mortar) and 6%-7% after the masonry has cracked." His explanation for this is that "there are many more planes of cracking in the *Dhajji-Dewari* compared to the modern masonry." It is this distribution of the forces throughout a large area of the wall, preventing destructive cracking in one

Many of the houses in Srinagar remain radically askew from weak soil and past earthquakes.

area, that leads to a much greater level of energy dissipation than would otherwise be possible. As a result, even though the mortar is extremely weak, causing the wall to yield under a much smaller load, the masonry continues to have a good chance of holding together. The timber runner beams and floor diaphragms keep the individual piers from separating, which would cause the house to break apart. In Kashmir, rigidity carries the potential for destruction. The more rigid a building is, the stronger it must be in order to avoid fracture. Because the primitive materials and means of construction used in Kashmir did not provide strength, flexibility was essential.

A similar form of construction can be found in Afghanistan but not in Nepal. The cultural context in which it developed extends to include Yugoslavia, Turkey, Iran and Iraq, all once part of the Ottoman Empire. [11] Houses found in parts of Greece affected by earthquakes also have horizontal wood members, but in the buildings seen by this author, the walls are far more massive. The use of horizontal wood ties is also common in seismic areas of Turkey, with less use in nonseismic areas, thus supporting the claim that they were used deliberately for earthquake resistance. [12] The bond beams in Turkey are credited with "incorporating ductility to the adobe walls, substantially increasing their earthquake resistant qualities." [13]

The *Dhajji-Dewari*. The half-timber, brick-nogged type, known as the *Dhajji-Dewari,* exists side-by-side with the *Taq* in Kashmir. Half timbered construction continues to provide an efficient and economical use of materials. The use of wood, while kept to a minimum, nonetheless enables the thin masonry walls to resist out-of-plane collapse, while also restraining the in-plane movement of the masonry.

Dhajji-Dewari comes from Persian and literally means "patch quilt wall." This method of construction appears to have emerged into common usage alongside of the *Taq* system during the late nineteenth century when bricks of a more standard large size became available. This larger size brick (65mm X 115mm X 230mm) [14] set into the timber frame enabled the construction of one-wythe-thick brick wall. *Dhajji-Dewari* buildings constructed with unfired mud bricks also were common, especially in the villages.

An example of Dhajji Dewari *construction.*

Variations of the brick-nogged type were common historically in many areas not affected by earthquakes, such as medieval England and Europe, where bricks provided an alternative infill to wattle and daub. It even extended into North America, where the German *Fachwork* tradition gave root to a number of vernacular buildings with masonry infill in the United States. Since much of this construction was far from earthquake country, it is not possible to ascribe its continued use in Kashmir solely to the incidence of earthquakes. It is clear, however, that the almost universal use of either timber restraint system is a logical response to both the incidence of earthquakes and the instability of the soils. Variations on this system have proved especially suitable in seismically active regions such as Yugoslavia, Greece, and Turkey, and it is probably from this region that the Kashmiri system developed.

In a survey of the damage caused by the 1963 Skopje, Yugoslavia, Earthquake, a London engineer, N.N. Ambraseys, reports that the "old adobe construction, particularly those with timber bracing, resisted the shock with some damage, but behaved far better than the [modern] brick or the hybrid [reinforced concrete with brick infill] construction." Many of the modern reinforced concrete buildings, which ranged from 3 to 6 stories in height, were seriously damaged or destroyed, while the less substantial adobe buildings survived. [15]

In Kashmir there are many examples of houses where both the *Taq* and the *Dhajji-Dewari* are used side by side in the same structure. The *Dhajji-Dewari* is frequently found used for the party walls between buildings, whereas the *Taq* is used for the front walls. In principle, the *Dhajji Dwari* is lighter in weight, allowing for its use on walls which are cantilevered over the street. The brick-nogged type of construction also is found in Greece, where it is sometimes used for the upper part of the houses - where masonry would be less stable because of the lack of the precompressive force provided by the weight of the building above. In Kashmir, the top floors of the houses were frequently made only of timber, probably for the same reason.

This construction type has shown enough resistance to earthquakes when compared to plain masonry structures, whether of fired brick or adobe block, that in some of these areas where earthen or brick buildings continue to be built it is encouraged by the local building codes. [16] A. S. Arya reports that it has formed the basis for the current Indian Standard Building Code #4326. [17]

Present-day Construction

Over the course of the last twenty years, construction practices have changed dramatically in the Kashmir Valley. Now, most of the new buildings are of reinforced concrete. Brick is still used, but only for infill walls between reinforced concrete floor slabs. Considering the world-wide trend towards concrete or steel construction, this is not surprising. In Kashmir, however, it does represent a major shift in the nature and the cost of construction. In addition, much of the building which is done in reinforced concrete is neither well engineered nor carefully constructed. Concrete in Kashmir, as in most of the Third World, is not treated as a sophisticated material requiring careful quality control. It is mixed by hand, dumped by the basket-full, and retempered if necessary. In addition, much of the construction is not engineered for earthquake forces. Instead, it must rely on the infill masonry for most of its lateral strength. The timber runner beams and *Dhajji-Dewari* frames have been abandoned as unwanted vestiges of the pre-modern way of life.

A Dhajji Dewari house being reconstructed using the traditional materials, including mud mortar. All of the exterior walls were reconstructed while the family continued to live in the house.

This author did come across one project involving the reconstruction of a house in Srinagar where the *Dhajji-Dewari* system was still being used. In this particular construction project it was observed that the mortar in which the brick infill was laid was made from mud mixed with straw. A man was mixing this mortar with his bare feet. Next to this pile was another made up of cement and sand. In response to the inquiry as to why both materials were being used for mortar on the same project, the mason pointed out that the mud was used for the brick infill, while the cement mortar was being used for a brick wall behind the structure which did not have the timber surrounds.

While the mason could not fully explain in English why it was done this way, it was clear that he understood that the use of cement for the infill bricks would be a mistake. It is possible that the higher cost of the cement contributed to the decision, but wood is even more expensive. Mud was being used because cement would not have withstood the movement of the timber frame without cracking. Like many traditional systems, the *Dhajji-Dwari* system is an almost organic balance in the economical use of locally available natural materials. Once one part of it is changed, the whole system necessarily must change.

In this particular case not only was the internal core of an existing house conserved while all of the exterior walls were being reconstructed, but the family continued to live in the house as the work was being done. Such was probably the rule rather than the exception in Kashmir, until the recent introduction of Western-style building technology. When asked the age of the Kashmiri houses, earthquake engineer Anand Arya responded by telling the story of a barber who passed his razor on to his son, saying that it was precious because "it had been in the family for three generations." This barber went on to say, "My father replaced the blade, and I replaced the handle." His point was that these changes made in the course of its use did not erase the time honored significance of the artifact, and "the Kashmiri houses are the same as that razor." They are ancient, regardless of whether the physical fabric had been replaced in time, simply because they represent the embodiment of a tradition. The timeless quality of the buildings in Srinagar is undoubtedly a product of the fact that they have been rebuilt in fragments whenever needs changed or deterioration required it over many generations. This probably explains why the travel diaries from the nineteenth century describe a typical Srinagar scene to be one of rickety falling down houses, which look every bit the same as their late twentieth Century counterparts.

The "Modernization" of Srinagar: The Destruction of the Old City

On every level, from the scale of the individual dwelling to the scale of urban and regional planning, Kashmir's reach for modernity threatens to be a disaster. The tragedy is all the greater, because this fragile place is also one of the most unique and beautiful places in the world. For one hundred years, it has been the beauty and character of Srinagar's natural and human environment that has been the region's primary "export." It is this same beauty that is threatened with destruction in the current efforts to "modernize" it.

The clash between old and new in the historic part of Srinagar. Buildings, like the one on the right, threaten the coherence, scale and character of the historic center of Srinagar.

The least recognized but most important issue is the tremendous aesthetic and cultural loss that inevitably would accompany the rebuilding of Srinagar and other cities that have similar pre-modern vernacular buildings. Total replacement of these structures with buildings of a new reinforced concrete technology destroys that continuity. The work is taken out of the hands of the people who had traditionally done it and put into the hands of specialists trained in a new way. An alien form thus makes its appearance on the landscape. What is needed is a combination of traditional vernacular construction techniques with a modest and compatible introduction of some modern materials and technology.

The problems in Kashmir are not entirely the fault of the shift towards reinforced concrete construction. The desire to have a concrete house is emblematic of the desire to be modern, especially when modernization is actually confused with Westernization. If it were only people wishing to renew their houses in a new material, the change would be gradual, and the culture and way of life would remain intact. However, Srinagar itself is being rapidly eroded by a town planning scheme designed to modernize the city by widening the narrow streets in order to carry auto and truck traffic. In the eight years between this author's first visit in 1981 and his most recent visit in 1989, many of the narrow lanes had been widened into major traffic ways. The buildings along one side had been demolished and replaced with a continuous stream of buses, trucks, and motor rickshaws, with horns blasting. Rarely were sidewalks constructed, as people have always walked in the street. Now they must compete with the motor traffic, and residents frequently get run over.

The new road constructed during the 1970's which replaced the picturesque 14th century Mar Canal which used to penetrate the heart of Srinagar. The sewerage line which was supposed to replace the canal was deleted in a budget cut, so now the sewerage which used to flow out of the city through the canal now backs up into Dal Lake.

The Chief Town Planner, M.L. Chaku explained that before they had built the roads "the center was dead." It was clear that his conception of city "life" was incompatible with the traditional life of the walking pace, the mule carts, the small shops facing directly onto the lanes, and the residences mixed together with the shops. The main new street has the shops lined up like bunkers, and few of these new shops appear to support the kind of activities and industries as the older ones.

The local desire for modernization presents a real social dilemma. To recommend a maintenance of the old houses and narrow streets because they are picturesque is unsupportable. Reasons for preservation must be founded in a broadened understanding of how the buildings can continue to support the health and quality of life of the people in the future. Ironically the technology of these houses, although traditional in execution, is still "modern" in concept.

Above: *A house in ruins shows the timbers imbedded at each floor level in the Taq System masonry wall.*

Above right: *A Taq system house undermined by the river shows the remarkable flexibility and strength of this timber/masonry system (and the fearlessness of the workers.)*

Embroidery craftsmen in the living room of a Taq System house. The traditional Kashmiri house has no chairs and few tables. The Kashmiris are accustomed to sitting on the floor.

Modernity should not only constructed on a Western model, and in this case the blind pursuit of the Western model portends disaster. It is a disaster not only because of the major cultural loss that the destruction of the historic environment would cause, but also because, except for the most wealthy, the comfort and quality of life of the people will most likely be diminished by the changes.

For example, by abandoning the soft restraints of the timber beams, while failing to provide the strong restraints of good engineering and quality control in the construction, the new concrete houses are potentially far more dangerous in earthquakes than the traditional timber and masonry ones. With reinforced concrete, a greater degree of life safety can be promised, but, as seen in Armenia, not necessarily delivered. Perhaps by forgetting the unwritten knowledge of past generations, in preference for the seeming certainty of an imported industrialized alternative, a greater risk may result.

Another shortcoming exists in the overall thermal comfort provided by the concrete houses. These houses usually have many large windows, but central heating is practically nonexistant in Kashmir, and most Kashmiris would not be able to afford the fuel it would require anyway. An additional disadvantage is that the concrete has a much greater thermal conductivity than does the mud, timber, and brick making the new houses impossible to heat with primitive stoves. Some of the better traditional homes even had a room, called a "*hamam*", constructed with its floor slabs above a wood fire box which allowed the hot gasses to heat the floor. When interviewed in 1989, many people commented that in winter the newer houses were much colder even than those mud houses which lacked the *hamam*.

Even the sanitary arrangements of the new houses in the old city fail to fit the local conditions. The new houses usually have bathrooms with flush toilets, but the government has yet to install a modern sewerage system in Srinagar, spending its money on new roads instead. As a result, the flush toilets only serve to transport its contents to a ditch in the middle of the public footpath! In the past, the "night soil" had been gathered by workers on a daily basis and taken to the fields, but as of 1989, there were no provisions for the removal of either liquid or solid waste, other than allowing it to migrate slowly to the river in the open gutters.

In other words, modernization has come to Kashmir from the wrong end first. The home appliances and visible trappings of a consumer society are beginning to be accumulated, before the infrastructure is in place. The results are devastating, and these changes have substantially eroded the ecological balance which traditionally existed in the valley. In addition, the removal of the people from some of the older neighborhoods has upset the human ecology as well, because Muslims and the Hindus have moved to separate areas in the new colonies which tends to aggravate the sense of difference and distance between the two communities. As one member of the Legislative Council, Sadiq Ali, observed, in the older neighborhoods the two groups had traditionally lived close together in harmony.

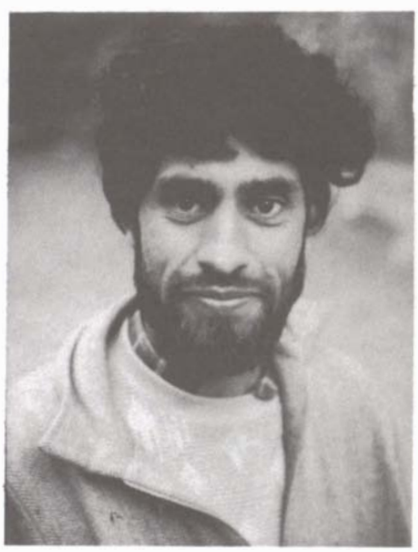
What is ironic is that all of this planning effort begins with the desire to improve the quality of life of the people and to repair the environmental damage that has already occurred. The problem is that in an area like Kashmir, First World industrialized solutions just will not work. With foreign aid, facilities such as water treatment plants can be constructed, but they will not work unless the local community has the money and technological know-how to

A Kashmiri family in front of their Dhajji Dewari *home.*

operate them.[18] Solutions must be in sympathy with the existing society and economy of the region. Kashmir could have a lot to teach the world about life in balance with nature, but first it must rediscover the value of its own traditions. The place to begin is to rediscover the advantages of the timber and mud houses - not in order to return to the past but to bring this technology into the future as an essential step in the effort to return intrinsic wealth to the people in the form of affordability, comfort, family closeness, and social compatibility.

The possibility that this approach might be viable was made poignantly clear when the head of one family living in a traditional mud and brick house, Fayaz Bhat, reported in an interview that for years he believed that he would have "to build a new [modern concrete] house" like that of his neighbors, to replace his house originally constructed by his grandfather. He said that when he was traveling in central India, he met an English couple and was struck by how they were always interested in the old things. He said that it was only then that he realized that, when he returned to Kashmir, he "did not have to tear down his grandfather's house." As T. S. Eliot said in Little Gidding: "We shall not cease from exploration, and the end of all our exploration will be to arrive where we started and know the place for the first time."

These old structures possess something which no architect can put into a new design - the visible manifestation of *time*. Most of all, these structures already belong to the people. They are their houses, their businesses, their parents and ancestor's houses. They carry the unspoken history of generations. They are not just good design; they are an inextricable part of a way of life which defines the character of Kashmir. Their destruction will do no less than destroy this relationship, and thus diminish the cultural heritage which can be a source of Kashmir's pride. It is a loss which no amount of money or material goods can recoup, and it is not the tourists who will suffer most when the loss takes place. It will be the Kashmiris themselves.



Fayaz Bhat, when interviewed in 1989.

---

[1]V. S. Naipaul, An Area of Darkness, London, 1964, p123.

[2]With the recent fundamentalist-inspired conflicts, most of the Kashmiri Hindus have been forced to leave Kashmir.

[3]Seismicity of 8-9 on the Modified Mercalli scale (Arya, interview)

[4]This system, sometimes incorrectly identified as "Dhajji-Dewari," actually has no specific name in Kashmiri to identify the construction method. The closest name identified by local experts to describe it is "Taq." "Taq" refers to the modular layout of the piers and window bays, ie: a 5 taq house is 5 bays wide. The piers are almost always 11/2 -2 feet square, and the bays are approximately 31/2 feet in width. This traditional system with the piers and horizontal wooden runner beams was in common usage before the Dhajji-Dewari came into use. The bricks commonly used were small size, rough surfaced, and hard fired. They are known as "Maharaji Bricks." The reason for the name is unknown. Bricks of this type can be found in the Mogul Period buildings as early as the 16th Century, but the houses which survive date from the 18th and 19th centuries.

[5]*Dhajji-Dewari* comes from Persion and literally means "patchquilt wall." This method of construction appears to have emerged into common usage alongside of the *Taq* system during the late nineteenth century when bricks of a more standard large size became available. This larger size brick (21/2"x41/2"x9") set into the timber frame enabled the construction of one-wyth-thick brick wall. *Dhajji-Dewari* buildings constructed with sun-dried mud bricks were also common, especially in the villages. The brick-nogged type of construction is common throughout many parts of Europe from the middle ages, including some of the half timber construction in England and the *Fachwerk* in Germany. Examples originating from these traditions can be found also in the United States. Since most of these areas were far from earthquake country, it is not possible to ascribe its continued use in Kashmir fully to the incidence of earthquakes. It is, however, clear that the almost universal use of either timber restraint system is a logical response to both the incidence of earthquakes, and the existence of soils subject to differential settlement.

[6] As folk lore has it,the hard-fired brick technology was imported to the valley by the Maharaja. The date for this is uncertain.

[7]Gosain, N. and A.S. Arya, 1967. "A Report on Anantnag Earthquake of February 20, 1967.", Bulletin of the Indian Society of Earthquake Technology, Vol 4, # 3, September, 1967.

[8]Arthur Neve, Thirty Years in Kashmir, London, 1913, p38

[9]Frederick Drew, The Jummoo and Kashmir Territories, Edward Stanford, London, 1875, p184.

[10]Gosain & Arya, "Anantnag," p. 29 (italics added). In this case the authors are referring to the *Taq* system. (The English spelling of *Dhajji-Dewari*" varies.)

[11]A.S. Arya, interview, August, 1988.

[12]. Gurpinar, et al, "Siting and Structural Aspects of Adobe Buildings in Seismic Areas," International Workshop on Earthen Buildings, Univ. of New Mexico, 1981, p 145.

[13]Alkut Aytun, "Earthen Buildings in Seismic Areas of Turkey," International Workshop on Earthen Buildings, Univ. of New Mexico, 1981, p 352.

[14]21/2"x 41/2"x 9"

[15]Ambraseys, N.N., 1965. An Earthquake Engineering Viewpoint of the Skopje Earthquake, July 26, 1963.

[16]For example see: Panayotis Carydis, "The Extent of the Problem of Earthen Buildings in Greece," International Workshop on Earthen Buildings, Univ. of New Mexico, 1981, p 120. (The buildings constructed "have withstood the various earthquakes quite well.") Also Arya reports that India encourages the use of this system.

[17]Arya, interview, August, 1988. (Arya participated in the preparation of this code.) Note that the comparison here is with other forms of masonry construction which are still commonly used in India. Neither this nor the Dhajji-Dwari are as resistive to seismic forces as properly constructed steel and reinforced concrete buildings.

[18]For example, when the new tourist and convention hotel, the Centaur Hotel, designed by an American and an Indian architect, was approved, it was promised to have a sophisticated sewerage treatment plant. It is reported that this plant has broken, and has not operated for years. The hotel is right on the edge of Dal Lake, into which its sewerage now flows.

MUD CASTLES (KASBAS) OF SOUTH MOROCCO - WILL THEY SURVIVE ?

Jean-Louis Michon, architect, Dr. in Islamic Studies (Paris, Sorbonne),
UNDP/Unesco Consultant for project CERKAS, Morocco
30, chemin des Cornillons - 1292 Chambésy - Switzerland

ABSTRACT

In the southern parts of Morocco earth, used in the form of "pisé" and sun-dried bricks, has been for many centuries the main building material and has produced under the guidance of traditional master-masons innumerable settlements and impressive fortresses (kasbas).

Due to historic circumstances and socio-economic changes, this architectural heritage has undergone a marked deterioration during the last decades.

In an effort to save at least a part of this patrimony, the Moroccan government has set up, with help from UNDP and Unesco, a "Center for the Restoration and reuse of the Southern Kasbas" (CERKAS) which is based in a restored section of the historic Kasba of Taourirt (Ouarzazate).

The first project to be implemented by CERKAS will be the rehabilitation of Ksar Ait Ben Haddou, a Berber fortified village of great architectural value and interest to tourists which has already been inscribed on the "List of World Heritage".

KEYWORDS

Conservation - Morocco - Kasba - Ksar - Rammed earth - Pisé - Re-use - Rehabilitation

The main justification for presenting a paper on the above subject stems from the affinity existing between South Moroccan earth buildings and the adobe constructions found in this Southwest region of the U.S. - the so-called "pueblo area" where the present Conference is taking place. My strong feeling is that active links and fruitful exchanges of information and experience may be established between all those who, on both sides of the Atlantic Ocean, are interested in the conservation and perpetuation of earthen architecture, for its historical and cultural value as well as for its technical, economical, social and ecological potentialities.

The "kasbas" of South Morocco : types and characteristics - their origin

In Arabic, the word "qasaba", usually transliterated as "kasba", means "fortress" and generally (like in many parts of North Africa and throughout North Morocco) applies to purely military works, either guarding strategic routes and rebellious areas or protecting cities against potential invaders. In South Morocco, however, the term "kasba" has taken a broader meaning, being used to designate the half-defensive and half-residential mansions built by the feudal chieftains, the "lords of the Atlas" and their lieutenants whose power was exercised over vast territories in the Atlasic and sub-Atlasic regions. The term even came to be applied to a variety of single family, patriarchal dwellings belonging to local landlords and embodying some elements of military architecture, in particular to the very typical castellated house, with its four towers at the corners and central patio, locally called the tighremt, a Berber name meaning "small citadel". To the same family belong the agadirs, i.e., the collective granaries where the village dwellers used to keep their provisions (of grain, barley, onions, etc.) and where they could seek a refuge behind high walls in case of an attack by enemies. Finally, a whole village built upon a rocky eminence, with its houses tightly packed to form a rampart dominating a plain or valley, may also be called "kasba" by way of simplification, while the real word to be used to designate a fortified village should be "ksar" (plur. ksour).

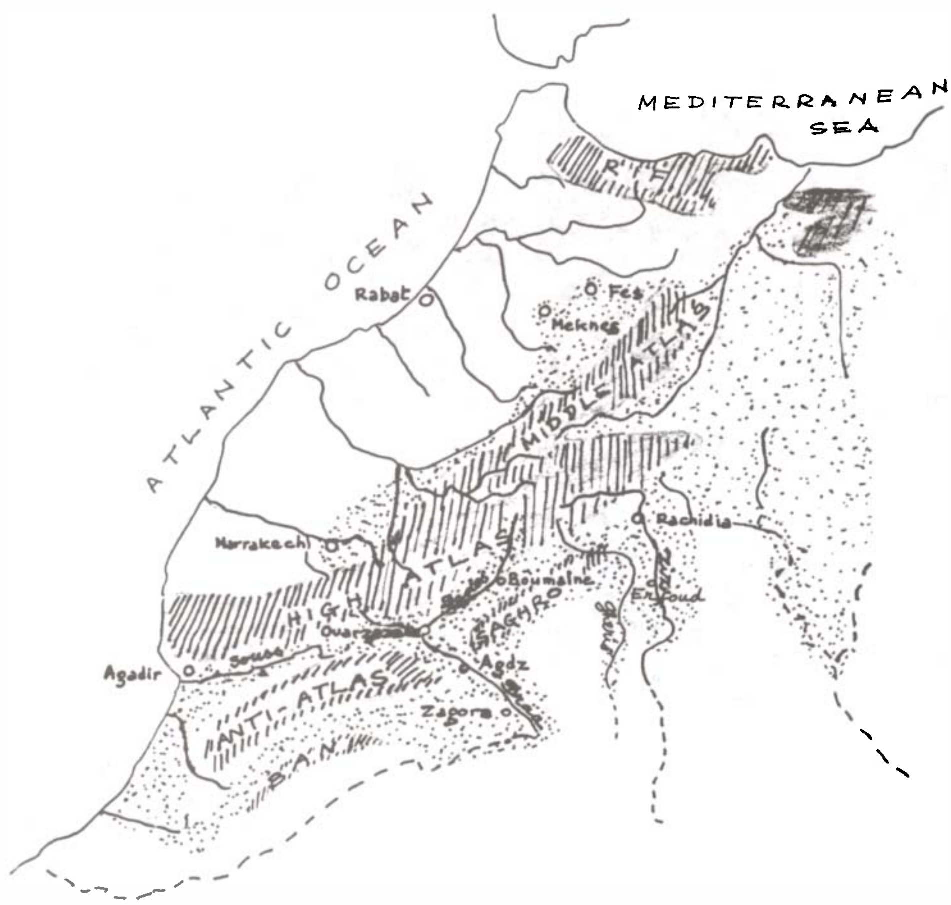


Figure 1. Morocco - Range of mud architecture

: rammed earth buildings

: mountains

Source : Nijst A. et al., Living on the edge of the Sahara, The Hague, 1973; p.5.

The kasbas built with rammed earth or pisé (Arabic: tûb, tâbya) are mainly to be found in what the French historian Henri Terrasse (the first to devote a well-documented and beautifully illustrated monograph to this architecture) has called the "exterior Morocco". This area looks beyond the Atlas range eastward and southward towards the Sahara, and westward to the Atlantic (in contrast with the "interior Morocco", north of the Atlas, which is closed in by the Atlantic and Mediterranean coasts)(see fig.1). Stretching along the valleys of the rivers which spring from the Atlas: the Ziz, Gheris, Drâa, Todgha, Dades, the kasbas climb up to very high altitudes and even reach plateaus where rain and snow are abundant and stone -still used in many parts- would appear to be a more appropriate material. From historical evidence, it thus appears that the art of building with earth had been first practiced by oases dwellers and had spread northward little by little, notably under the influence of the several dynasties originating from the Sahara.

The very origin of the southern kasbas nevertheless remains a fascinating and largely unelucidated problem. Henri Terrasse himself, in the above-mentioned monograph (1), does not exclude the possibility of an Egyptian filiation (slanting walls, pyramidal towers) and insists on the Roman influence (impluvium house as prototype of the tighremt, ksar with its regular plane derived from the castrum and submitted to the law of the cardo). Mrs. Dj. Jacques-Meunié, who is an authority on South Moroccan history, puts forward an hypothesis according to which kasbas and ksour of Moroccan oases might be late descendants of a very old art from Persia and Mesopotamia (2). Jean Mazel favours the theory of an importation from Yemen and Hadramawt via the Jews and Hymiarites several centuries before the advent of Islam in the region (3).

(1) Terrasse H., Kasbas berbères de l'Atlas et des oasis Paris 1938; p.70 et seq.

(2) Jacques-Meunié D., Architectures et habitats du Dadès, Paris, 1962; p. 102.

(3) Mazel, J., Enigmes du Maroc, Paris 1971; p. 132-133.

Only systematic research based on comparative data drawn from archaeology, ethnography, linguistics (terms and songs used by craftsmen, oral traditions) and history will be able to shed light on the respective contributions brought from the various sources. It might be one of the tasks of the newly-created "Center for the Restoration and Reuse of Southern Kasbas"(CERKAS; see below) to promote and organize exchange of information between specialists of architectures in various parts of the Islamic world in order to solve this problem.

Functional role of the kasbas

Apart from their defensive role against potential aggressors -a role which has lost its signification since the French "pacified" the region some sixty years ago and the more so since Morocco regained its independance in 1956- the kasbas and ksour of South Morocco are designed to protect their occupants against several climatic constraints, namely:
- The extreme variations in temperature, both daily and seasonal, against which the thick mud walls offer a very efficient insulation. The presence of a patio, the positioning of small openings in the external walls and the very height of the houses create an effect of draught with natural conditioning action.
- The sand storms which are buffered against the walls and angled alleys of the ksar or against the blind façades of the houses.
- The blazing light of the sun which is subdued by the shade of the patios and narrow alleys and by the use of wood lattices (machrabiya; fig.2).

Being situated in areas of essentially agrarian economy, inhabited by populations of various ethnic and tribal origins, who however are all of Muslim religion, southern architectures have to respond to a number of collective and individual needs. They are meant, inter alia:
- To group people according to their ethnic, tribal or professional affinities (peasants, craftsmen, tradesmen, religious teachers and students), which is always translated, in space, into very compact structures.
- To mark a clear delineation between "public" spaces, in the ksar as well as in the family house, and private quarters.
- To guarantee for each family, the privacy of its hurm, the protected domain of the women.
- To allow for a reasonable quantity of food and fodder to be kept within the house at all times, dates and cereals being the staple foods while sheep, goats and occasionally a cow may be sheltered in a pen outside the house or on the ground floor surrounding the patio.
- Finally, to facilitate religious practice. Thus, each village, and even the greater kasbas, has its own mosque where the community gathers for Friday prayer.

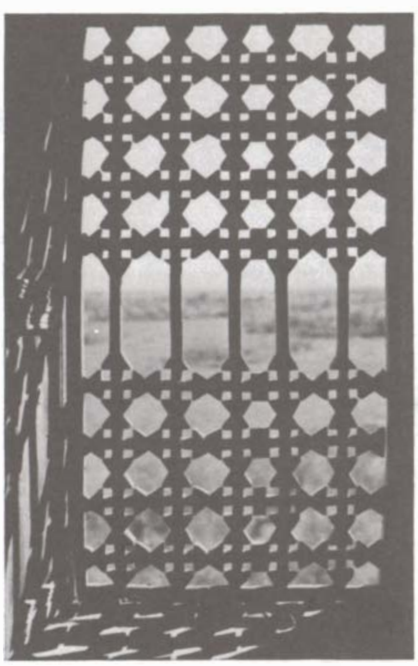


Figure 2. A Berber machrabiya (Kasba of Toundoute, at the foot of High Atlas range; photogr. Ministry of Culture/ Baamri, 1975)

Briefly outlined, such are some of the main factors which have contributed to shape the various types of buildings and settlements commonly grouped under the denomination "Southern kasbas", and of which a few representative specimens are shown on the following pictures.

Figure 3. Building a kasba.
The master mason and his assistant are pounding earth, lightly moistened , in wooden shuttering (lawh) about 2,0 m long and 0,9 m high. Average thickness of the wall is 50 cm. Six such lawhs are mounted in a daytime.
(Ksar Tirsal, Djebel Rat, High Central Atlas; photogr. by author, sept. 1976)

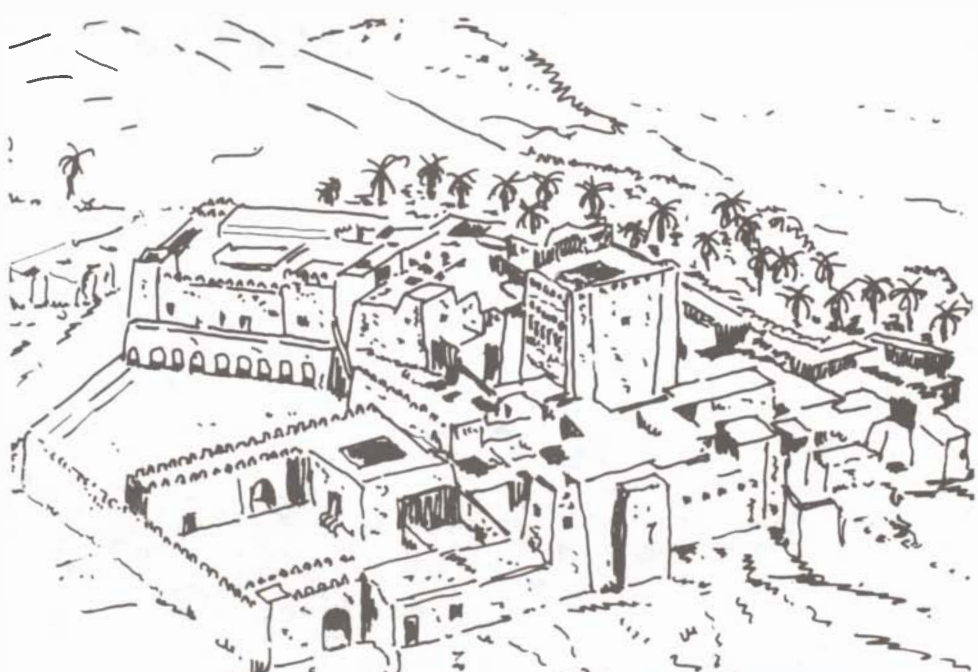


Figure 4. A chieftain's kasba : Tifoultoute (near Ouarzazate).

It comprises an old tighremt (on right) and a more recent one (left), with a large entrance courtyard (front) and numerous dependancies.

(sketch by author, after an air photograph Ministry of Housing/ Papini, mid-1960ies)

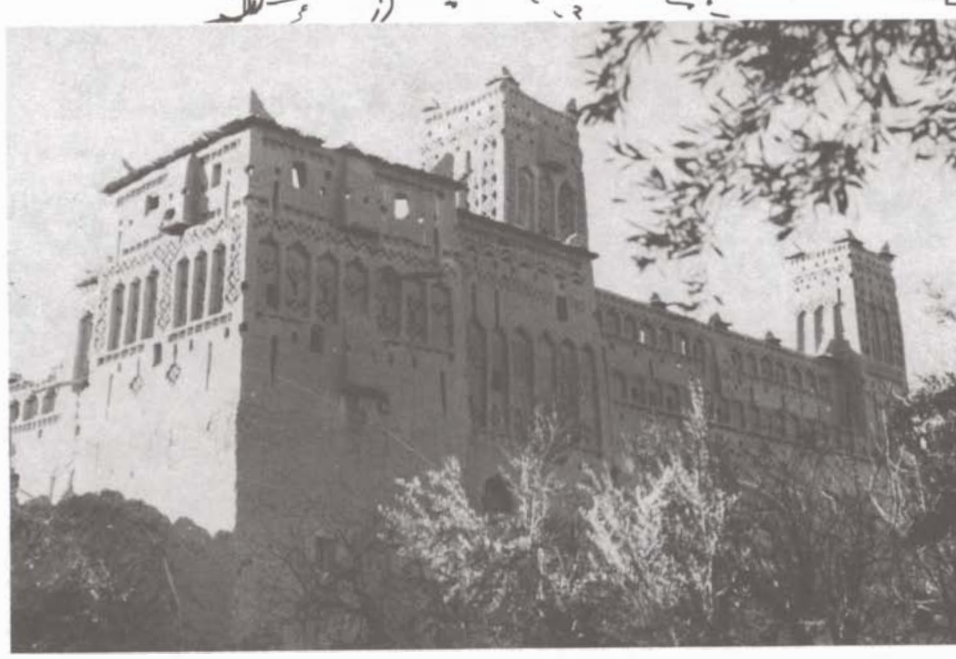
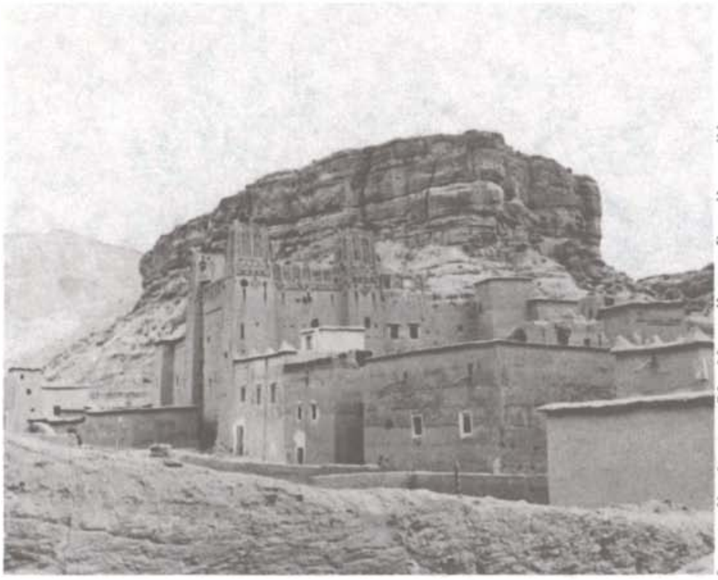


Figure 5. Kasba Ait Souss, Skoura

The oasis of Skoura, east of Ouarzazate, contains a number of beautifully decorated kasbas the walls and towers of which are made alive with crude briok reliefs and arcades.

(Photogr. Ministry of Culture/ Baamri, 1975)



Figures 6 & 7. Two tighremts (one-family dwellings) on the Atlas foothills.
Right : Imin Ouarguifrane (after photograph J. Vérité, 1976)
Left : Ait Aissa, Bou Taghrar, M'goun (photogr. by author, may 1977)

Figure 8. Interior of a kasba, showing the construction of the patio and galleies, supported by mud-brick pillars; palm-trunks and reed-stems support the layers of pounded earth and waterproof coating of lime and silt of the terrace.

(Igherm Amallal, N.E. of Ouarzazate; photogr. Ministry of Culture/Baamri, 1975)

Figure 9. The village of Ait Hammou ou Sa'id, near Agdz, comprises all the main elements of the "Southern kasbas" architecture, i.e.: the village -ksar- itself (left) surrounded by walls; the towered dwelling -tighremt- of a notable (center); and the stately fortress -kasba- dominating oued Drâa and the palm groves (right). (Photogr. by author, may 1977).

Problems of conservation

From the above descriptions and pictures, it may be realized that a number of dangers threaten the very existence of many of these buildings and settlements.

The main cause of decay of earth buildings, apart from the occurrence of natural disasters like earthquakes and floods, is always to be ascribed to human factors, i.e., to neglect in maintainance on the part of the occupants or, worse, to the partial or complete abandonment of a ksar or kasba. In the case of larger kasbas, for instance, those which had once belonged to the "Lords of the Atlas", historical and political circumstances accompanying the return of Morocco to Independance (in 1956) have brought with them the "fall" of these local chieftains who, having lost their wealth and power, moved out of their field residences. Thus many an imposing kasba has become a prey for local "cannibalism" and, bereft of all its doors, windows and rafters, has quickly been dilapidated to a point of no return. Elsewhere, particularly in rural communities, economic and social changes have attracted at least a part of the population to the cities, or have prompted the young generation to separate from the patriarchal family unit, creating new housing types mostly copied from urban models and using industrialized materials. The consequence has been either the juxtaposition of two heterogenous styles of building or, even worse, the disruption of the previous architectural unity of a ksar and shocking intrusion of cement blocks and aggressive forms, coatings and materials (corrugated or plated iron doors replacing the carved and often delicately painted wooden doors, etc.). Moreover, in a context of impoverished rural economy, even a landlord cannot afford to maintain his kasba or tighremt properly, as he used to do it in the past : he must be content to periodically renew the coating of its terraces but will omit the repair of the eaves protecting the top of the walls, so that water will penetrate into the pisé, weaken its strength and eventually cause entire sections of the higher floors and towers to collapse.

The causes of disuse and decay of loam constructions being manifold, a variety of remedies have to be applied. A first attempt to encourage the inhabitants of the ksour to renovate and modernize their villages and dwellings themselves using traditional methods was made during the years 1968-1974 by the Ministries of Interior and Housing, with participation from the World Food Programme of FAO (the Food and Agriculture Organisation of the United Nations). The latter institution has distributed supplementary food rations to those villagers who volunteered to work for the recoating of the ksar walls, the installation of drainage and water supply systems, the construction of pit latrines and animal stalls outside the village. About fifteen villages, mostly situated in the Drâ'a valley, benefitted from this programme, which proved quite successful and met with great enthusiasm on the part of the population. Though logistical difficulties led to its discontinuation, it nevertheless brought many lessons which will no doubt be useful for the broad programme presently envisaged for the rehabilitation of Southern architectural heritage.

Between 1972 and 1977, the Moroccan Ministry of Culture has undertaken, with technical help from UNDP and Unesco, to establish a full system of inventory of the national heritage, including monuments and sites, museum property and folk arts and traditions. Since the rich patrimony of southern architectures had hitherto been utterly ignored and neglected by the higher levels of authority, a special effort was made to bring it to light and draw official attention to the dangers which confronted its survival. A "pre-survey" was then made of some 300 kasbas and ksour of particular value. The resulting documentation, in the form of identity cards and photographs has formed the basis of a programme of conservation and rehabilitation to be carried out in cooperation with all governmental departments.

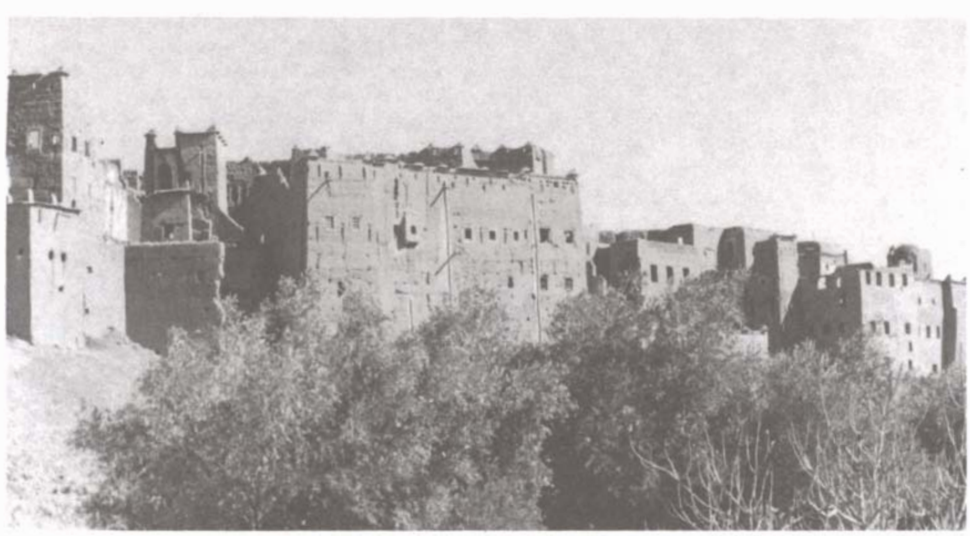


Figure 10. Kasba Taourirt, Ouarzazate, viewed from South. This part is now occupied by the Center for the Restoration and Reuse of Southern Kasbas (CERKAS) and its restoration has just started (photogr. Ministry of Culture/Baamri, 1975).

The Center for the oonservation and re-use of Southern Kasbas (CERKAS) : present status and perspectives

After a decade during which no protective action was taken on any of the surveyed monuments, the Ministry of Culture decided to create, with support from UNDP and Unesco, an organ with the specific task of safeguarding and revitalizing the arohitectural patrimony of the South Region, using it as a vital component of the general development of this relatively unprivileged part of the national territory.

The Center for the Conservation and Re-use of Southern Kasbas (CERKAS) set up in 1987 now exists and funotions, although still with a rather limited staff (one director, two architects, some draughtsmen, clerical staff and teams of masons and unskilled workers). Its headquarters are located in Kasba Taourirt, Ouarzazate, a former seat of power of the Glawa qâ'ids, a section of whioh has been restored to house the Center. This operation in itself has been a very successful experience and has aroused confidence even in those who did not believe that a badly damaged earth building could be rehabilitated at a very reasonable cost (less than half the prioe of a new oonstruction) and provide comfortable and aesthetic premises for all kinds of uses: as offices, meeting rooms, workshops as well as housing quarters. Of the spacious area which the Municipality of Ouarzazate put at the disposal of the Center (about 3,200 m2 on the ground), more than half has to the present been rehabilitated and work is being pursued to restore and re-use the remaining parts (see fig. 10).

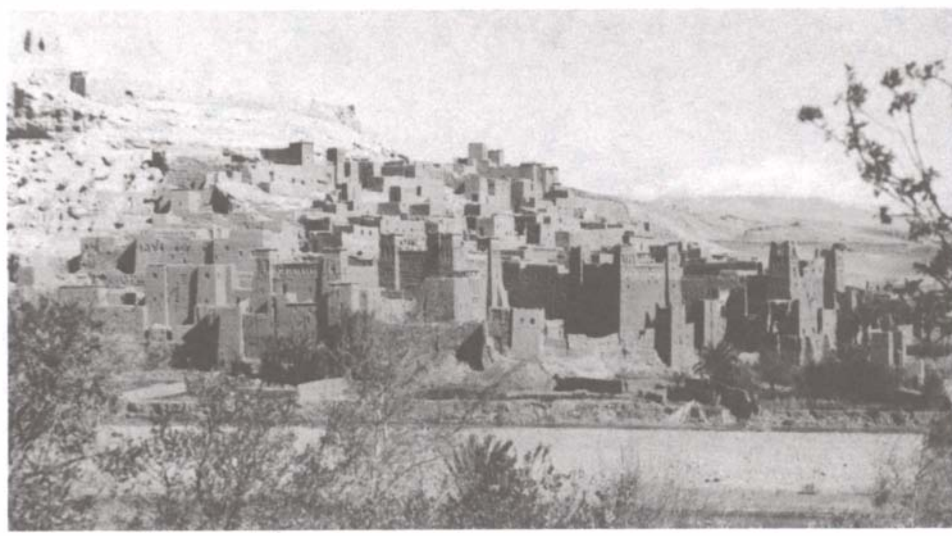


Figure 11. The ksar Ait Ben Haddou (25 km N-E from Ouarzazate) is threatened with destruotion. Its rehabilitation is now being planned under the leadership of CERKAS (Photogr. Ministry of Culture/Baamri,1975)

The first project to be tackled by CERKAS -apart from the restoration of its own precincts- concerns the rehabilitation of Ksar Ait Ben Haddou, an ancient village formed by a number of tighremt ascending a hill at the foot of which flows a mountain river while its summit is orowned by an antique citadel (see fig. 11). Considered as a unique specimen of the southern tradition of earth architecture, and as a model of harmony between natural and man-made environment, this ksar has been classified as a monument having "outstanding universal value" and included in the World Heritage List. Deserted by the majority of its population who have resettled the opposite bank of the river (where they have found more amenities and facility of communication with nearby Ouarzazate), the ksar is now on the verge of utter ruin and a request is being presented for its inclusion in the "List of World Heritage in Danger" according to article 11,4 of the World Heritage Convention of 1972.

The master-plan currently being established to safeguard the ksar is based on the asumption -confirmed by oral evidence obtained from the inhabitants themselves- that most ksourians will come back to live in their original homes provided they are given basic facilities and opportunities to maintain, and even raise, their present standard of life. The main components of the project are: provision of safe tap-water, electricity (possibly from solar energy), drainage and sewage systems, security against floods and landslides as well as various equipments: post and telecommunications, Quranic and primary schools, health center, sport and recreational installations, local museum and handicraft workshops, the whole process of rehabilitation being conducted in the spirit of authenticity, according to the principles of the Charter of Venice and other international standards and recommendations, due account being taken of local specificities. It is hoped that this project, which receives full ooperation from all Provincial authorities and services, will be actively supported by the international community and will serve to demonstrate how tradition and modernism may be associated and oontribute together to creating a better and more dignified way of living for rural populations in arid or semi-arid areas of the Third World.

Apart from the referenoes appearing in the present artiole, a guidanoe to bibliography has been given in my artiele published in ICOMOS Information N°4, 1986, pp. 2-14.

See also my paper on "Earth Arohiteoture of South-Morooco : Problems of Conservation", in : Proceedings of the 8th General Assembly of ICOMOS, National US ICOMOS Committe, Washington D.C. 1987, Vol.II, pp. 961-968.

TRADITIONS AND TECHNIQUES OF EARTHEN ARCHITECTURE OF SRI LANKA

B.D. Nandadeva
Department of Fine Arts
University of Kelaniya
Kelaniya
Sri Lanka

ABSTRACT

The aim of this paper is to present an account of the earthen architectural traditions of Sri Lanka, and the techniques followed through several periods of time, as seen in archaeological evidence and in the practices of present day building construction. The author will explain five different building techniques and other uses of mud for building work. These building techniques vary from the simple methods of construction of walls, with or without timber skeletons, to advanced methods of construction using adobe or rubble, and the use of mud for flooring. Aspects of maintenance of mud houses under tropical-monsoonal conditions will also be dealt with.

KEYWORDS

Earthen architecture, wattle and daub, timber skeleton, mud tempering, rammed mud, sun-dried bricks, tropical-monsoonal effects

Introduction

Earth must have been the only building material known in ancient Sri Lanka until knowledge of fired brick and stone masonry was introduced from India around the third century B.C.; this date coincides with the beginning of the historic period of the country. However, the use of these more durable materials seems to have been confined to religious and other public buildings as well as buildings exclusive to the royalty; the houses of commoners were constructed of earth. Excavations by archaeologists in ancient settlements belonging to the Proto or Early Historic periods have yielded only foundations of such buildings.

Earth is the most popular building material, even today among the low-income populations of Sri Lanka. Earth is used for the construction of foundations, walls with or without timber frames, floors of buildings and as a bonding medium in constructions where non-earthen materials are used. Even among the more affluent classes and even the moderate-level income groups, who tend to have their dwelling houses built of permanent material, earthen constructions still play an important role. While the main house is constructed of brick and cement, one or two other peripheral buildings, detached from the main house, such as the open-hearth kitchen, shed for bric-a-brac and a pit toilet are constructed of earth.

Technical Aspects

Knowledge of such aspects of building construction is acquired through experience. In the construction of simple dwelling houses, the owner does everything himself, with the help of friends or family members. Sometimes, advice is sought from an elder in the village. Experience and common sense help to solve simple technical problems as they emerge. The body of knowledge involved in the construction of mud buildings is a rather simple one, illustrated in the following four main points.

1. Site selection: A mound or high ground, free of the possibility of water-logging, is considered as the best site for earthen buildings.

2. Preparation of earth: Much care is taken in the quality of earth used for construction purposes. Humus-free soil of a sticky quality is considered as the best material. By adding water and trampling under foot, the soil is transformed into a mud of a soft consistency. Often, earth from anthills is mixed in order to increase the cohesiveness. The mud is then piled-up into a dome shape and covered with banana leaves or similar kind of leaf or jute bags to conserve heat loss, and left for a period of three to four days. Hydration, hydrolysis and microbial action within the mud now generate heat which tempers the mud. This tempered mud has a high degree of adehesion and is suitable for all types of building construction work. Any failure in any of these steps may result in poor bonding quality or subsequent cracking or loss of mud from the wall.

3. Obtaining correct right-angles at corners: There is an oral tradition of specifications of lengths and breadths of buildings. These are adhered to very closely. Traditional builders find it sufficient to have corners at approximate right angles. The right angle is marked by the simple expedient of comparing the diagonals.

4. Obtaining the plumb of the wall: This is considered as a crucial factor. A simple weighted rope is used to obtain the perpendicularity of the wall.

Types of Earthen Constructions

The author has identified six different methods of application of mud to buildings.

Figure 1. Wattle and daub house under construction, showing the roof tatched with woven coconut branches and the timber skeleton, partly filled-in with mud.

Figure 2. A part of the timber skeleton of a wattle and daub house showing a column supporting the roof, vertical 'core columns' and horizontal bamboo splinters.

Figure 3. Balls of mud placed inside the 'pockets' of the timber frame of a wattle and daub wall; new work with wet mud is seen at the top of the picture.

1. Wattle and daub houses (where walls are constructed using a timber skeleton): This is the most popular and widespread method of earthen construction in Sri Lanka. The archaeological evidence from ancient settlements indicates that the builders of the past had taken an enormous effort to use a raised, damp-resistant podium, made of rubble pressed into soft mud, in order to protect the timber framework from rising damp and termite attacks. As an added precaution, dressed stone slabs, cut to take the timber columns, were placed on this podium.

The present day wattle and daub builders show no serious concern about having a raised platform or sometimes even a foundation. Not having a solid foundation, indicates a major deviation from tradition.

Construction work takes place in this order; the floor is laid, the timber columns of the walls are fixed, the timber-work of the roof comes next, followed by thatching with cadjan (woven coconut branches) or straw. The earth-work of the walls is then taken up under the protective roof. This order of work allows protection for the workers from the heat of the tropical sun, prevents washing away of partly constructed walls, gives a storage place for the tempering mud mixture and prevents the walls from too rapid drying.

Narrow trenches are cut demarcating the position of the walls. The trenches are sometimes filled in with rubble pressed into soft mud to act as a foundation. Sometimes no foundation is used. In either case, the timber frame of the wall is erected along these trenches.

The timber frame or the skeleton of the wall is constructed by first putting in a row of core columns, between the columns that support the roof, at an interval of 40-50cm. The material is invariably of cheap and low quality. Trees or branches of about 15cm in diameter are split into two, to form the upright columns. Then splintered bamboo shafts about 5cm are fixed horizontally at an interval of about 20cm onto these core columns on the inside and outside of the building so that they run parallel to each other, thus forming a 'pocket' in which balls of clay is placed (see figs 1,2). The wood work is bound by coir rope or green vines. Spaces are left for doors and windows when the timber frame is built.

After completion of the frame, the actual mud-building work now begins. Tempered mud, formed into balls of about 12 to 15 cm in diameter, are placed inside the pockets of the timber frame. As the soft wet mud cannot bear much load, the construction work has to be done in stages to allow sufficient time for drying and hardening of the previously placed mud (see fig. 3). At this stage, the wall is levelled by sçraping out the mud with the

Figure 4. A completed wattle and daub house, after a final coating of soft kaolin. The raised plinth provides a place for relaxing or storing things.

fingers and splashing it back to cover any exposed part of the frame. Finger marks are left on the walls so as to produce a rough texture. The wall at this stage is called the 'katu mati bittiya', literally the rough-textured mud wall. 'Demati gahanava', literally applying the mud for the second time is done after the first coating is adequately dried. This time too, splashing the mud and scraping are done by hand. If the owner so desires, a coating of lime, kaoline or cow-dung is put on to obtain a better finish (see fig. 4). Sometimes, motifs of Folk Art are drawn on the wall, not only for decorative purposes but also to serve magical functions of warding off evil and inviting prosperity.

The wattle and damb technique is also used for a special type of building known as the 'tampita vihara', that stands on stone pillars, exclusively used as image houses in places of Buddhist worship. Here, a wooden platform is erected on top of short vertical stone pillars that serve to prevent dampness seeping through the walls. The timber framework for the wall is then set on the wooden platform. The main columns which support the roof are fixed outside the timber frame. Only the walls are of earthen work; the floor is made of timber. These walls act only as an enclosure and a canvas for religious paintings and other decorative art. The walls do not take the load of the weight of the roof.

2. 'Tappa bitti' or rammed earth-walls: This is a method of erecting a solid mud wall with no timber skeleton within. Planks of timber, about 20 to 25cm wide, are set on the 'rubble in mud' foundation about 25cm apart along the entire length of the exterior and interior lines of the wall to be built. They form a mould into which mud can be rammed. The planks are removed only after the mud is adequately hardened and able to stand without sagging. This method does not allow building more than 20 to 25cm of wall-height at one time. This process is repeated over and over again until the required height of the wall is achieved. The most important point here is to build all the walls of the entire house simultaneuosly. All the door and window frames have to be fixed while the wall is being constructed. A temporary canopy of a thatched roof is made in order to protect the walls from rain and excessive solar radiation. Once the construction of the walls is completed, a traditional thatched roof or, as is done today a roof of corrugated galvanized iron sheets is placed using a timber structure set on the walls so that the load of the roof is transfered through the walls.

The walls constructed in this manner are sometimes plastered using a mixture of clay and sand and then lime-washed. Rammed earth walls are considered much more durable than the wattle and daub ones.

Figure 5. A house with rammed earth-walls, under construction; note the temporary roof standing on timber supports.

There is another technique of constructing walls that is called 'tappa bitti' but differs from the method explained above. This probably evolved from a method used to construct boundary walls (known as tappa) around private properties mainly in the coastal region during the Late Historic Period (c. 16 to 17th centuries). This method has now gained popularity as a house-building technique especially in areas where timber is scarce.

Figure 6. A section of fig. 5; the new work with wet mud looking darker than the rest of the wall, is noticiable.

Here, the method of construction is very simple. Once the 'rubble-in-mud' foundation is done, mud balls are placed on top of each other, in two or three rows, to build the wall. The width of the wall varies depending on the load it has to receive from top. It is possible to build a height of about 50 cm at one time giving an interval of about three to five days for that section to dry before the work on the next section starts (see figs. 5,6). This wall may be coated with mud or plastered with a mud and sand mixture and then lime-washed if desired (see fig.7). It must be noted that no supporting timber frame is used.

Figure 7. A completed house with rammed earth-walls and a tile roof with the front wall plastered and white-washed; the side-wall shows how the work progressed.

Figure 8. A house constructed with sun-dried bricks (adobe).

3. 'Moda gadol bitti' or walls with sun-dried bricks(adobe): The use of sun-dried bricks, made by using a wooden mould, is still a popular building construction method (see fig.8). It is the only true adobe construction method in Sri Lanka. Dimensions of these bricks are generally much larger than that of fire-baked bricks. Walls are built on a 'rubble-in-mud' foundation. The method of construction is the same as in fired-clay brick construction, but here wet mud mixed with sand is used as the bonding medium (see fig.9). These buildings are sometimes plastered with a mixture of mud and sand and then lime-washed.

Figure 9. Bonding of sun-dried brick work.

4. Walls built with 'kabok' or blocks of laterite: In the southern and western coastal belt of the island, laterite is quarried in blocks. These blocks are used in the construction of walls using a mixture of tempered mud and sand as the bonding medium. If desired, these walls can be plastered and white-washed.

5. 'Sakka bammi' or stone-and-mud-wall: Mud is used as a bonding medium when walls are constructed of rubble made up of stones of varying sizes (see fig 10). In this case, some soft sand is mixed into the tempered mud. Walls constructed in this manner can have a width of about 30-40 cm. If desired, the wall can be plastered with the same mixture of mud and sand, and white-washed over. This technique is used also in the construction of 'Tampita vihara', a type of religious building that stands on stone pillars (mentioned above).

6. Flooring: Traditionally the mud buildings have earthen floors. Moistened earth is spread-out over the floor area and rammed manually with the use of a simple wooden rammer. The firmly rammed floor is coated with moistened mud. A second coating is done with a mixture of anthill clay and fresh cow-dung. The third or the final coating is a layer of fresh cow-dung and water. A floor made in this manner is very clean and insect-resistant. Another advantage of this floor is that it absorbs instantly any spillage.

Figure 10. A wall made of rubble bonded with mud.

Maintenance

The maintenance of a mud-built house in Sri Lanka generally means the replacement of the tatch roof and the repaire of the cow-dung coated floor. When the floor has to be repaired, it is merely dampended and a coat of anthill clay and cow-ding is applied, followed by a coat of moist cow-dung. This adds another few milimeters of new material to the floor. This is done customarily as preparations for the annual Sinhala and Hindu New Year celebrations around early April. After many years of such repair, the floor level rises substantially. It is, therefore, a practice to remove a few centimeters of old layers, probably once in ten years before applying a new coat.

During heavy monsoonal rains, rising dampness is a problem. The only known remedy is to drain the water from the compound to help to keep the site dry. Once a building gets dampened in this way, it takes a fairly long time to dry as these houses have very few openings and air circulation inside the house is restricted.

Figure 11. The cracked kaoling coating falling off a mud wall.

No complicated technology is applied to maintain the walls. The main causes of wall decay are termites who distroy the timber frame and build nests within the wall, and rats who burrow into the foundation. Cracking of the wall can be seen as a result of tilting or settling. Also, the process of expansion and contraction caused by rapid changes in humidity and temperature in the atmosphere result in the cracking of the mud coating of the wall and eventually falling off. Use of insufficiently tempered mud too contributes to the same result (see figs. 11-13). When cracks become very apparent, they are simply filled in with mud rather than treating the cause of decay.

Summary

In rural Sri Lanka where the socio-economic base is predominantly agricultural, the earthen building traditions described above are the most popular methods of housing construction. As the materials are freely available in abundance, and the technology involved is simple, and common knowledge, and the maintenance does not present serious problems, the rural house owners prefer to go for earthen houses, despite their impermanancy. However, due to the economic development experienced by the rural agricultural sector in recent times, together with the government support for better housing, a new trend is emerging in favour of permanant non-earthen material such as fired-brick and cement.

(The author acknowleges the grant support given by the Getty Conservation Institute to participate in this conference to present this paper.)

Figure 12. The exposed timber skeleton, of a wattle and daub wall, after the loss of the second coating of mud.

Figure 13. Decay of timber work after the loss of the mud-coat of a wattle and daub house.

ABSTRACT

The use of earth for building in Chile is as ancient as the country, being a synthesis of Indian and European techniques brought over Spain. For over four centuries earth was the most important material for building especially in rural areas, where agriculture developed as the most important economic activity. Today, Knowledge of earth building is in decline, eventually to be lost entirely.
The present study attempts to recall the cultural factors involved with earth building. There is a great heritage of different types of construction with historical and cultural values influencing, that need help to be restored.
The factors that cause damage and destruction to these construction are earthquakes and inundations. A second aim of this study is to investigate the use of earth building techniques for low-cost housing in present day in Chile.

KEYWORDS
Palabras claves:

-ADOBE
-TAPIAL, Tamped earth (pisé)
-QUINCHA, Earth on timber frames.
-Hacienda, Farm houses
-Earthen Construction techniques.

REVALORIZACION DEL MATERIAL TIERRA EN LA ARQUITECTURA CHILENA

Hugo Pereira G. Arquitecto
Centro de Estudios de la Tierra
Carlos Antúnez # 2467 Santiago-Chile.

Definición del área de estudio:

Se define la siguiente área geográfica que presenta construcciones en base a tierra. Es la comprendida aproximadamente entre los paralelos 20º y 40º Lat. Sur y 75º y 85º meridiano. Dentro de ésta área, en la que se observan construcciones en tierra existe una sub-área que concentra el mayor desarrollo de estas técnicas y que coincide con el ámbito en que se consolidó la cultura chilena y que contiene la mayor densidad poblacional del país. A esta última se la conoce como valle central teniendo como límite norte el valle del río Aconcagua y como límite sur el valle del río Maule.

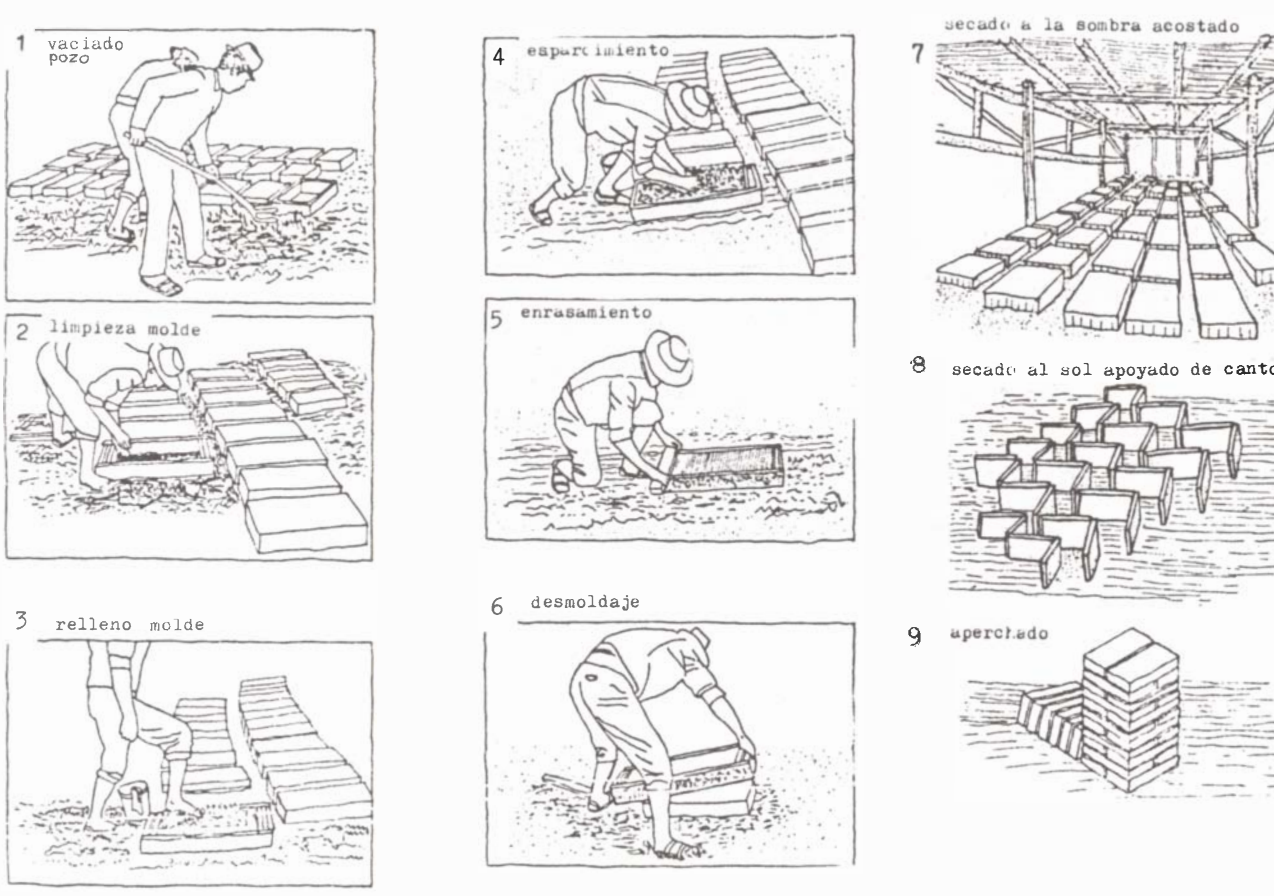
El régimen de lluvias de esta sub-zona es de entre 500-1000 milimetros anuales.

Clima : la zona del valle central tiene un clima templado mediterráneo con tres estaciones secas y una lluviosa. El norte grande se caracteriza por la ausencia de lluvias y su condición desértica, la que es suavizada por los efectos de enfriamiento de la corriente marítima de Humboldt que asciende desde la Antártida a lo largo del litoral.

Tipología edificatoria de Construcción con tierra :

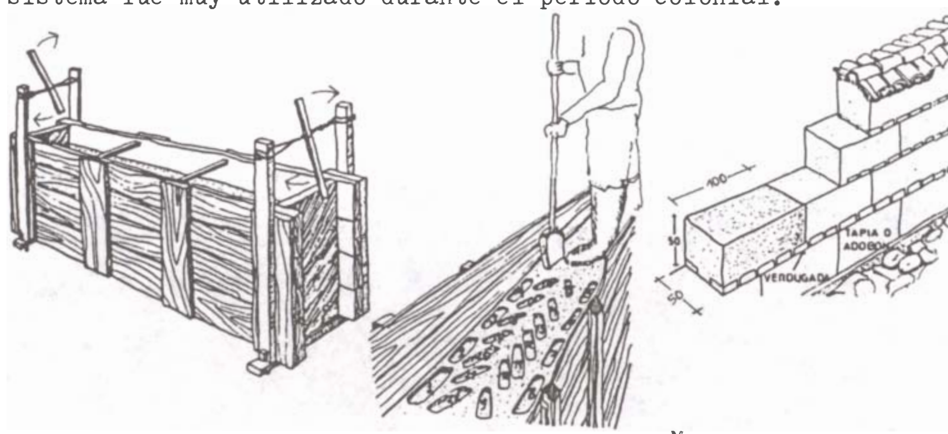
Los principales sistemas constructivos en base a tierra usados en Chile a lo largo de su historia son:

ADOBE : Albañilería de prismas de tierra-paja, ejecutados in situ, secados al sol. Usualmente miden 10 x30x 60 cms, se usa generalmente paja de trigo, esporádicamente paja de cebada, ambos cereales abundantes en la agricultura chilena. La revoltura se hace en pozos donde se deja impregnar de agua la paja, durante 1 día a lo menos. revuelto a pie o con animales, dependiendo del volumen de mezcla a preparar (graf.1)



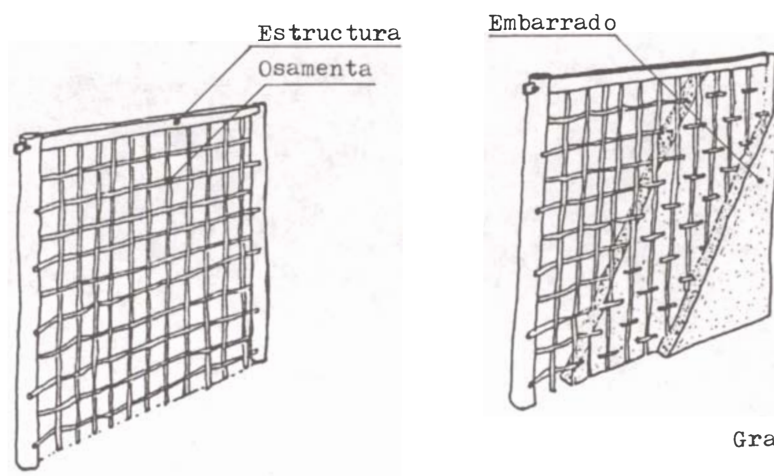
ilustr. L. Dominichetti, R. Marchetti i y otros, ALBAÑILERIA 1 de bloques de adobe Apuntes Catedra de diseño estructural, Acultad de Arquitectura y Urb. Universidad de Chile, Santiago, Chile.

TAPIAL : Consiste en la confección de bloques de mezcla de tierra-paja in-situ mediante la compactación en moldes de madera de grandes proporciones, siendo la más usual 50X50X 100 cms (Graf.2) Este sistema fue muy utilizado durante el período colonial.



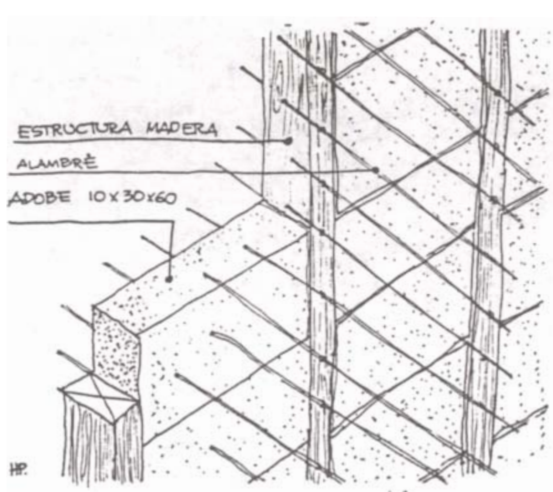
Molde Faena Apisonado Muro Graf.2

QUINCHA : (enquinchado o encañizado) Consiste en la confección de un entramado de ramas independiente al cúal se le adheriere por impacto una mezcla de tierra-paja en estado plástico. Esta técnica tiene una amplia gama de alternativas dependiendo del lugar específico en que se emplea y de las disponibilidades del lugar. (Graf.3) Durante la colonia al entramado de caña revestido en barro se le conocía como "bahareque".



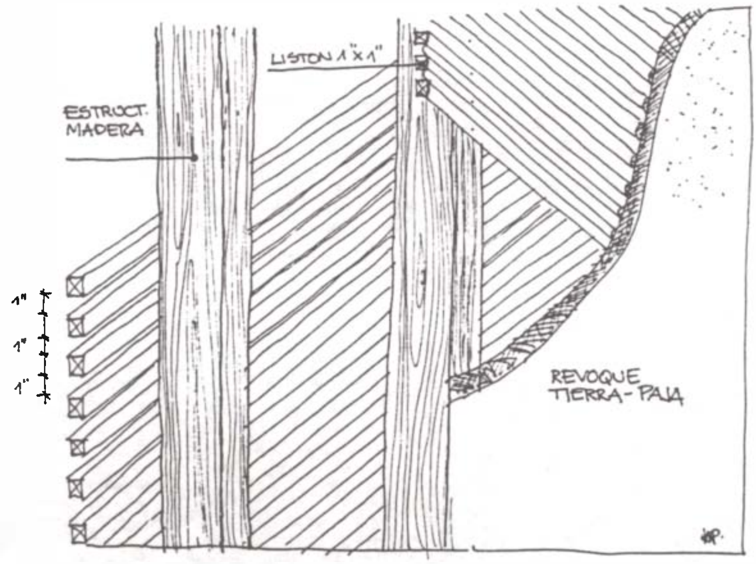
Graf.3

ADOBILLO : Consiste en la colocación en posición de canto de adobes de 10 X 30 X 60 cms. sujetos por medio de una estructura de madera y varias corridas de alambre fijo a la estructura cada 20 cms. aprox. (graf.4)



Graf. 4

PALILIAJE: Consiste en la proyección de una mezcla tierra -paja en estado plástico, sobre un entramado de madera de 1 "X 1", separado 1", afianzando a una estructura de madera.(Graf.5)

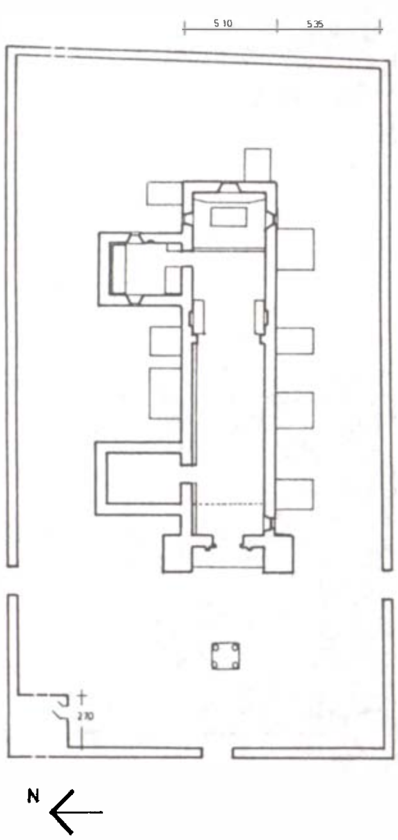


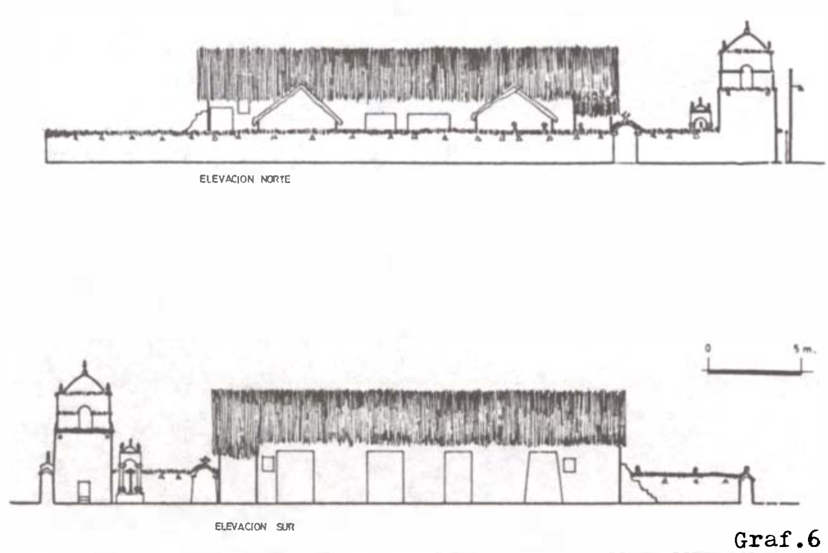
Graf.5

Antecedentes históricos:

Las construcciones en base a tierra,hechas por los conquistadores españoles son las primeras de las que tenemos registros. La casa de Don Pedro de Valdivia en Quillota (1542) probablemente fue construída en tierra dadas las descripciones de macisez que de ella se tienen.El mismo Pedro de Valdivia utilizó la técnica del adobe en la construcción de la muralla defensiva de la ciudad de La Serena luego de su destruución por parte de los aborígenes,testimonio que encontramos en una carta que el conquistador envió al rey Carlos V en 1541;en ésta explica que cortó 200.000 adobes para su construcción y que estos medían 1 vara de largo por 1 palmo de alto.(1)

En el norte grande el uso de la tierra se asocia con la técnica de albañilería de piedra, usándose como argamasa de pega; en cierros exteriores se utilizaba la técnica del tapial. Ia cubierta de estas construcciones es más liviana que la cubierta de teja del valle central, utilizándose paja gruesa abundante en las praderas pre-altiplánicas (caña brava). Estas construcciones son más antiguas que las del valle central ya que se encuentran emplazadas en la ruta de la conquista de Chile desde el Perú, a través del llamado camino del Inca, el que recorría toda la zona norte a través de la precordillera. (Graf.6)





Graf.6

ilustr. J. Benavides,R. Márquez de la Plata,L. Rodríguez, Arquitectura del Altiplano Caseríos y villorrios ariqueños Stgo.Chile,Fac. de Arquitectura y Urbanismo U.de Chile. Edit.Universitaria 1977,88 89

1) E. Greve, Historia de la Ingeniería en Chile Tom. 1 Santiago, Chile Imp. Universitaria 1938.

Existen testimonios acerca de la utilización de la tierra en las construcciones agrícolas,como los del naturalista francés avecindado en Chile Claudio Gay,quién describe detalladamente la vida del país durante el siglo XVIII. Al respecto escribe Gay,que se "cortaban" adobes y que con ellos se hacían tapias en los campos las que servían de cierros (cercos) para las cuadras (unidades de medida de los campos).Estos se hacían con paja revuelta con tierra con la ayuda de animales.Se refiere también el autor a la selección de los suelos,debiendo rechazarse los arenosos y utilizarse los arcillosos;se refiere también al tiempo de duración de las tapias, estableciendolo entre 30 y 40 años,y esto a causa de la constante utilización que hacen los animales de los muros,para frotarse.(2)

La primitiva "ruca",vivienda de la tribu de los mapuches, pueblo aborígen de la zona sur de Chile (mapu=tierra,che=hombre),estaba construída principalmente de un entramado de troncos y ramajes de árboles". (ver graf.7)

Graf.7

la construcción aborígen sólo les pudo ofrecer la "ruca",de la cúal tomaron los sistemas de trabazones de los materiales de coligue;la"ramada",derivación criolla de la anterior y la "pirca" separatoria de los campos de cultivo que parece también de origen precolombino".

En Chile, a raíz de una crónica escasez de recursos técnicos y de mano de obra calificada, se desarrolló una Arquitectura caracterizada por la austeridad y sencillez,obra de las manos de artesanos-campesinos. Esta característica austera es consecuencia también de los continuos terremotos que se encargan de eliminar de los edificios todo lo superfluo. El 13 de Mayo de 1647, un violento terremoto destruye gran parte de lo dificultuosamente edificado a la fecha.

No existen datos científicos precisos al respecto, pero lo cierto es que este hecho marcará un hito en la historia de la Arquitectura chilena ya que obligó a nuestros antepasados a replantearse los principios constructivos que habían aplicado hasta entonces.Comienza a desarrollarse entonces una Arquitectura distinta,los muros empiezan a engrosarse, llegando a sobrepasar 1,00 mt. de espesor,disminuyen los vanos y las grandes luces; las alturas de las construcciones se restringen, eliminándose torres y todo elemento agregado a la estructura que pudiera significar un riesgo de desprendimiento.(3)

Las repercusiones del sismo afectaron también la configuración de la casa chilena del siglo XVII adoptándo sistemas constructivos tales como la "quincha" original de la ciudad de Lima,Perú,técnica mixta de tierra y madera distanciada cáda 90 cms - 120 cms y listones horizontales en los que se teje la caña, soporte del barro (4)

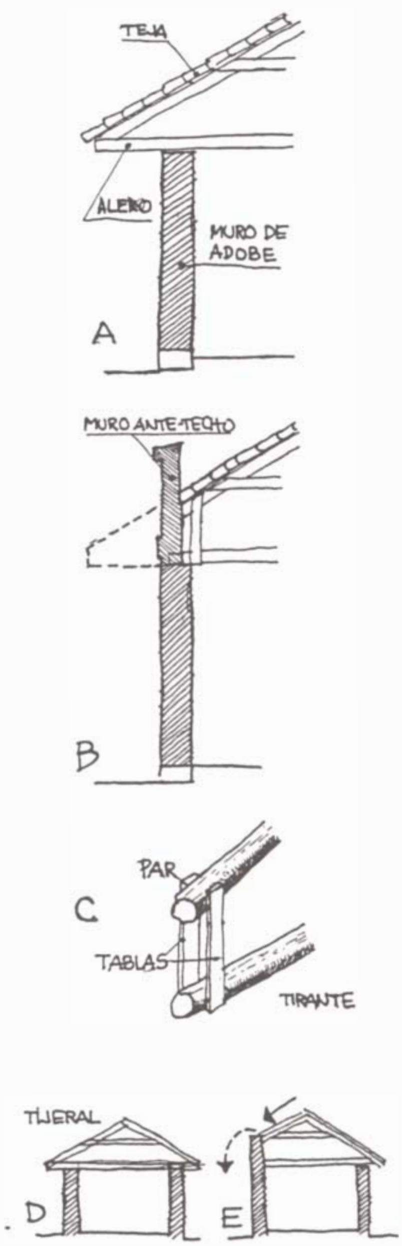
En otros escritos del período colonial encontramos testimonios sobre la importancia del adobe en la construcción otorgándosele excelentes características de comportamiento antisísmico,incluso comparándolo con edificaciones de piedra y ladrillo.

Las haciendas, constituían las grandes unidades de producción del campo chileno del período colonial, constituyendo centros de gran actividad y concentración poblacional y expresando arquitectónicamente algo propio, hecho que se fundamentaba en la utilización.

2.- C.Gay Manuscritos sobre las costumbres generales de Chile.V-19 Santiago, Chile, Arch. Nac. Cat.Gay-Morlán 1771,12,23,56,58

3.- B.Vicuña-Mackenna, Historia Crítica y Social de la Ciudad de Santiago desde su fundación hasta nuestros días: 1541 - 1868 Stgo, Chile Editorial 1869.

4.- E.Pereira, Historia del Arte en el reino de Chile.Buenos Aires Argentina. Impresoras Argentinas 1965,50 .



Graf.8

Históricamente, en un período de tres siglos y medio, la Arquitectura chilena utilizó masivamente el adobe,como material constructivo.Esto es posible constatar en construcciones de diverso tipo, religiosa, Habitacional etc,tanto en el ámbito rural como urbano. A raíz del proceso de Independencia Nacional,se produjo un corte histórico con la cultura del período colonial,y es así que a partir del siglo XIX, se manifiesta fuertemente una tendencia a la adopción de modelos y arquetipos extraños al período anterior;fenómeno que se agudizaría a fines del s. XIX. Las nuevas estéticas serían abandonadas con la misma irresponsabilidad con que eran adoptadas. Un eclecticismo desenfrenado se apoderaría de la arquitectura nacional. Comenzó un proceso de destrucción de los testimonios edilicios del pasado colonial, entre los cuales abundaban edificios construídos en base a tierra, con el consiguiente empobrecimiento del patrimonio arquitectónico.

A partir de la década de los 40, a raíz de la industrialización del país y el aparecimiento de nuevos materiales de construcción, en el mercado,y a causa de las destrucciones ocasionadas por el terremoto de 1939, disminuye notoriamente el empleo de las técnicas de construcción con tierra, especialmente la del adobe.

Lo que ocurrió fue que se destruyó una gran cantidad de casas construídas con adobe, pero no se investigó el porqué. El dramático caso de las destrucciones de la ciudad de Chillán, que cobró miles de vidas humanas es ejemplar. Al respecto el profesor E.Guzmán que las fallas en las estructuras se debió a una grave modificación del modelo estructural primitivo.

"Se trata de viviendas antiguas de adobe, con alero a la calle, que fueron en algún momento"modernizadas",suprimiendo el alero o parte saliente de la techumbre y prolongando hacia el muro de la calle hasta ocultar el techo. Al cortar el extremo del tijeral,se sostiene el par con un soporte vertical,probablemente dos tablas laterales en cepo (graf.8C)mientras se construye el muro , para apoyarlo allí en definitiva.Con éste cambio se consigue transformar el triángulo perfectamente indeformable (graf. 8d),en un elemento de cuatro lados,que no sólo es deformable , sino que da origen a una fuerza inclinada que empuja al pequeño muro antetecho; con gran parte del peso de la cubierta de teja , tratando de volcarlo.(graf. 8E). Después de una transformación como ésta , resulta extraño que el muro antetecho no caiga de inmediato.En todo caso , la techumbre dela la vivienda queda transformada en una trampa,que caerá sobre sus moradores justamente en el momento en que salgan a la calle por efecto del sismo." (5)

<u>Deficit habitacional y proyecciones del uso del material tierra</u>

Chile tiene un déficit habitacional de aproximadamente 1 millón de viviendas. De acuerdo a los porcentajes de incidencia de las partidas en el costo total de una vivienda, podemos descubrir que la incidencia de los muros sobre el costo total aumenta mientras más económica es la vivienda, y vice versa, pudiendo llegar a incidir hasta el 50% del costo total (6), considerando que el material tierra prácticamente se encuentra a muy bajo costo en gran parte del área del valle central de Chile, es que es posible asegurar que sin duda es un material alternativo que brinda excelentes posibilidades de aplicación en viviendas de bajo costo. Las recientes experiencias de construcción con tierra así lo están demostrando;el período 1983-1987, se dieron cerca de 18.000 soluciones habitacionales que utilizaban la tierra como material de muros y aislación térmica sobre el encielado. Muchas de éstas experiencias han empleado el sistema de autoconstrucción dirigida, lo que ha contribuído a abaratar los costos. Los principales motivos que han llevado a elegir estos sistemas mixtos de construcción en base a tierra son los siguientes:

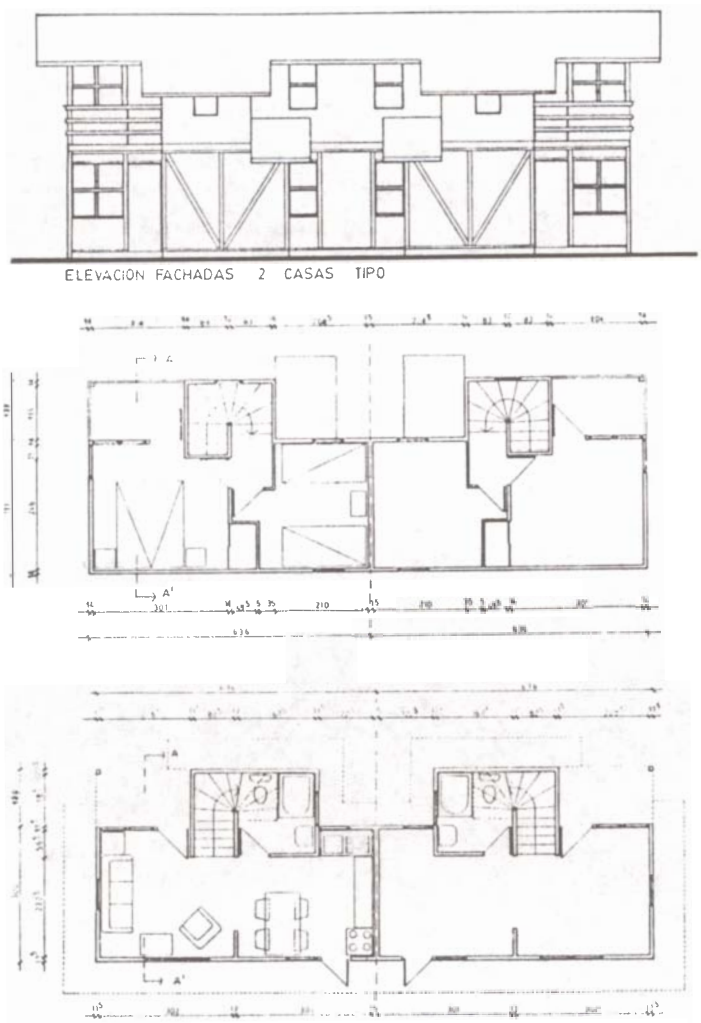
1) Seguridad antisísmica
2) Buena respuesta a condicionantes físico-ambientales
3) Rapidéz de ejecución
4) Posibilidades de reciclar materiales en desuso
5) Facilidad para implementar autoconstrucción

La mayor parte de éstas viviendas han surgido a causa del déficit producto del terremoto de 1985, que destruyó una gran cantidad de viviendas, especialmente localizadas en áreas rurales.

El desarrollo embrionario de esta tecnología obliga a estudiar con mayor profundidad las condiciones físico-químicas de la tierra,ya que hasta el momento se ha trabajado utilizando como base de datos la simple experiencia de obra, sin la asistencia de un estudio técnico riguroso.

En alguna medida, las construcciones realizadas presentan deficiencias producto del desconocimiento del material tierra , lo que lleva muchas veces a presentar un panorama confuso en relación a la real posibilidad de aplicación de éste material.

Un caso interesante de vivienda económica construída en base a un sistema mixto de tabiquería de madera y tierra (palillaje) y malla metálica,es el ejemplo del Graf. 9, ejecutado en 1986 en una Comuna de extrema pobreza de Santiago,Chile, ejecutado por autoconstrucción con asistencia técnica de profesionales. (taller Norte,Arqtos. J.M.Cortínez, R. Jiménez).



ilustr. A.Hays,S.Matuk, F. Vitoux,CRATERRE. TECNICAS MIXTAS DE CONSTRUCCION CON TIERRA Plan Construcción, 1986, Rexcoop,

Graf.9

Conclusiones : La tecnología de construcción en base a tierra , tiene una gran proyección a futuro,ya que habiendo sido abandonada recientemente (década 1940-50), se hace necesaria en vista a la manutención,reparación y modificación de un legado patrimonial de gran valor arquitectónico que abarca cerca de tres siglos de historia.Es importante retomar científicamente el estudio del material de tal forma de poder incorporarlo al repertorio de materiales "seguros". Es particularmente útil , poder promover el uso de técnicas mixtas de construcción con tierra , dado que por una parte se elimina la variable de "riesgo sísmico" , y por otra se aprovecharía un abundante recurso material en nuestro país,como es la madera. Según proyecciones realizadas durante 1985,en Chile se habrían construído gran cantidad de viviendas de bajo costo en base a éste último tipo de técnicas, con diversos inconvenientes de orden normativo y socio-culturales,hecho que avala como cierta la opción de desarrollar la investigación científica en esta área y que tendría subsidiaramente otro efecto muy positivo,cuál es,el de recuperar un aspecto perdido de nuestra identidad cultural.

5 - E.GUZMAN. Curso de edificación Cap IV Santiago Chile Edit. Universitaria 1977, 205

6 - J.SALAS SERRANO " Aspectos Económicos de las Construcciones con tierra" MONOGRAFIA No 385 - 386 INSTITUTO EDUARDO TORROJA, MADRID ESPAÑA (1987): 77 - 82

EARTHEN ARCHITECTURE OF NEW YORK STATE: ADOBE CONSTRUCTION IN A NONARID CLIMATE

Richard Pieper, Director of Preservation
Jan Hird Pokorny, Architects & Planners
306 East 51st Street, New York, NY 10022

ABSTRACT

The use of unfired earthen mixtures for the wall construction of load-bearing masonry structures has generally been regarded as unsuited to the harsh climate of the northeastern United States. In fact, at least twenty-four mid-nineteenth century earthen-walled buildings exist in New York State today, attesting to the potential for exceptional longevity of earthen construction in this unlikely climate.

Unburnt brick construction in New York State was influenced by reports documenting earthen walled construction in Canada and England in the 1830's. Mud brick construction was championed at the same time in the United States by U.S. Commissioner of Patents Henry Leavitt Ellsworth. Ellsworth's patent reports reprinted excerpts of British and Canadian journals, and documented Ellsworth's own experiments with mud brick construction. By the mid-nineteenth century over forty mud brick structures dotted a nine county area spanning half the state. Buildings reflect then current Greek Revival, Gothic Revival, and Italianate styles, and were erected by members of various socioeconomic groups.

KEYWORDS

Adobe, Cob, Pisé, New York State, History

In the United States, the use of earth for building construction is most frequently associated with the adobe structures of the southwestern states or the sod houses of the untimbered stretches of America's northern plains. In the northeast, infrequently applied techniques such as "wattle and daub" and "mud nogging" exploited the insulative properties of earth used as infill in wood frame buildings. The use of unfired earthen mixtures for the wall construction of load-bearing masonry structures has generally been regarded as unsuited to the harsh climate of the northeastern United States, however. In fact, at least twenty-four mid-nineteenth century earthen-walled buildings exist in New York State today, attesting to the potential for exceptional longevity of earthen construction in this unlikely climate.

The early popularization of earthen construction in nineteenth-century United States may be traced to the seminal writings of Francois Cointeraux, French agriculturalist and architect, whose publication of a series of cahiers on pisé, or rammed earth, construction in 1791 started a chain of translations and adaptations that reached the United States in the nineteenth century. Cointeraux was not the first Frenchman to report on rammed earth construction, which had been chronicled by others reporting on pisé construction then common in the areas around Lyons. Cointeraux's reports were backed by considerable personal experimentation, however, and he pursued the dissemination of his techniques with a proselytic zeal that soon attracted the attention of like-minded architects in Great Britain.

By 1797 Cointeraux's first and second cahiers on pisé construction were translated into English by noted English architect Henry Holland, and published with new illustrative plates in the Communications of the Board of Agriculture of Great Britain. Holland's translation was reworked and plagiarized in America by Stephen W. Johnson, who published Rural Economy: Containing a Treatise on Pisé Construction in 1806 in New Brunswick, NJ. Johnson's book was illustrated with plates resembling Cointeraux's original engravings, and included sections on such disparate topics as road building and viticulture. Most significantly, Johnson included a chapter on "cob" or mud walling, a traditional English technique of monolithic earthen wall construction, which, unlike pisé, used a mixture of moistened earth and straw. Johnson's book, and Holland's translation, which was republished in the agricultural journal The American Farmer in 1821, sparked a series of experiments in pisé construction in the Mid-Atlantic and southeastern United States that were chronicled in agricultural journals in the first four decades of the nineteenth century. Curiously, no similar experimentation in true pisé construction appears to have taken place in New York State.

New York's earliest documented extant earthen structures are two cob walled residences. The Lawrence Johnston House (1832 or 1833) and the William Gorse House (1836) are located a few miles apart in Penfield, Monroe County, near Rochester. While the Johnston House's wall construction is now obscured by clapboard siding, several exposed areas in the interior show that the mixture of mud and straw was placed within wooden wall forms in layers about 15 cm (6") deep. An account of the construction of the Gorse House republished in Penfield's Past: 1810-1960 by Katherine Wilcox Thompson states:

> "A pen was built on the ground and clay drawn from a nearby creek bed spread over the ground to a depth of about a foot. On this, cut straw was spread to a depth of three to four inches. Oxen were driven around and around inside the pen to thoroughly mix the ingredients. Plank forms about a foot high were set up on the wall foundations and filled with the clay mixture. As soon as the clay and straw had dried sufficiently to be self-supporting, the forms were raised and another course poured. Floor joists were laid across the walls and another layer poured on top, thus embedding the joists in the wall. When completed a year later, the house was given a thin plaster coat of clay and the interior walls were plastered and kept white-washed."

About the same time that Gorse and Johnston were experimenting with cob wall construction outside of Rochester, English architect and horticulturist John Claudius Loudon was publishing his influential Encyclopedia of Cottage, Farm, and Villa Architecture (1833), a compendium of designs and prescriptions for construction that contained no fewer than twenty-nine illustrations for cottages that Loudon proposed were appropriate for earthen construction. Loudon noted Cointeraux's pisé experiments but also quoted the report of fellow Englishman John Denson whose Peasant's Voice reported on the use of "clay lumps" or unburnt brick, for the construction of cottages in Cambridgeshire.

Whether prompted by Loudon's encyclopedia or simply immigrant English technique, buildings were being constructed of unfired mud brick near Toronto, Canada as early as 1836. By September 1842 the Canadian publication The Church was reporting of the new Hurontario Church, "the new church is to be built of mud (or unburnt) brick, which in the opinion of the best informed architects, is the material of all others the fittest for the building with in this province." In February 1843 The British-American Cultivator, a Toronto agricultural journal, reported that "houses, properly constructed (of unburnt brick) are warmer, more durable, and also cheaper than frame, and are destined to take the place of the log shanty, as well as the more expensive wooden walls."

Unburnt brick construction was being championed at the same time in the United States by U.S. Commissioner of Patents Henry Leavitt Ellsworth. Son of U.S. Supreme Court Chief Justice Oliver Ellsworth, and brother of Connecticut Governor William Ellsworth, H.L. Ellsworth chronicled advances in agricultural science in his patent office reports of the 1830s and 1840s. Ellsworth's reports of 1842, 1843, and 1844 reprinted excerpts about unfired brick from Loudon's encyclopedia and The British-American Cultivator, and reported on Ellsworth's own successful experiments with mud brick construction in Washington, D.C. and Grand Prairie, Indiana that had begun in 1842. Ellsworth's influential reports were widely excerpted and reprinted in agricultural journals such as The Cultivator (Albany, N.Y.) and The Genesee Farmer (Rochester, N.Y.). The New York Tribune, which published an excerpt about unburnt brick construction soon after the first report's publication in February 1843, separately reprinted a sizable portion of the report in pamphlet form under the title Useful Works for the People No. II.

Ellsworth's motivation to experiment with this novel form of construction was apparent. Already a landowner in the Wabash Valley of Indiana, Ellsworth was to become an agent for Federal lands in the area following his departure from the Patent Bureau in 1845. An illustration of Ellsworth's proposed "prairie cottage" in the 1844 report leaves no doubt that, in spite of his rather large (5.5 m x 16.5 m, or 18' x 54') experimental brick structure in Washington, D.C., Ellsworth was proposing that unburnt brick would well serve those of modest means settling on the prairies of the then far west.

Ellsworth's intentions notwithstanding, at mid-century over forty mud brick structures, most not nearly so simple as Ellsworth's prairie cottage, dotted a nine county area in New York that spanned half the state. Ontario County was quite certainly the center of this mud brick vogue; census records indicate that at least twenty-two mud brick structures had been built in the county by 1855, far more than in any other. At least fourteen mud brick buildings were constructed in the village of Geneva alone.

One contemporary account reveals that the initial use of unburnt brick in Geneva antedated Ellsworth's first published report, however, and the discrepancy between the brick sizes recommended by Ellsworth (30.5 cm x 17.8 cm x 12.7 cm, or 12" x 7" x 5", and 30.5 cm x 15.2 cm x 15.2 cm, or 12" x 6" x 6") and that of the majority of mud brick buildings in Geneva (38.1 cm x 30.5 cm x 15.2 cm, or 15" x 12" x 6") suggests that English or Canadian practice may have served as a model for the earliest Geneva construction.

In September 1844, The Home Missionary, journal of the Presbyterian and Congregationalist American Home Missionary Society, published a lengthy article entitled "Churches of Unburnt Brick" featuring an analysis of "several houses of unburnt brick" in Geneva and proposing that "houses of worship of unburnt brick are desirable for congregations of the ordinary size..." The president of the A.H.M.S., Henry Dwight, was a Geneva resident, and Geneva was the site of the society's western New York office. Although the article obviously intended that the use of mud brick construction be adopted by impecunious congregations, much of the domestic earthen architecture that sprang up in Geneva following The Home Missionary report was anything but modest. By 1850 one mud brick Gothic Revival style residence had been constructed for Miles P. Squier, former regional secretary for the A.H.M.S. and the niece of Henry Dwight's wife, Sarah Bradford, lived in another prominent earthen structure on Geneva's fashionable South Main Street. Still another adobe was constructed on a nearby lot belonging to Charles Cooper, the namesake of Bradford's eldest son.

Of the fifteen mud brick residences eventually constructed in the Geneva area, eleven are extant today. Five of the Geneva adobes exhibit striking decorative similarities, and no doubt the apparent popularity of mud brick here was due in part to the presence of a body of builders willing to work with this unusual material. It is apparent also that Geneva mud brick construction influenced others wishing to experiment with the method that Ellsworth and others were espousing; the 38.1 cm x 30.5 cm x 15.2 cm (15" x 12" x 6") brick size can be found in buildings in Bath, Steuben County, and Interlaken, Seneca County. By 1855 earthen buildings had been constructed in Erie, Monroe, Steuben, Ontario, Yates, Seneca, Tompkins, Oswego, and Otsego counties.

Although the architectural treatises of the period were not silent on the subject of unburnt brick, few dealt with the mode at length or in adequate detail to assist a would-be builder. One notable exception was The Architect (1849), a journal published by the New York City architect William Ranlett. Ranlett's book may have been the first eastern publication to use the Spanish term "adobe" for the construction technique that previously had been identified as "unburnt brick," "sundried brick," "mud brick" or even "Egyptian brick." While Ranlett devoted only two pages and three designs to adobe construction, he gave detailed prescriptions for construction and undoubtedly his copiously illustrated pattern book lent a certain cachet to the novel building mode that had prompted so much publicity in the previous five years. It appears that Ranlett's work inspired the construction of what is by far New York's largest documented earthen building, the Judge Samuel Ludlow Residence in Oswego. Under construction in 1851, the Ludlow residence when complete had a major facade seventy feet long, two 2-1/2 story hip-roofed ells forty-five feet long, and an adobe tower with a wood frame top that rose forty feet. Today clad with fired brick, Ludlow's residence serves as a convent for a neighboring Catholic high school.

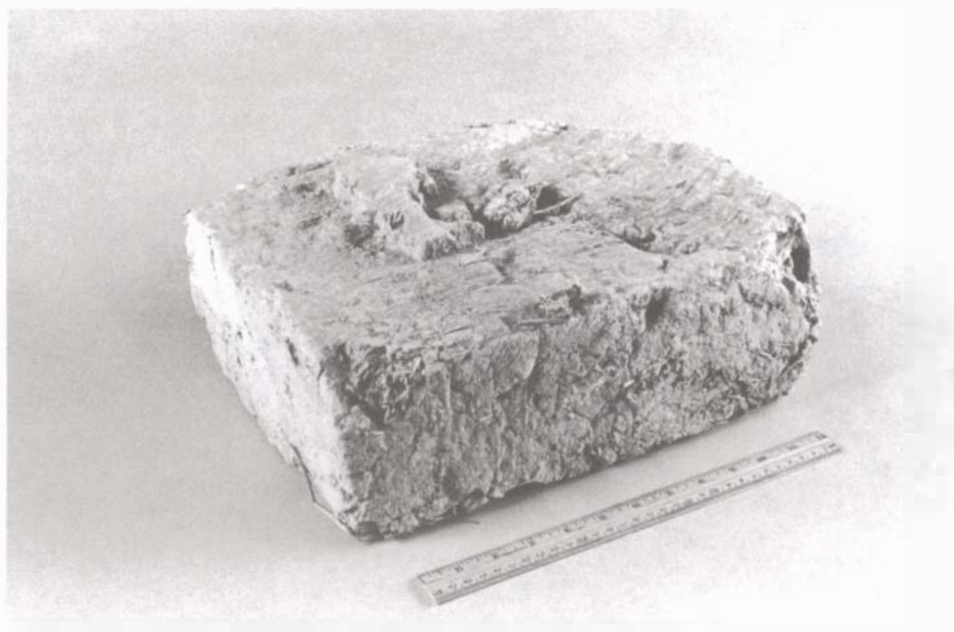
By the early 1850's, however, the mud brick vogue was slowing considerably, no doubt prompted in part by the difficulty of preventing exterior stucco finishes from failing. The stucco problem had been mentioned frequently in early accounts, and prompted at least two New York State builders to include horizontal wooden members within the walls between alternate layers of brick so that the completed masonry building could be sided with wood.

Despite the generally glowing tone of the early press, not all later publications treated the topic so favorably. In his 1852 book Rural Architecture, Lewis F. Allen indicated "we are aware that unburnt bricks have been strongly recommended for house building in America; but from observation we are fully persuaded that they are worthless for any permanent structure, and if used, will in the end prove a dead loss in their application." The Cultivator, which in March 1847 had published an article about mud brick construction entitled "The Cheapest and Best Mode of Building", was by February 1855 stating "...this mode of building is falling into disuse, doubtless for some substantial reasons, among which is probably the difficulty of having every part done well, and especially the great difficulty of securing good cement, so essential to success." Some innovative builders, inspired by Orson Fowler's The Octagon House, A Home for All turned instead to what was to become the next heralded replacement for fired brick masonry--the gravel wall. As early as February 1846 one correspondent to The Cultivator offered a comparison of the two technologies:

> "I read in Ellsworth's report of last winter, the manner of building cheap houses of unburnt brick; but I think they have an improvement in Wisconsin over all others. The material consists of gravel and lime--one-eighth part lime, and the balance of coarse sand

and any kind of gravel or small stones, mixed so as to make a mortar that will "set" so hard as to stand well."

All but three or four of New York's adobe structures can be confirmed through census research to antedate 1855, although one Geneva building is known to have been constructed after 1870. Few stylistic generalizations can be made, even in Ontario County, where the disparate buildings reflect then current Greek Revival, Gothic Revival, and Italianate styles. Similarly, the buildings cannot be said to have been favored by one socioeconomic group; the 1855 census records values for the buildings ranging from $100 to $15,000, stretching the limit of what might be considered vernacular architecture. Today most remaining examples are in sound condition and all are occupied. Many retain their original exterior stucco finishes, although some have long been resided with wood clapboard, aluminum, or brick, and hide their identity from the casual observer. Quite certainly others remain to be found, unlikely relics of an innovative era in American masonry construction, confirming the claims of adobe's nineteenth century proponents about the durability of earthen construction in New York's harsh climate.



Mud brick from 247 Washington Street, Geneva, New York. Brick size is approximately 38 cm x 30 cm x 15 cm (15" x 12" x 6") and is typical of adobe buildings in New York State.

Samuel Sill residence, circa 1845, 247 Washington Street, Geneva, New York.

John and Sarah Bradford residence, circa 1845, 629 South Main Street, Geneva, New York. Gothic Revival design was utilized for a number of adobe residences in Geneva.

14 West Morris Street, Bath, New York. This Greek Revival style residence is covered with a natural cement stucco which was scored to resemble ashlar.

Theodore Irving residence, circa 1845, 731 South Main Street, Geneva, New York. Several of Geneva's adobes retain their original exterior natural cement stucco.

RETENTION OF THE TRADITIONAL VALUES OF AFRICAN EARTH ARCHITECTURE

David Smail, Architect
P O Box 240305
Ndola, Zambia

ABSTRACT

The critical shortage of housing is probably the single greatest problem facing developing countries in Africa today.

Severe economic restraints, coupled with unimaginative and ill-directed policies by developers have created hectares of sterile concrete block units unaffordable to the average worker.

Across Africa examples of fine vernacular architecture created by self-reliant developers are evident. These non-pedigreed architects used the earth, their own unskilled labour, and their concerned minds to create architecture with qualities of communal awareness, security, serenity, and aesthetics. Unfortunately, these have been neglected by historians.

Retention of these values will educate consultants and authorities on the merits of traditional design and use of materials and possibly unleash the energy to make use of the abundant supplies of land, labour, love, economy, and earth to solve the housing problem.

KEYWORDS

TRADITIONAL VALUES, ADOBE, DECORATION, MODERN URBAN - BLIGHT

One of the greatest problems facing practically all counties in Africa today is providing satisfactory shelter for their burgeoning urban populations. The mushrooming of the towns and cities has been a feature of both the colonial and post-independence period since the end of the Second World War with the consequent increase of satellite townships and shanty dwellings surrounding the old town centres housing those in search of a pot of gold.

The response of most governments has been directed through their quasi-governmental housing authorities. Many agencies with deep social commitments tried to help by building new housing estates in modern renewal projects. The existing shanties were regarded as slums - chaotic and "bad"; the planners and sociologists failed to understand or appreciate the social organisations, the delicate expressions of neighbourliness and territory found in them. New "good" housing was provided on the grid, lacking heart, individuality, privacy, and security. Soon, discomfort became tension and developed into vandalism and thuggery, similar to what happened in the vertical developments erected in the First World by similar well-meaning developers. Comparing a typical scheme in Zambia (Figure 1) with an older development in Mali (Figure 2) one can only be saddened by the results of progress. The town plan of Mopti in Mali is full of delight, surprise, interest, drama, and variety, as organic as a cross section through the gut of a chicken, compared to the inhuman precise grid now universally common as the accepted answer to modern housing developments.

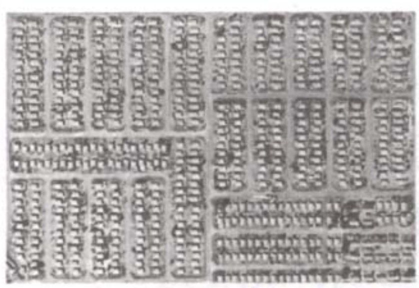


Figure 1 Modern Housing plan

Figure 2 Mopti in Mali

Those responsible on the town councils, aid agencies, architects, planners, and contractors congratulated themselves on their success with typical pronouncements, as one made by the Lusaka City Council on one such scheme: "the local authority low cost house has within 20 years, developed from the traditional hut built of sun dried brick to a modern structure of plastered blockwork and asbestos cement sheeting that will stand comparison with public housing all over the world". (Reference 1).

That these units were sterile and costly mattered little to the developers; cement or burnt brick are mandatory, big windows looking across small plots on to the heat of the road are the norm, corrugated iron or asbestos roofing sheets are a must. Aesthetics are regarded as a frivolity and therefore totally expendable. The very real cost in foreign exchange expenditure, deforestation through burning bricks, and lack of comfort in small hot houses with curtains inevitably drawn in a vain search for coolness, privacy and security are all accepted as part of the modernisation process. Traditional housing values have been dismissed as unsuitable for the contemporary scene. One of the early voices raised to protest the trend was that of founder President of Tanzania, Julius Nyerere, who said, "the widespread addiction to cement and tin roofs is a kind of mental paralysis". (Reference 2).

It is important to appreciate the very elementary level at which a solution to this problem must be found. Even one of the standard local-authority-type houses costs the equivalent of about 30 years of earnings for an average worker and is consequently unattainable. Modern housing can only really be afforded by companies for their employees. Many countries in Africa have to import many of their building materials for the most basic house and due to the crippling foreign exchange problems these costs are enormous. Materials such as cement, glass, tin roofing, plastic floor tiles or piping cannot be used in low cost housing. Environmental restraints exclude others like timber, as the deforestation of great areas of the continent rules out wood for either burning bricks or for structural purposes.

This leaves earth and, to a lesser degree, grass, reed, lime, and some small timber sections as the available construction materials.

Attempts to build a truly appropriate structure using only local materials have been scorned by authorities, consultants, and contractors alike. The problem of overcoming the "minimal" connotation of using earth structures is very real indeed. The authorities invariably regard these proposals as condescending: Doesn't independent Africa deserve at least the same modern building materials as the developed world? Conservative contractors prefer using tried and tested materials without risk. Also, the true savings in using earth as a medium are negated by inflated costs or insurance added by the builder. Traditional crafts, rarely used, have tended to die out. Consultants prefer to concentrate on larger more prestigious jobs and so very little constructive thinking has gone into low-cost housing design.

Land is readily available, as is earth as a building material, and there is plenty of labour due to high unemployment and the population explosion. These are the seeds of a solution, provided that the prejudice against mud can be overcome. The way through this dilemma can be seen in several examples from across the continent, where for centuries laymen have built sensitively planned houses out of basic materials and created true examples of quality vernacular architecture; a tradition that must be conserved.

Three schemes typical of many throughout Africa are the Hausa compounds in Nigeria, the Tswana housing in Botswana, and the Ndbela dwellings in South Africa, have the following similarities of :-

a) They are self-designed and self-built, non-pedigreed architecture;

b) They have a bilobial plan with its heirarchy of spaces, from public to private, giving a sense of privacy, territory, and neighbourliness; (Figure 3)

c) They are economical since they use readily available earth as the major building material;

d) The decoration of the earth structures declares the author's pride in his or her creation

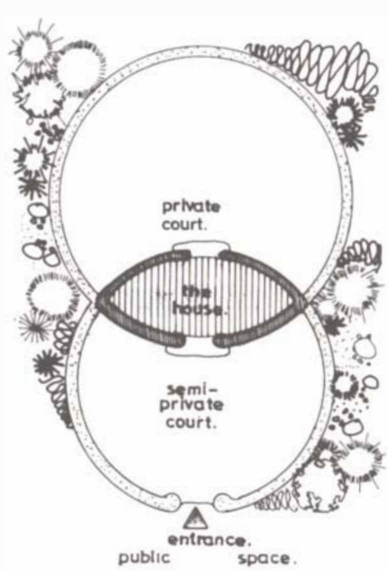


Figure 3 Bilobial Plan

The most interesting of the Hausa people's mud-built architecture is situated at Zaria in the Northern Savannah region of Nigeria. As in the Malian town of Mopti, the Hausa houses or compounds cluster along busy foot-paths around the town's two main focal points; the mosque or palace and the social economic centre, the market place.

The compound plans generally follow the design of two courtyards with their characteristic heirarchy of spaces leading from public to semi-public, to semi-private, and private areas. (Figure 4). The entrance is normally crowned with an impressive thatched roof under which the head of the household practices his trade or craft and meets the passing world. The first court is a transitional semi-public space with several rooms for servants, guests, adolescent boys, and sometimes a horse or cow. The quarters for the head of the household open off the first court and have a meeting area for important guests, while the inner courtyard houses the wives, girls, boys below the age of puberty, chickens, kitchens, and granneries. The privacy and tranquility of the courtyards form a haven from the bustling roads, a serene open-aired space, private and secure. The earth-built walling provides a unifying element to the compound that is delightfully decorated with sculptured rabbit ears, bas-relief, murals, and various roof forms. All in all a public demonstration of the owner's private pleasure in his architecture (Figures 5 and 6).

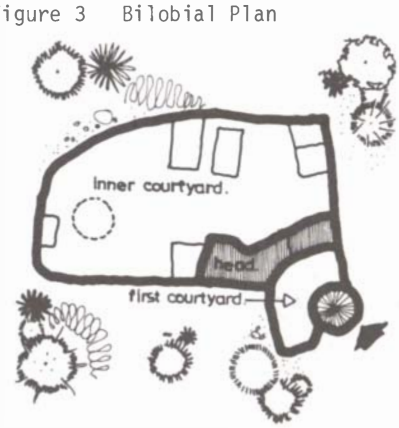
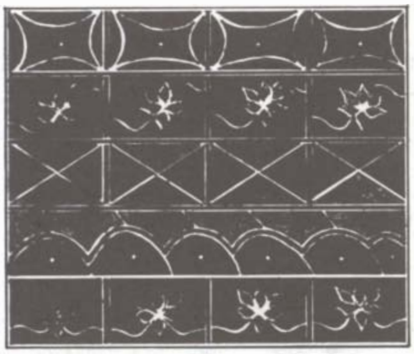


Figure 4 Hausa House Plan


Figure 5 Hausa architectural elements



The earth walls are built from egg-shaped bricks the size of a melon that are made at borrow pits from earth that is trampled with water to form a workable mix before being roughly moulded and left to dry for at least two weeks. Mortar of a similar mix is used for laying the bricks directly on a 450 mm deep foundation trench. No more than three courses are laid each day, but the walls are plastered again with the same mortar both internally and externally.

Both straw/thatch and mud are used for roofing, the latter being applied in two layers 50 mm and 75 mm thick supported on split poles which are tied into the mud walls.

Figure 6 (left) Typical hausa mural

Further south in Botswana the Tswana people have for centuries been building bilobial dwellings similar to those of the Hausa using similar earth materials, yet with more subdued but equally heartfelt decoration. (Figure 7)

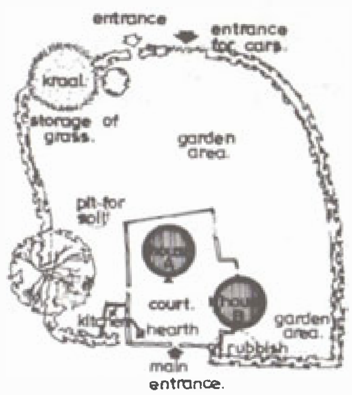


Figure 7 Typical Tswana House Plan

Women do all the building and crafting in mud. They collect the material, mould the blocks, erect the walls, and they do the plastering and colouring. The wall is built from a mixture of sand or clay and water, although cow dung is often added to the mix. The soil is carried in baskets on their heads to the building site. Foundation trenches 100 mm deep are dug, levelled, and lightly compacted.

Two types of bricks or blocks are used for the wall; wet (traditional) or dried. Wet bricks are moulded by hand about 300 mm x 50 mm in size and laid on top of each other while still damp, plastered and allowed to dry - three courses at a time.

Bricks may also be shaped in a simple mould of wood. Water is not pressed out as this would reduce the strength of the bricks. The bricks are dried in the sun then laid in a mortar of the same mixture as the brick. There is very little difference in strength between the wet or sun-dried brick, although some inveterate improvers say it is easier to cut out and re-use the sun-dried type.

Figure 8 Floor Pattern

The wall is always covered with two or three layers of plaster, both inside and out. The plaster is put on by hand and a finishing coat of sand, water, and cow dung is used, which covers any cracks or crazing and gives the house a smooth look. Women will go to great lenghts to decorate their walls, and complete redesigns will be done for special occasions such as births, initiation ceremonies, graduations, weddings, funerals, or even at the start of the planting season.

This concern with beauty is illustrated by the description by an old woman who told how she collected the mud when colouring her house and the other houses in the yard. "The brown mud I collected in Sekwane (about 35 km away) and the pale brown from Muchudi (about 30 km away). The black mud I collected from South Africa where I went to stay with my mother's sister. The other type, the yellow-ochre, was collected from a borehole north of this village. We went there to collect mud, but we are not allowed to by the owner of the borehole. The ivory white was collected from a stream which passes through my fields at the lands " (Reference 3).

Roofs are thatched and have big overhangs to throw the rainwater from heavy storms well clear of the base of the wall. The floors of the houses are rammed soil, finished with a mixture of cow dung and water spread with the hand in beautiful patterns giving a hard, odourless, dust-free surface that does not attract flies (Figure 8).

The tree of life grows from man's heart

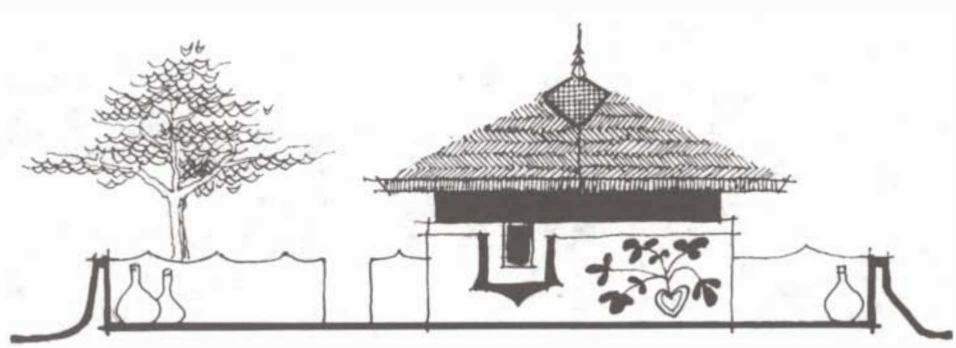


Figure 9 Typical Tswana House

The Ndebele people of the Northern Transvaal of South Africa have developed the bilobial theme into a very sophisticated and refined art form. A series of territorial stateme ıts is made defining the heirarcy of spaces that form their dwellings (Figure 10).

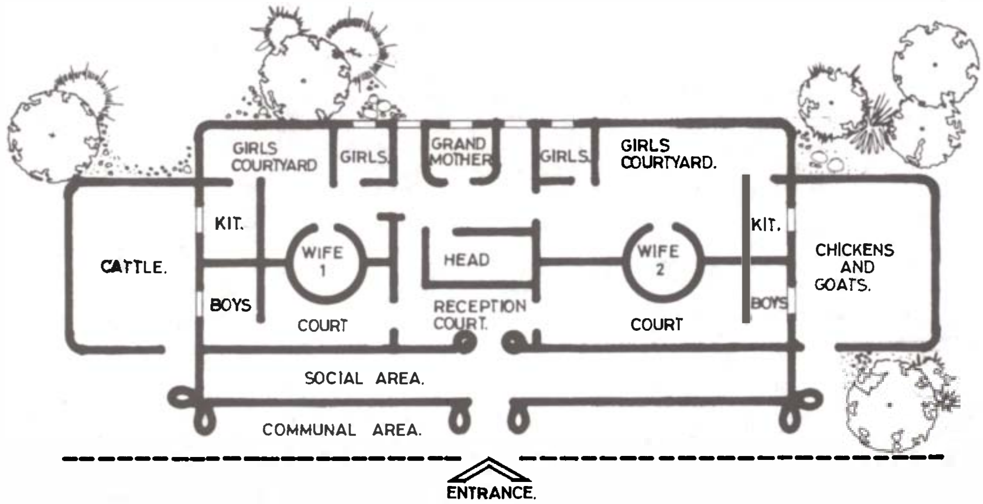


Figure 10 Plan of Ndebele Dwelling

The public area is a hand-crafted low platform that indicates the house is being approached; a second area is entered through gate posts and has a low wall. This is where the women of the household do their chores, supervise the children, and socialise with the settlement. Further zones with higher and higher walls lead to the front court with the dwellings buildings forming one side of the court. A series of rear or side courts radiate from the main dwelling, each housing a kitchen, a dwelling for the eldest daughter or grand-parent, or livestock compound. This building type responds to environmental conditions to a remarkable degree and the exhuberant decoration illustrates the delight of the Ndebele people for their creation.

Dr Hassan, the great Egyptian architect, has shown his brilliant ideas for building in earth and taught the construction of an earth vault without using any timber formwork. Several attempts at building earth domes and vaults in areas with heavy rainfall have failed and the discovery of a covering that uses neither cement or timber (for burning tiles) will open up the whole field of building low-cost houses. Experiments with sisal fibre, lime, or pozzalano cement, where available, have made some progress; tiles burnt with heat generated from a methane biogas digester have been manufactured but are not as yet satisfactory.

History has been indifferent to indigenous housing developments with very little recorded material, preferring to concentrate on the "noble" architecture. This is perhaps the reason for the current neglect of earth as a valuable construction material in the Third World. It is ironic that mud is completely accepted by the hotel industry for their luxury hotels serving First World tourists and also by city dwellers for their country retreats where, despite the lack of high-tech luxuries in their splendid apartments, the environment of the structure enables them to relax in serene surroundings.

Retention of the qualities of earth as an acceptable construction material is a necessity. Conservation of the tradition of building in earth which is freely available, plastic, easily worked, economic and beautiful is a nec-essity not for the sake of quaintness but the retention of a spontaneous architecture. As Dr Fathy has said, the cost of building the present ugly town developments will drive us to build more beautiful homes in mud as this will be all we can afford.

NOTES - REFERENCE

1. Gardens and Outdoor Living, National Housing Authority, Zambia, 1972

2. D. Greenwood, Architect, Hausa Compounds Zania
In-Situ Journal, Zambia Institute of Architects, 1979

3. Anita and Viera Larsson, Traditional Tswana Housing
Swedish Council for Building Research, 1984

ACKNOWLEDGEMENTS

1. Enid Cameron-Smith, Misundu Mud Pits, Zambia

2. Sandy Grant, Muchude Museum, Botswana

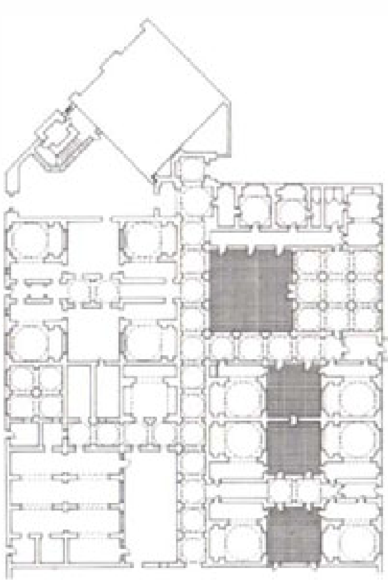
Figure 11 (left) Ndebele Mural

ABSTRACT

The Dar al Islam community, located near Abiquiu, New Mexico, was first conceived by Abdullah Nuridin Durkee and Sahl Kabbani in 1979 and implemented through grants from many individuals and Islamic foundations. The founders commissioned the well-known Egyptian architect Hassan Fathy to design the project, and he visited the site in 1980 with two Nubian masons to present his plans and demonstrate his techniques of building in mud brick. After a promising start and the construction of the mosque, which was to be the focal point of the community, problems in building procedure began to emerge, greatly increasing construction time and cost of what was intended to be a low-cost, self-help village. The source of these problems is indicative of the obstacles facing those who contemplate similar projects in the southwestern United States.

KEYWORDS

Dar al Islam, Hassan Fathy, Adobe.



1. Village plan as revised, provided by the Dar al Islam Foundation.

THE LESSONS OF DAR AL ISLAM

James McLeod Steele Jr.
Texas Tech University
College of Architecture
Lubbock, Texas 79409 U.S.A.

The idea behind Dar al Islam was first conceived by Abdullah Nuridin Durkee, after a chance meeting with Saudi businessman Sahl Kabanni in Makkah in 1979. Both men then discussed the possibility of a seed community for American Muslims who had previously been fragmented and seemingly cut off from the mainstream traditions of their religion. Initially visualized as both a religious and educational as well as a residential center, the community began to emerge as one that would provide a cultural focus for more than one hundred Muslim families and would be a model for others of kind throughout the United States. After a great deal of effort, the search for a suitable site for such a project led its founders to select 1,200 acres of land in the Chama River Valley near Abiquiu, New Mexico, fifty miles north of Santa Fe, which was purchased with funds made available by Kabbani, as well as the Princesses Mothie and Johara, who are the daughters of the late King Khalid ibn Abdul Aziz of Saudi Arabia. Because of its relative seclusion and the similarity of its terrain to other Islamic countries such as Tunisa, Algeria, Morocco, Syria, Iraq, Iran, Afghanistan, and parts of Pakistan, this site seemed ideal to all concerned. As Durkee himself has said:

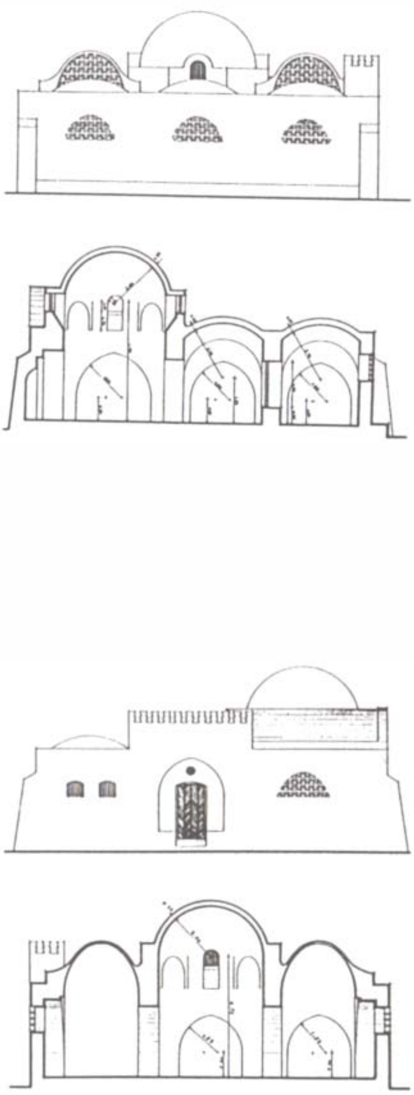
> In addition to its physical assets, that is, the necessary land, water, and soil for cultivation, construction and habitation, the Abiquiu site has geographic, climatic, and cultural characteristics that make it ideal for an Islamic Center. Located at the same latitude as many of the major Islamic regions of the world, it also shares a similar topography, climate, and long history of mud brick architecture.(1)

Even before an architect for the complex was chosen, the heart of the new community was intended to be a mosque, as well as a madressa, or religious school, and a riwaq, or living quarters for the students and teachers using this school. In addition to these religious and educational institutions, an administrative center to include an Institute of Advanced Islamic Studies, as well as houses, shops, a women's center, library, and clinic were also considered essential to the establishment of the new village. Because of his venerable reputation as the leading architect in the Islamic world at that time, as well as his long experience in using mud brick construction, Hassan Fathy was unanimously considered to be the most logical choice as the designer of Dar al Islam, and after having been introduced to Abdullah Nuridin Durkee by journalist Abdullah Schleifer in Cairo in 1980, Fathy enthusiastically agreed to do so without a fee, because of his deep belief in the ideals involved in the project. Soon afterward, in June 1980, Fathy visited Abiquiu and presented his proposals to the prospective residents there, while also showing the construction methods to be used. These were demonstrated by two Nubian masons (Muallims) who accompanied him and were based on a system that has been used in Egypt since 3000 B.C. In this system, which is eloquently described in Fathy's book Architecture for the Poor, as used in his village of New Gourna on the west bank of Luxor, a vault serves as the base unit, and the construction of this vault begins with the erection of a "kick-wall" built up to the desired height of the space to be constructed. Once this kick-wall is complete, the masons, usually working in pairs, do a free-form outline of the parabolic vault in mud on the wall as a guide. Although this may sound simple, the proper shape of the curve is crucial for structural success and learning how to lay it out without surveying tools of any kind requires long hours of practice, usually received in a father-to-son apprenticeship arrangement.

After this mud guideline has partially dried the muallims dress the rough edges with sharp adze before applying the first course of mud bricks to it. The bricks of this first course, and of each successive course of the vault, differ from those used in the construction of the walls in that they have a higher proportion of straw to mud, which makes them much lighter, and each brick is scored with two finger grooves by the muallims, while still wet, to give more friction and adherence to the mud mortar.

A starter brick is then laid straight up at the base of the vault line on both sides, and mud mortar is packed on it to form a wedge that is thinner at the top of the bricks and wider at the bottom. This sets the angle for each of the vault courses to follow, ensuring that they incline toward the kick-wall in compression, rather than remaining perpendicular to the ground, which would make them collapse.

As each course of bricks is added, the muallims gradually make the mortar thicker at the base of the arch than at the peak to make sure the entire assembly is leaning on the end wall, as well as staggering the joint lines between each row of bricks to assist bending. This calculated incline of the vault as it is put into place accounts for the characteristic massive vertical end wall and sloped front edge of the vaults that are usually found in the mud-brick buildings around Aboul-Riche and Gharb Aswan in Upper Egypt.(2)



2. Mosque Elevation and Section. Courtesy Hassan Fathy and the Aga Khan Award for Architecture.

The presentation of this technique was made to more than 300 people who included architects and adobe builders from all over the United States and Mexico as well as government officials interested in the economic potential of the system and, of course, the intended residents and board of directors of the community. The presentation also began to evolve from a construction workshop into a teaching session, in which Fathy gave a series of lectures that compressed a half century of hard-won experience into a stream-of-consciousness summation of the architect's most personal beliefs. Perhaps seeming somewhat disjointed and irrelevant to many of those in attendance, who had little or no knowledge of the remarkable background of the speaker, these lectures nonetheless went to the heart of many of the questions that were later to emerge as problematic issues for the community. One man in the audience, for example, made the observation that the mosque being proposed by Fathy was the result of thousands of years of evolution in a certain environment and culture, and had its own justification as a spiritual and ceremonial building, but that "most of us here are not concerned with ceremonial buildings but with the places people live in, as well as the whole question of solving the problem of re-developing the village economy as well as its architecture."(3) While not directly responding to this statement, Fathy answered that

> . . .the solution to any problem requires time and effort and cannot be achieved overnight, especially when we have had two-hundred years of cultural alienation. I personally cannot solve it, because it has gained a great deal of momentum, like a steamroller pressing an entire culture in front of it. People make excuses today by saying that everybody is now the same, but I say, no sir, this is escapism and we must not avoid our responsibilities. We should never be chauvinistic or exclusive, but have to be open minded about tradition. If something doesn't work we must wipe it out with the confidence that it is not worthwhile keeping.(4)

Both themes, of a concern for comfortable habitat on the one hand and the appropriateness of cultural traditions on the other, continue to reappear throughout the brief history of Dar al Islam and offer an important key to understanding the lessons that it provides.

In addition to the inspiration provided by these lectures and the feeling of high expectation and cooperation that the workshop provided, the immediate tangible legacy of this official inauguration of the community was the elegant 220 m^2 Masjid, or Mosque, that still remains the spiritual heart of the complex, standing as a graphic reminder of the structural and spatial possibilities that once existed. Ingeniously designed to achieve the separation of the sexes required in all religious and secular public buildings in the Islamic world, the Mosque is dominated by a large dome which is built over its main prayer area. As in the construction of a majority of his domes, Fathy uses the Sassanid method here, so that the corners where the arches meet to form the springing of the dome are first leveled off and then bridged with half domes to form squinches. These squinches then in turn create an octagonal base on which the structure sits.(5) Regardless of the deceptively simple success of the vault and dome construction of the Mosque, however, the American masons were unable to continue the example of their Nubian instructors, and structural revisionism slowly began to creep into the construction process. Expensive plywood templates, which still litter the site, were soon substituted for the parabolic curves that the

Nubians produced, and had to be used to form all future arches and springing lines of vaults. Small details that went unobserved during the Nubian demonstration also soon began to have unexpected and drastic consequences on construction progress. Score marks have always proved essential for the adhesion of one brick course to the next in vaults and domes in the past; they have been etched on the face of mud bricks by Egyptian, Nubian, and Hebrew masons in Egypt for 5,000 years and can still be seen in the remains of the storehouses of the mortuary complex of Pharaoh Ramses II in Luxor, built between 1290 and 1225 B.C. but at Dar al Islam they were eliminated with disastrous results.(6) Mortar, on the other hand, while essential on the brick faces of these same vaults and domes, proved dangerous when applied to the ends, because its inevitable shrinkage caused loss of contact and ultimate failure. Significant changes in the composition of the mud brick itself, such as the expensive addition of limestone aggregate suspended in a lactic acid emulsion with long cellulose fibers added to cope with thermal expansion, were made to offset the poor adhesion of the local soil. The final result of the initial failures that occurred seems to have been a basic distrust of the traditional system proposed by Hassan Fathy and successfully used by him in numerous major projects in Egypt. This distrust is especially evident today in the full lining of laminated plywood used as shuttering to permanently support the long barrel vaults covering the kitchen and dining area at the end of the village center, as well as in the steel reinforcing bars that project out of unfinished adobe walls, and in the concrete slabs, corner columns, and lintel beams that reduce the final high tech mud brick infill to a symbolic remnant of its former self.

3. Plywood forms for arches. Photo: James Steele.

The persistent concerns voiced about comfort levels in the cold nights and winters of New Mexico, which were raised during the opening ceremonies for the center, have also been put to rest by the installation of costly, electrically heated radiant mesh embedded in all concrete slabs. Commercially produced, fired clay bricks that are now in evidence in the uncoated domes of the arts and crafts center next to the main dining room also give clear testimony to the ultimate extent of the builders' distrust of mud brick, and the conceptual distance that has been traveled between the architect's original intentions and the realities perceived by decision makers at Dar al Islam later on. To be fair, many of the alterations made, such as concrete floor slabs, corner posts, and ring beams, were required by New Mexico's building code, which, while permitting adobe construction, converts it into something quite different from its traditional counterpart.

Perhaps nothing proclaims this conversion more unmistakably than the regulations related to coatings, and it is these that have had the most disastrous consequences on the overall physical appearance of all the buildings of Dar al Islam, making what should be a soft and natural earth plaster surface look like pressed plastic. While making a token gesure at acceptance of adope as a building material, this code, especially in its attitude toward coatings, betrays a prejudice that is unfortunately pervasive among all highly industrialized societies in the developed world. In the southwestern United States, that prejudice is usually rationalized by building authorities by reference to studies that track in great detail the deterioration of a single mud brick submerged in water. As Jean-Louis Bourgeois has noted in his excellent assessment of the inherent fallacy behind the use of such evidence as proof of the supposed weakness of adobe and the unsuitability of natural mud plaster as moisture protection in temperate climates, dissolving a single brick by constant immersion in water is an unfair way to evaluate the stability of an entire wall system intermittently dampened by rain. As Bourgeois has said:

4. Barrel vaults. Photo: James Steele.

> The tests are accurate. They are just irrelevant. . . such behavior has little to do with the performance of an adobe wall. No brick that supports any weight in a slanting wall ever gets that wet. How a single adobe brick resists water attacking from six sides has little to do with how a massive adobe wall resists rain from one side. . . .Adobe bricks function as a structure. . .traditional adobe is not just a material. It is a system.(7).

The consequence of the acceptance of such tests by those enforcing building codes has been the requirement that cement plaster be used as a coating for adobe rather than the more natural and historically proven finish of mud plaster that allows the adobe wall to breathe and dry out normally through evaporation after being wet by rain. Because it is also thermally incompatible with the mud brick that it is supposed to protect, cement plaster frequently cracks, allowing water into the wall that cannot then escape. Such cracks are already in evidence in many of the walls now coated with cement plaster at Dar al Islam. In severe cases, this trapped water causes the adobe to disintegrate and collapse.

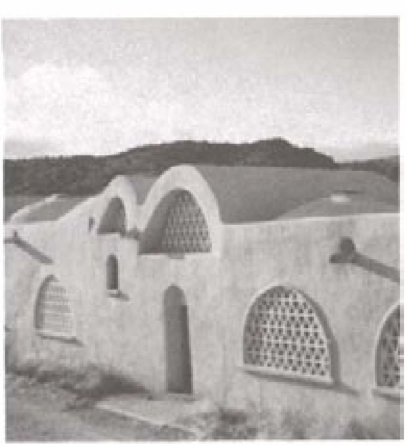
5. Buttress wall and concrete lintel beam. Photo: James Steele.

As a result of the combined effects of disillusionment with the lack of progress on the construction, as well as the alarming cost overruns caused by building code restrictions, the backers of the project began to have second thoughts. These doubts were not helped by life-style differences of the would-be residents in comparison with the people in the country for which such self-help mud brick architecture was originally intended, and the distrust of adobe that seems inherent in contemporary society in the western hemisphere, which did not impress financial supporters who are accustomed to seeing concrete, glass, and steel construction finished with great speed in their own country. In the six years following the completion of the Mosque in 1981, only half of the village center had been completed at great cost, with an estimated $630,000 in 1987 dollars then being required to finish the remaining part of the core area.(8) As these second thoughts began to turn into intractable doubts about the future of the project and tempers flared, founder Nuridin Durkee saw no alternative but to resign from the Board of Directors of Dar al Islam in 1989, preferring the peace and quiet of research and study in Cairo to further frustration and disappointment in Abiquiu. In recently reviewing the basic differences between using mud brick in the way proposed by Hassan Fathy and that required in New Mexico, Durkee echoed most of the reasons already listed here and proposed that locally produced pumice, or tufa, brick which is considered by building authorities to be more impervious to water damage than adobe, be seriously considered as an alternative material in the future.(9) Durkee's resignation, as well as this final position on the use of mud brick in Dar al Islam is a sad commentary on a vision that once held so much promise and a material that has come to symbolize the southwestern United States in the mind of the general public.

Conclusion

The lessons provided by Dar al Islam, then, to those contemplating the use of adobe construction in this region of America, and particularly those enamored with the self-help techniques associated with the work of Hassan Fathy, are certainly harsh. While it would seem to be easy to fault the builders of the community itself for their failure to carry on with the original intentions of the architect and his gift of an inexpensive structural system that had taken him an entire lifetime to perfect, this would be too simplistic. Also faulting the restrictive building codes of the area, which are admittedly disrespectful of a material that they proudly claim to "improve," is also unrealistic. The fundamental flaw behind the failure of Dar al Islam certainly includes both of these factors but finally goes beyond them to the basic questions of the appropriateness of using Hassan Fathy, along with his methods and style, in the project at the outset. By choosing this undeniably remarkable architect, the founders of the project were choosing to believe that the prospective residents of Dar al Islam would also embrace his ideas of self-help housing built with natural, available materials, as well as the Spartan lifestyle of the Egyptian peasant. As Abdullah Schleifer, who introduced Nuridin Durkee to Hassan Fathy in the first place, has so perceptively noted, construction at Dar al Islam is not proceeding in accord with

> the mutual aid cooperative system outlined by Fathy in his writings. This sytem requires pre-existing communal ties and traditional social structure, a neighboring parent village for satellite settlement, tribal or clan relationships and a subsistence economy that provides. . .the time and the available willing labor for cooperative work. The Abiquiu project unfolds in a social void.(10)



6. Cement plaster coating. Photo: James Steele.

As Fathy himself said in his lectures that inaugurated the project, such a void cannot be filled overnight.

In a deeper sense, Fathy was obviously chosen as the architect of Dar al Islam not only because of the economic appeal of the structural system that he had resurrected, but also because he had then come to be recognized as "the Father of Contemporary Islamic Architecture" for his Herculean efforts in encouraging all of the countries in the Muslim world to search for an expression of their unique architectural identity.(11) These efforts have not only made him a role model for countless numbers of young architects throughout the developing world, but have also made him an enduring symbol of high achievement to Muslims everywhere.

In his lectures at Dar al Islam, Fathy also stressed that the plans for the village he had designed stood for far more than just a construction project, but also represented "a mission" for all concerned.(12) While the failure of that mission still may not be considered a foregone conclusion, its completion really does now appear to be all but impossible. The current state of affairs at Rio Chama must be disappointing for the intended residents of Dar al Islam, but if this village is left unfinished it will most certainly represent the final frustration in the career of Hassan Fathy and stand as one more haunted community left needlessly abandoned in the wilderness.

Notes

1. A. N. Durkee, "Hassan Fathy in New Mexico," The Building of Architecture (Pennsylvania: The Graduate School of Fine Arts of the University of Pennsylvania, 1984): 59.

2. J. M. Steele Jr., Hassan Fathy (London: Academy Editions Monograph Series, 1988): 52-53.

3. H. Fathy, Lectures at Dar al Islam (Geneva, Switzerland: Aga Khan Award for Architecture, 1980), tape transcripts.

4. Ibid.

5. D. Dillon, "A Mosque for Abiquiu," Progressive Architecture (June 1983): 90.

6. G. W. Van Beek, "Arches and Vaults in the Ancient Near East," Scientific American 257, no. 1 (July 1987): 96.

7. J. L. Bourgeois, Spectacular Vernacular: The Adobe Tradition (Apeture Books, 1989): 167-169.

8. Dar al Islam News Bulletin (Abiquiu, New Mexico: Dar al Islam Foundation, 1986.

9. Personal interview with author at the American University in Cairo, October 18, 1989.

10. S. A. Schleifer, "Hassan Fathy's Abiquiu, An Experimental Islamic education center in rural New Mexico," Ekistics 304 (Jan/Feb 1984): 59.

11. H. Sugich, The Arab News, Jeddah, Saudi Arabia, Sept. 26, 1985: 3.

12. Fathy, Lectures.

ABSTRACT

The objective of this work is the professional and scientific community with the characteristics of existing traditional construction which is part of the cultural heritage in the territory of the Socialist Republic of Macedonia. This tradition is distinguished by certain architectural, structural, cultural, and historical values. Sun-baked (adobe) clay is the main construction material.

An initial inventory of this cultural heritage showed us that earth as a main building material is used in various forms as adobe brick for the construction of bearing walls, partition walls, for infill in timber-framed structures, and as a main material for mortar and plaster. The inventory also shows that such structures have significant architectural, structural, physicochemical characteristics.

Located in Macedonia (a region prone to earthquakes ranging from 6 to 10 degrees of MMS intensity), these buildings have some traditional aseismic elements and systems which have allowed them to survive many earthquakes such as the recent Skopje earthquake in 1963. For this reason, our future task is to obtain information through scientific research about the characteristics of these structures to better understand, protect, and conserve them as valuable traditional antiseismic elements and systems.

KEYWORDS

INTRODUCTION

GENERAL CHARACTERISTICS

TYPE OF STRUCTURE

EARTH USE

GOODNESS AND WEAKNESS

ASEISMIC TRADITIONAL ELEMENTS

CONCLUSIONS

TRADITIONAL SUN-BAKED (ADOBE) BRICK STRUCTURES IN MACEDONIA, YUGOSLAVIA

Lazar Sumanov
Grad. eng. Architect - Senior Conservator
Republic Institute for Protection of Cultural Monuments (RZZSK)
P.O. Box 225
91 000 - Skopje
YUGOSLAVIA

Introduction

The territory of Socialist Republic of Macedonia, Yugoslavia bears material witness to architectural achievements from the ancient times to the present. It's most famous for its rich archaeological sites, the extraordinary medieval churches and monasteries, frescoes and icons, urban and rural architecture of the nineteenth and early twentieth centuries. However, there is no explanation why adequate attention has not been paid to sun-baked (adobe) structures in our Republic.

Earth mixed with water and various additives has been used as a building material for more than 10,000 years and is still in use. More than one-third of the world's population is still living in adobe and similar structures. The systematic inventory which has been carried out since 1987 has proved that on this very ground, throughout almost the whole territory, there are individual examples and even whole villages (the village of Konjari near Debar), which consist of adobe structures of not only historic and cultural but also architectural structural values worthy to be further investigated and protected by law.

Functional, architectural and structural characteristics

Sun-baked bricks are most frequently used as a basic material for the construction of simple or very complex ground floor or multistorey structures, which are mostly rectangular and are situated either individually or in rows. The ground floor and basement are almost always used for household production activities or as a ware house or pantry, while the porch serves for tool storage. The kitchen is most frequently located on ground floor, too. The upper floors are usually utilized as a living room, dormitory, or summer residence.

There are examples of structures with bay windows, typical for the residential buildings of the urban and the rural architecture of timber-frame structures of smaller proportions. These windows are made skillfully and incorporate well into the total outline of the structure. We often encounter buildings consisting of a ground floor and two stories, for instance. A building in the village Cucer near Skopje (see fig. 1) which is more than eighty-five years old and has a basement, a ground floor and two stories, displays impressive architectonic characteristics of mass and perforation distribution, as well as other extraordinary values. This is the tallest building of this type that has ever been observed in the Macedonia region.

Although the whole territory of Macedonia, especially the area surrounding Skopje, is seismically active with high magnitude earthquakes (9 Mercalli degrees), the Cucer structure suffered no damage during the 1963 earthquake. Scientific investigation was initiated to analyse the building's structure characteristics.

Sun-baked bricks have also been used for the construction of the secondary structures, most frequently in combination with timber structural systems (see figs. 2-4).

The openings of the residential buildings are of smaller proportions (narrower and lower) (see figs. 1-3) than the common ones, while the height of the premises is the same (being 1.9-2.2 m. for the ground floor premises and 2.1-2.4 m. for the upper floor premises). As a rule, the residential buildings are characterized by a hipped or complex roof; only rarely was saddle roof with low cable walls constructed. Tiles or stone plates are exclusively used for roof covering. Most frequently, the facade, timber structural elements of the doors, windows, and fence carpentry were not coloured or plastered (see figs. 1-4).

It has to be noted that all structures, either residential or secondary, are proportioned in compliance with human proportions, which is one of the main characteristics of the architectural traditional heritage in Macedonia.

Types of structural and nonstructural elements

Since the First International Symposium on Earth Structures in Yazd (Iran, 1971-1976), and third in Ankara (Turkey, 1980) and the fourth in Lima and Cusco (Peru, 1983), the following classification of the different types of structural elements was adopted:

1.0 - Hand-formed in layers
- 1.1 - simple forming
- 1.2 - earth balls, thrown and molded

2.0 - Sun-baked bricks (adobe or blocks)
- 2.1 - cut from hardened soil
- 2.2 - formed in mold
- 2.3 - molded and compacted

3.0 - Tapial-rammed earth
- 3.1 - compacted by hand blows
- 3.2 - mechanized or vibrating compaction

4.0 - Wood or cane structure, wood or cane mesh closures plastered with mud or infilled by sun-baked bricks

The results from the inventory of Macedonia adobe structures shows that the following individual or combined structural and nonstructural elements are present in Macedonia: under categories 2.1, 2.2, 2.3, 3.1, 4.0.

The proportions of the bricks range from 8/20/8 to 14/30/12 cm, depending upon the molds used which may have one or even ten cells. The quality of molding is always higher when a mold with a smaller number of cells is used.

The thickness of the weight-bearing walls ranges between 60-120 cm. (see figs. 1-2) in the lower basement premises and 40-60 cm. in the upper premises, while the wall thickness of structures under 4.0 of the above classification measures 15-30 cm. (see figs. 1-4).

The adobe structures are characterized by sun-baked brick weight-bearing walls lying on foundation walls of crushed stones in lime mortar. These walls are 1 m. high which is approximately the maximum level of the capillary moisture in winter and springtime. The base of the block masonry is protected against capillary moisture, which is one of the most dangerous effects on thise type of structures (see figs. 1-5, 7).

Timber bond structural elements have been placed on almost all the bearing and non-bearing walls at a vertical distance of 1-1,2 m.; this proved to be quite successful in strengthening and providing stability to these structures.

Other use of earth

Earth mixed up with water, sand, hay, animal hair, blood and urine has been used as a binding material for the sun-baked brick walls (see figs. 1-7). It has also been used as a plaster (see figs 1-2) and as the infilling of the wood meshes (wattles) (see fig. 5).

In urban areas, the facades are often plastered with lime mortar or lime plaster so that sun-baked brick walls would be better protected against the mechanical effect of rain (see figs. 1-2).

Other characteristics and weakness of adobe structures

The earthen structures have some advantages and disadvantages. First of all, they are good heat and sound insulators and are easily and cheaply maintained, there are many sources of damages which are merciless in affecting these structures:
- water (in the form of rain, running water, capillary moisture, or condensed water)
- sun (indirect damage caused by abrupt drying of the dampened walls, cracks form after several cycles of moistening and drying and contribute to the severe damage of the elements to the total structure)
- wind (drifting hard sand and dust particles which damage the surface of the walls mechanically)
- soluble salts (by means of chemical disintegration)
- biodeterioration (plants-insects-animals)
- inappropriate maintenance
- floods and earthquakes

TRADITIONAL ELEMENTS OF ASEISMIC RESISTANCE OF ADOBE STRUCTURES

Elements which increase earthquake resistance of Macedonian earthen adobe structures:

- quality building materials, good knowledge, experience and adequante use of additives (organic and inorganic)
- use of high quality wood, such as oak and pine
- maximum effort to eliminate capillary moisture in the very first stage construction
- quality of manufactured construction of weight-bearing walls and structures, timber-frame and all other horizontal and vertical connections
- regular protection of the adobe surface against rain damage
- regular (almost daily) maintenance
- use of horizontal wooden belts, without exception, as the highest aseismic resistance elements

In the following text we will be more familiar with the elements mentioned above.

a) As a principle, without exceptions, molds for surface sun-baked brick have one or two cells. For other use bricks for inside of walls are from molds with three and more cells. The largest mold is with ten cells (see figs. 1, 3, 4 - 7).

b) Materials for brick or mortar always incorporate cut straw or animal hair as reinforcing elements.

c) The foundation of all structures are manufactured of stone in lime mortar whose end is always 1-1.2 m. above the ground level. This is higher than the maximum level of ground capillary moisture in winter and spring time, and the contact zones of adobe wall with foundation are always dry and safe (see figs. 1-5, 7).

d) Brick wall adobe structure is of high quality. Regularly spaced bricks are inserted through all cross section of the wall in horizontal and vertical section. The thickness of the mud mortars are of the same size and are of good quality.

e) Almost without exception, all wall-bearing structures, and partition walls of adobe brick structures have horizontal wooden belts 1-1.2 m. in vertical distance. A wooden grid (named kushak) consists of two parallel longitudinal beams 8/8,8/10,10/10 cm. connected to each other with smaller wooden elements 4/4 - 6/6 cm. spaced 60-70 cm. in the rectangular direction. This wooden belt is in contact with the floor and roof construction. One wooden belt is located on the same level through all structure; this is an extremely important antiseismic traditional element (see figs. 1-5, 7).

f) In many cases the surface structure is plastered with mud plaster (with cut straw or animal hair as an additive)and a layer of lime plaster (0.3-0.7 cm.) manufactured during the wet stage of mud plaster. As a tradition, each user and owner of adobe structure in the spring time applies lime wash to all plastered surface; this ensures 1 year protection against damaging climate factors.

g) The final floors of the structure are built with timber-framed constructions, with adobe brick or mud as infill elements and they have significantly smaller thickness (15-30 cm). They have a very light construction, which is a very logical and important principle in earthquake-prone regions: to have lighter structure on the top than on ground floors.

i) regular ongoing maintenance.

CONCLUSIONS

Initial inventory and research done 1987-89 proved that in the territory of Macedonia (region prone to moderate and strong earthquakes) significant cultural heritage exists. Earth is the main building material used in various forms as sun-baked bricks, mortar and plaster, all of which have certain valuable qualities which are needed scientifically to be confirmed, as a future task. This data will allow for better understanding, protection and conservation of this cultural heritage. The application of these data on buildings and structures with the same or similar characteristics as a cultural heritage or standard modern adobe structures would be a contribution of the past to the future.

Fig. 1 - Most significant adobe structure in Macedonia

v. Cucer (Skopje region) - Durakovci House, massive adobe weight-bearing structure in combination with timber-framed structure (final floor). Village Cucer is located at 8 km distance from Skopje 1963 earthquake epicenter. No visible damage.

Fig. 2 - Typical traditional aseismic elements

v. Cucer (Skopje region)

Fig. 3 - Mixed structures

v. Gornjani (Skopje region) - Combination of massive adobe weight-bearing structures and timber-framed structure. Ground zone - stone masonry in lime mortar.

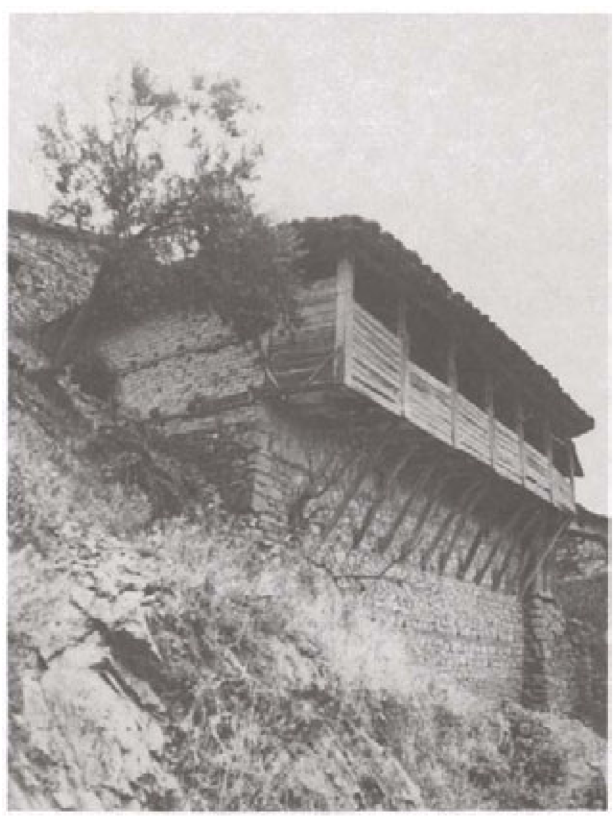


Fig. 4 - View to the valley

v. Kuceviste (Skopje region) - Stone masonry adobe wall weight-bearing structure and cantilever (erker) of wooden structure with characteristic diagonal wood elements.

Fig. 5 - High quality of manufactured elements
v. Kuceviste
(Skopje region)

Fig. 6 - Typical rain protection
v. Germjan (Bitola region)

Fig. 7 - Modern reinforced concrete belt
Struga (South Macedonia) - Application of reinforced concrete belts in adobe wall weight-bearing structures as a reflection of reinforcement new structures after Skopje 1963 Earthquake.

CONSTRUCCION TRADICIONAL EN EL NORDESTE ARGENTINO

Graciela María Viñuales
Bolivia 82
3500 Resistencia
ARGENTINA
T (54) (722) 29294

ABSTRACT

Ancient building in the northeastern area of Argentina employed adobe and wattle and daub techniques, of which both rural and urban examples of the eighteenth, nineteenth, and early twentieth centuries still remain standing.
At present, the use of earthen masonry has been practically lost, while wattle and daub is more widely used and in a larger range of varieties.
Internal migrations in the eastern humid zone produce constant adaptations. Where a dry climate prevails, such as in the west, there are settlements which remain more stable both in time and type of design. There earth is used also for roofing.
Recent economic changes have produced peripheral neighborhoods in various cities, reflecting the origin of their dwellers.
A well-ordered register of the situation and a set of solid bases for their preservation and maintenance must also take into account the social, economic, and cultural milieu to which each one of the examples belongs.

KEYWORDS

history, adaptation, preservation, techniques, transferences, masonry, wattle and daub, rammed earth

Presentación

Desde las épocas de la conquista española se sabe que en la zona era corriente el uso de la tierra como material de construcción. Asimismo, éste se unía a otras tradiciones propias del aborigen como el entretejido de ramas y troncos que hacía con gran destreza. Los aportes hechos por los hispánicos de diversas regiones y lo que el medio mismo permitía, llegó a conformar una forma de hacer arquitectura en la que la tierra era elemento fundamental.

Sin embargo, fuera de algunas publicaciones de escasa difusión y de artículos diseminados en revistas, no ha sido esta arquitectura objeto de un estudio sistemático. Menos aun lo ha sido una propuesta técnica de mejoramiento y conservación. Intentos parciales desde centros de estudio o de gobierno han sido efímeros y muchas veces directamente combatidos.

La zona que nos ocupa -la del nordeste argentino- es de clima tropical, con temperaturas que pueden pasar los 40°, aunque con posibilidades de tener algún día del año unas horas con 0°. Pero dentro de la zona hay dos partes bastante diferentes: la del este con clima húmedo, influído por la cuenca del Río de la Plata, y la del oeste, conocida como El Impenetrable, en donde el clima es seco. Si bien en ambas hay bosque, sus diferencias son notables.

En la parte húmeda, cuando en invierno se superan los 35° es casi seguro que sobrevenga una tormenta de 150 km/h con intensas lluvias y con el consiguiente cambio drástico de temperatura. En la parte seca, esto puede llegar a ocurrir alguna vez, pero lo normal es que el agua aparezca en el verano cuando los deshielos de los Andes llenen nuevamente los cauces secos de los ríos. Debe tenerse en cuenta además, que los regímenes de lluvias y de cauces no son regulares, por lo que no son raras las inundaciones y el cambio de cuencas menores.

Este panorama geográfico ayudará a comprender los problemas arquitectónicos de la región. Pasaremos ahora revista a ellos.

1. Sistemas

Las crónicas y dibujos coloniales nos muestran la hechura de tapias explicándonos todos los pormenores de su ejecución. Asimismo, aparecen menciones en distintos puntos de la zona de fabricación de adobes, palo a pique y distintas "enramadas". Debemos decir que la zona seca estuvo escasamente poblada por españoles a finales del XVI, siendo abandonada a principios del siglo siguiente. El extremo este (húmedo) correspondió a la zona de las Misiones Jesuíticas que se desarrolló en forma autónoma. La parte central (también húmeda) es la que tuvo una intensa vida hispánica y es en la cual nos quedan los principales ejemplos de edificaciones antiguas.

No todas las técnicas han podido afincarse definitivamente en la región. Factores de urbanización, falta de mano de obra, estímulo por la rapidez y la moda, han dado lugar a un nuevo panorama.

La zona húmeda, con su cambiante geografía, muchas veces obliga al poblador a emigrar y a rehacer su casa periódicamente adecuándose al nuevo sitio. La influencia de las generaciones jóvenes hace que tales ciclos de traslado y acomodo se vean alterados, con lo que también se tergiversen las formas de construcción y mantenimiento.

En la zona seca, en cambio, el clima y el tipo de idiosincrasia lleva a viviendas más estables, aunque a veces sean de uso estacional, principalmente para los hombres. La falta de lluvias o de grandes huracanes permite que las construcciones, aun sin uso continuado, perduren varios años.

1.1. Tapias, adobes y terrones

Aparentemente, *tapias* y *adobes* fueron de uso corriente desde finales del XVI. El ladrillo cocido sólo se usaba en ocasiones, y su verdadera difusión se dio hace aproximadamente un siglo. Los hornos trataban de reservarse para cocer tejas y ladrillones de piso. Hoy quedan en pie ejemplos de casas con galería al frente en varios sitios de la ciudad de Corrientes y en diversos centros poblados de esa provincia.

Lo mismo podríamos decir de Santa Fe, aunque los ejemplos son menores en número, pero mayores en su envergadura. Justamente en esta ciudad se encuentra la iglesia de San Francisco, levantada a mediados del XVII con el sistema de tapias y que hoy es Monumento Nacional. Se continuaba aquí con el tipo constructivo que había tenido toda la ciudad en su anterior emplazamiento de 1573.

Aparentemente, la tapia fue una tipología corriente hasta finales del XVIII, pero más tarde se fue optando por el adobe que resultaba más fácil de trabajar. Así éstos siguieron en uso hasta nuestro siglo, y cuando se comenzó a repoblar hacia la zona del oeste, los adobes fueron también usados. Sin embargo, con el tiempo -y quizá por una imitación del ladrillo- en algunos lugares las dimensiones de los mampuestos se fueron achicando de tal modo, que hoy encontramos adobes de medidas similares a las de aquéllos.

Otro sistema de mampostería utilizado ha sido el del *terrón*, conocido aquí como "champa". Fue de uso común en las zonas rurales y hoy todavía se lo vé de vez en cuando. Su difusión principal se encuentra en la porción sur de nuestra área de estudio.

El barro también aparece hasta la actualidad como mezcla de asiento y de revoque de construcciones de ladrillo. Pero a este aspecto lo hemos dejado expresamente de lado en la presente ocasión.

El techo de *torta* pertenece igualmente a los sistemas de entramado. Se realiza con un enmaderado similar al de un techo de tejas, pero su cubierta está formada sólo por tierra, trabajada en diferentes capas. La torta es de uso corriente en el noroeste argentino y poco a poco se fue diseminando por el extremo oeste de nuestra región, a partir de las repoblaciones del finales del XIX y principios del XX. Hoy es común su uso en toda la zona seca, pero con una inclinación mínima y con un gran grosor que atempera los calores.

1.3. Las adecuaciones urbanas actuales

Los problemas económicos que se han agudizado en estos últimos quince años, han hecho llegar a las ciudades pobladores rurales que han tratado de conseguir puestos de trabajo en la construcción de grandes conjuntos habitacionales impulsados por el gobierno. Paradójicamente, esa mano de obra no calificada fue usada pero sin contemplarse sus propias necesidades de habitación. Ellos mismos entonces, levantaron sus barrios en la periferia de las ciudades, utilizando terrenos fiscales o abandonados, a veces inundables y con falta de todo servicio. Y a pesar de ser sitios bajos, fueron aun desnivelados muchas veces por sacar de allí mismo la tierra para hacer sus casas de chorizo o estanteo.

Las técnicas que conocían se aplicaban, pero ahora con materiales diferentes. Si bien la ciudad proveía fácilmente de alambres, que se conseguían por compra o por desecho en el lugar de trabajo, las ramas, cañas y pajas ya no estaban en las cercanías y debían ser pagadas o procuradas muy lejos. El centro urbano arrojaba, en cambio, otros desechos que podían utilizarse y ser aun mejores y más fáciles de trabajar que los rurales, pero se necesitaba de una adecuación de técnicas y de una preparación diferente. Para ello los pobladores tuvieron bastante inventiva, aunque no todo fue coronado por el éxito.

Hasta hoy se utiliza el reciclaje de embalajes de madera, de donde también se sacan y enderezan alambres y clavos. Los envases de latón como los de aceites, combustibles y dulces son desarmados y utilizados para protección de los sitios más expuestos a aguas y soles, así como para cerramientos, donde igualmente aparece la tela metálica. En las cercanías de las fábricas de tanino se apela a las astillas de madera de quebracho para impermeabilizar los zócalos. Asimismo se usan diferentes desechos de otras industrias de la región.

Sin embargo, estas adecuaciones y transferencias dan pie a muchas equivocaciones, a veces provocadas por el material elegido, al que no se conoce suficientemente y al que generalmente se lo sobreestima por ser "moderno", otras veces por utilizar en una región lo que es propio de otra. En este sentido el caso más duro ha sido el de los que proviniendo de la zona seca han construído techos de torta (aunque algo inclinados) en la zona húmeda, con el consiguiente desastre posterior.

1.2. Tierra con entramado

La facilidad de algunos aborígenes nómades de la región para procurarse un refugio rápido frente a las tormentas hicieron de ellos diestros trenzadores de ramas y hojas. Con la llegada del español y la búsqueda de establecimientos más duraderos, se conjugó tal sabiduría con el uso del barro blando para darle cerramiento y mayor fortaleza a las construcciones. En el caso de los guaraníes ,que ocupaban la porción oriental y que sí tenían viviendas estables, se dio un caso similar, pero de mejores calidades. Por ello el sistema de tierra entramado se popularizó en toda la región hace ya 400 años.

Con el tiempo, éste ha sido el tipo utilizado con más asiduidad y con más variaciones. A la célula unitaria de cuatro horcones que sostienen un techo, se la ha cerrado de innumerables maneras. Describir cada una de ellas sería agobiante, baste decir que los tipos más usados se dividen en tres grandes familias: *estanteo*, *palo a pique* y *chorizo*.

El *estanteo* supone la organización de un entramado que se hace con ramas gruesas a las que luego se le intercalan otras más finas. La forma de tejido y el tipo de elemento vegetal tiene abundantes variedades, llegándose a usar cañas, pajas, cortezas, etc. Los trabajos más cuidadosos presentan un doble entramado que luego es rellenado con barro y agregados, haciéndose un terminación de barro más fino. Tiene mucho parecido con la quincha, aunque en general es algo más rudimentario. Esta familia de entramados no sólo varía en su composición y diseño, sino que en la misma región adquiere diferentes denominaciones que aluden a alguno de los elementos o de las técnicas usadas.

El nombre de *palo a pique* proviene de un tipo de construcción muy difundida en la colonia y que suponía una construcción de madera para cercar un terreno. Con el tiempo y el detrimento de la calidad de los palos y de su colocación se vio necesaria la complementación con barro. Pasó entonces a ser usado en viviendas y fue evolucionando hasta convertirse en un tipo de pared muy difundido, sobre todo con troncos de palma tipo "caranday", de gran longitud y sección constante. Hoy se lo encuentra con embarrado en una o dos de sus caras.

El *chorizo* es la forma de construir más popular de todas. Es rápida, no requiere mano de obra muy especial y puede hacerse casi con cualquier tierra. Por eso, es que se la usa mucho para construcciones estacionales o de paso. La mala calidad de la tierra se suple con las pajas que se le agregan. Antiguamente, sobre la base de los cuatro horcones se tendían ramas transversales o tiras de cuero mojado de las que irían colgándose los chorizos de paja y barro. Hoy día, esas tiras son de alambre bien tensado. Los chorizos se forman amasando paja y barro y se van colgando de abajo hacia arriba, bien juntos uno al otro hasta hacer el cerramiento. Después se revoca con barro.

Dentro de esta familia hay variaciones, pero no tanto por los elementos usados, sino más bien por la mayor o menor prolijidad de ejecución, fundamentalmente en el retorcido y contigüidad de los chorizos. Esta técnica que creíamos única de nuestra región la hemos encontrado en China, en donde también se usan chorizos horizontales para los hastiales.

2. Soluciones

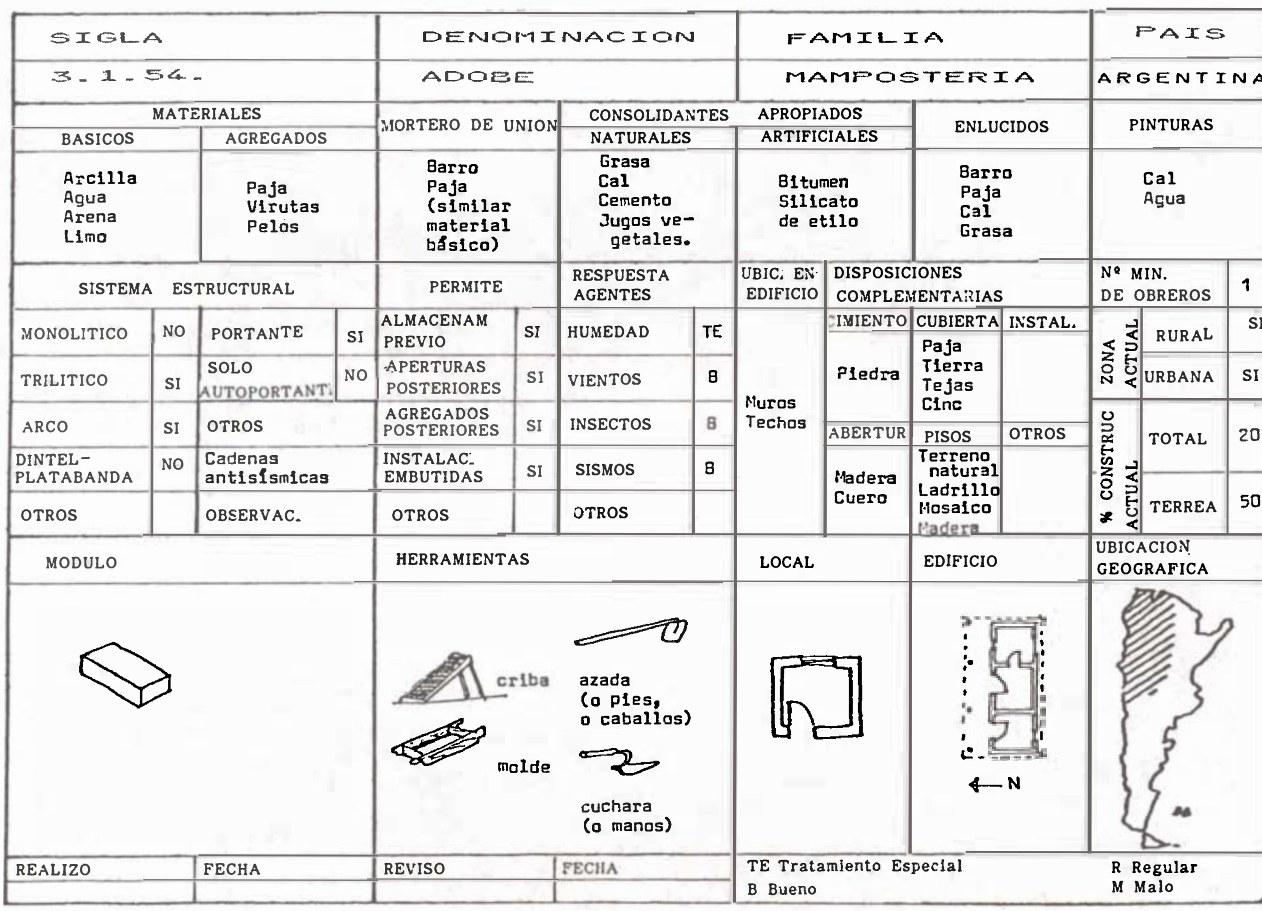
Han llegado entonces a nosotros edificios de antigua data, así como construcciones actuales de tierra de muy distintos sistemas y calidades. En muchos casos ellas son desconocidas por el habitante de las ciudades o son enérgicamente combatidas. En esto tienen ingerencia la industria de la construcción, los profesionales, los gobiernos y los propios centros de estudio. Y aunque desde todas estas áreas hay quienes estén trabajando para optimizar el uso de la tierra, se hace muy dificultoso remar contra la corriente general.

Los principales intentos favorables que hubo en la región serían: los encarados por la provincia del Chaco hacia 1969 con su Plan de Mejoramiento de Ranchos, los de la Universidad del Nordeste con el diseño de viviendas de *chorizo mejorado* los que actualmente encara el Instituto de Tecnología Agraria en la provincia de Corrientes y algunas construcciones de *suelo-cemento* realizadas en la provincia de Santa Fe hace unos 20 años.

Pero nosotros, desde nuestro Departamento de Conservación del Patrimonio Arquitectónico (Universidad Nacional del Nordeste) hace años que venimos trabajando sobre el tema, sea en el amplio espectro de la misma conservación de edificios antiguos de tierra, sea en el rescate de las técnicas como medio adecuado para construir en la región. Diversas publicaciones, conferencias, exposiciones y reuniones se han llevado adelante con este fin. Sin embargo es mucho lo que aun queda por hacer.

A la cuestión técnica es necesario que se una el estudio económico global y particular de los grupos que construyen con tierra, la visión de las tradiciones y costumbres y un correcto encuadre social y cultural donde se dan estas técnicas. No debe dejarse de lado la contemplación del tratamiento de los edificios históricos, sean o no monumentales, y el conocimiento profundo de aquellas técnicas que han sido abandonadas y porqué ello ha ocurrido.

Gráfico Nº 1. Cuadro básico de inventario



3. Conclusión

Es en este tema que estamos trabajando actualmente. El primer paso es la elaboración de un inventario de las técnicas de la región a partir de un cuadro básico. Sugerimos que tal cuadro sea tomado como referencia para los estudios de arquitectura de tierra en otros lugares. Por eso aprovechamos la ocasión para presentarlo a consideración a fin de hacerle los ajustes necesarios para su uso internacional. (Ver Gráf. 1).