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INTERNATIONAL WORKING GROUP ON IMPROVEMENT OF EARTHEN BUILDINGS IN SEISMIC AREAS

by

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FINAL PROJECT REPORT

INTERNATIONAL WORKING GROUP ON IMPROVEMENT OF EARTHEN BUILDINGS IN SEISMIC AREAS

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INTERNATIONAL WORKING GROUP ON IMPROVEMENT OF EARTHEN BUILDINGS IN SEISMIC AREAS

I. Introduction

This document will summarize the activities the International Working Groups on Improvement of Earthen Buildings in Seismic Areas. Those related specifically to the funding from AT International were primarily twofold: the organizing and implementing of a regional workshop in Lima, Peru, and the publication of an international newsletter. Both of these activities will be reported separately.

The general purpose of both of these activities was to increase the availability of adobe construction knowledge in seismic areas. They followed up some ideas that were initiated at the first conference on that topic: The International Workshop on Earthen Building in Seismic Areas, held in Albuquerque in 1981. This conference brought together 89 participants from 17 countries to discuss the state-of-the-art in earthen building construction. The objectives of the Albuquerque conference were:

a. To develop a clear statement of the problems associated with earthen low-rise building in seismic areas;
b. To define the existing state of the art in regard to earthen building materials, design and construction methods in seismic regions;
c. To identify and categorize existing national and international research finding in related areas and seek to establish their applicability to the seismic design and construction of earthen buildings;
d. To identify appropriate channels for technology transfer across international boundaries and to explore social and economic barriers to such transfer;
e. To identify opportunities for ooperative international research;
f. To identify and describe the gaps in the present body of knowledge and to define research needs.

This conference resulted in the publication of three volumes:

Vol. I: Conference Proceedings
Collected Papers
Topics: Structures, Materials. 693 pp

Vol. II: Conference Proceeding
Collected Papers
Topics: Social, Economic and Cultural Aspects; Implementation; Codes, Specifications and Standards. 519 pp

Vol. III Conference Report
Topic: Research Needs and Priorities.
122 pp

Over 350 sets of these volumes have been published and disseminated since 1981.

A group of international researchers, representing engineers, architects, planners and implementers, met at the Albuquerque meeting to discuss follow up activities. Two initiatives emerged from these meetings: the formation of the joint Indo-US Research Program to Improve Low-Strength Masonry Buildings to Withstand Earthquake Forces, and the definition of the International Working Group on Improvement of Earthen Building in Seismic Areas.

The former program has received funding for various small scale research projects from the National Science Foundation and the US Agency for International Development. There is still some work ongoing in this area.

The latter group identified as one of its primary objectives the publication of a Newsletter and the holding of some regional meetings on the topic of earthen housing. Suggestions for some meeting locations were in the Middle East, Latin America, and possibly China.

It was from a background of those discussions, which included people form Federal agencies, that the UNM and Intertect individuals conferred and made the decision to seek funding for the Newsletter and the first regional conference.

II. Latin American Conference

A. Planning

In September, 1981, Paul Thompson (Intertect) and Gerald May (UNM) traveled to Mexico and Peru in order to ascertain the feasibility of putting on a regional meeting to cover the Central and South American countries. This report is attached (Appendix I).

As a result of the trip it was established that there was widespread interest in the topic in Latin America, but particularly in Peru, where Dr. Julio Vargas-Neumann at the Universidad Catolica had been conducting structural research on adobe for a number of years. The Intertect and UNM personnel decided on that basis to hold the first conference in Lima, Peru, and funding was sought from ATI, USAID, and NSF to support that meeting.

After the proposal was written in October, 1981, there was a delay in securing cooperative funding from these three

agencies. Finally, we agreed to work toward a date of May, 1983. The attached Appendix II reports on a planning meeting among a number of constituents in Lima in December, 1982, which further defined the structure of the workshop.

B. Implementation

On May 23-27,1983, a workshop was convened in Lima, Peru, as a regional follow-up to the International Workshop on Earthen Buildings in Seismic (Albuquerque 1981). The objectives of the Workshop were:

1. To gather and disseminate existing information on the topic and to apply it to the seismic design and construction of earthen buildings within the region;

2. To identify research and program information needs on a regional basis;

3. To explore techniques for disseminating information and promoting increased interchange among implementing agencies, building officials, local craftsmen, etc.;

4. To identify appropriate channels for technology transfer within the region; and

5. To address the problems and needs identified in the International Workshop held in Albuquerque.

Representatives from 9 Latin American and Caribbean countries and from the U.S. spent four days in plenary and group work sessions to share experiences and to explore the needs of their respective countries in terms of the translation of technical knowledge into useful information for implementers.

Participants included not only engineers and architects but also representatives from the construction trades, agencies involved in the dissemination of educational booklets and audiovisual materials, organizations who conduct housing research and projects, individuals who specialize in sociological and evaluation studies, funding agencies and representatives from various governmental agencies and organizations involved in housing activities. A list of participants is included in Appendix III.

A technical meeting preceded the Workshop, wherein state- of-the-art papers were presented on the topics of structural engineering, testing, evaluation of damage, materials/ reinforcement, and codes and alternatives. Round-table discussions were held on these topics to begin the task of standardizing the terminology, classification

and statistical data used in testing, typology and evaluation of damaged structures.

The general Workshop concentrated on presentations and discussions of the socio-economic, technical and implementation issues related to the construction, improvement and repair of earthen buildings in earthquake-prone areas. Participants explored options for information dissemination and promotion, aspects of social acceptability, economic/financial factors, evaluation/repair/strengthening, typology, and the special issues involved in preservation of historic structures.

The group work sessions developed a series of conclusions and recommendations for the Latin American region, defining areas where more research is necessary and attempting to standardize the terminology used. The primary overall recommendation was that there is a need to create an awareness and sense of urgency among the various sectors involved in order to bridge the gap between the research underway and the large-scale application of results. While the focus has been on technological development, the technical issues must be viewed within the context of social and economic realities. Participants also identified the lack of ongoing financial and technical assistance as a major constraint to the integration of seismic resistant techniques within the normal local housing process. They agreed that stronger efforts must be made to disseminate information in a understandable and usable form to the people who need it -- builders, architects, housing project personnel, etc.

A special session was held to discuss the recent Popayan, Colombia, earthquake, wherein technical and geologic information was presented along with damage assessments and numerous slides.

The results of this Workshop were compiled in a set of Proceedings entitled: Memorias Seminario Latinoamericano de Construcciones de Tierra en Area Sismicas. (718 pp) The papers presented at the conference are compiled and reprinted, including the condensed Conclusions and Recommendations, in that volume. Over 150 of these volumes have been disseminated around the world.

C. Evaluation

The Conference was very successful in bringing together a diverse group of practicing and research engineers, architects, planners and housing officials. Officials from various housing ministries in at least five countries participated, as did a number of researchers from the United States. The regional emphasis at the conference tended to make it more focused and congenial; not only was the

language of the conference (Spanish) is common, but the problems, particularly those related to socio-economic aspects of housing, very much the same in the Latin American countries.

The structure of the conference attempted to meet all of the participant needs: to exchange technical information in the technical sessions; to meet in smaller topical working groups; to see actual implementation and research projects; and to draw a set of conclusions and make recommendations for the future. The schedule of events (Appendix IV) shows how that was carried out, and Appendix V summarizes the technical conclusions and recommendations that resulted from the discussion groups.

Individual reactions to the conference were almost uniformly positive. If there was a common theme to the participants' comments, it was that there should have been more practitioners' input and that more practical information should have been presented. The participants all approved of the ambience of the conference, and the attempt to convene a mix of ideas, backgrounds and opinions. We have received very positive feedback on the compilation of information from both the Albuquerque and Lima Proceedings. The impromptu convocations that occurred among people who had been involved in researching the Popayan earthquake, which had occurred only a few months before the conference, was unexpected and lent additional richness to the conference. Another session actually convened some people in Popayan after the Lima conference.

While any short-term conference is limited in its impact, it is our opinion, borne out by ongoing collaborations that have been initiated since then, that this conference was an important event in establishing and maintaining communication links between individuals with common interests. Because of the expense, political situation and difficulty of travel, the flow of collaborative information which we take for granted in the US is not well-established in Latin America. For that reason alone the Conference played an important role in technology transfer.

III. Newsletter

A. Planning

At the Albuquerque International Workshop on Earthen Buildings in Seismic Areas in 1981, a number of participants met informally to discuss ways of implementing some of the initiatives which had been discussed at the workshop. These informal meetings resulted in the establishment of a network

of researchers and practitioners involved in the field in order to stimulate further interest and maintain the linkages which had been formed at the Workshop.

This group of individuals identified four objectives to be pursued on behalf of the group:

1. To organize and formally establish a working group to facilitate the effective exchange of information, to focus efforts on vulnerability reduction, to help coordinate research efforts, and to promote research and action on the problems related to earthen building in seismic areas;
2. To establish a center for the collection and dissemination of information;
3. To publish a newsletter which would promote the further exchange of information among researchers and practitioners on an international level;
4. To organize follow-up activities including regional workshops which would promote regional cooperation, address the issues defined in the recommendations and research agenda of the Albuquerque Workshop, and develop methods of information dissemination on a local level.

Progress has been made on all of these objectives. Funding was sought from a variety of agencies to support the regional workshop and the newsletter. The AT grant was especially helpful in initiating the newsletter. AT and other agency funding made the Lima Conference possible, and a special collection of topical library material is being established in the Library at the University of New Mexico.

B. Implementation

The International Newsletter was designed to try to meet the needs of a disparity of interest groups: engineers, researchers practitioners, planners, and disaster assistance groups. As a result, it was difficult to thoroughly cover all areas of concern. The general guidelines for publication were developed in agreement among Intertect, UNM and AT grant monitors. A very simple two-column format was selected. Because of mailing costs, both side of the paper were used with minimum margins. A letterhead was designed to read: International Newsletter: Earthen Buildings in Seismic Areas, and the Albuquerque Workshop logo was modified and used on the masthead.

Basic topics covered in the Newsletter included the following:

Announcement of meetings and conference of interest

Lists of applicable publications

Meeting and conference reports

Specific project reports

Reports on technology transfer projects or educational programs

Regional news

Original articles or publications

Contributions to the Newsletter were sought through formal and informal means. A number of individuals in various parts of the world served as informal, but regular contributors of material from their respective regions. Their material was compiled and edited by Intertect and published and mailed by the University of New Mexico.

A mailing list was assembled, using as a basis the Albuquerque and Lima Workshop participant lists. The mailing list was expanded and enlarged as we gained additional indications of interest. At the present time, we have a mailing list of about 300 people from 33 counties (USA, Switzerland, India, Peru, Mexico, UK, Ecuador, Guatemala, Turkey, Belize, Argentina, Indonesia, Canada, Greece, Venezuela, Honduras, Chile, Colombia, Italy, France, Belgium, Costa Rica, Algeria, Dominican Republic, Nepal, Pakistan, Panama, Nicaragua, El Salvador, Portugal, China, W. Germany, Japan). The most recent mailing list is attached in Appendix VI.

Four issues of Newsletter were eventually sent out in February 1984, June 1984, October 1984 and June 1985. Samples of these Newsletters are attached in Appendix VI.

C. Evaluation

During the year of publication of the Newsletter we received many unsolicited positive reactions from readers who wished to contribute to the next issue or who wished to be placed on the regular mailing list. It became immediately clear that the Newsletter filled an information void, since there appeared to be no other instrument that had such a broad range of interested readers nor such an international readership. It was also apparent that the two workshops (Albuquerque and Lima) had brought together a fairly unique set of international experts, and the Newsletter served a very valuable role in keeping that body alive and in touch with each other. We were generally not copied in correspondence that occurred among members of the

group, but we know from many individuals that there continued to be a rich flow of information among them. Publication of the mailing list alone was extremely valuable in providing names of contacts in various countries with interests in the field of earthen housing to each other.

A subset of the Working Group met at the Albuquerque Conference to discuss cooperative research among Indian and U.S. counterparts. This resulted in a whole series of interactions and the creation of a joint Indo-US Program to Improve Low-Strength Masonry Housing. This group collaborated on a series of proposals for subtasks, some of which have been funded by the National Science Foundation or AID. At least one of those projects is now complete, with the publication of a 204-page monograph written by Intertect personnel in December 1984 entitled Vernacular Housing in Seismic Zones of India.

The Working Group also arranged to meet at the 8th World Conference on Earthquake Engineering in San Francisco, in July 1984. A letter report on this meeting was sent to AT in August 1984 (Appendix VIII), and it is significant to note that this group again noted the value of the ATI support in maintaining the network:

> "All the participants expressed their appreciation to NSF, AID and ATI for the funding which made development of this Working Group possible. They unanimously agreed that the network, regional workshops and newsletter were extremely valuable and must be continued and expanded."

In the late spring of 1985, an evaluation questionnaire was sent out to all readers of the Newsletter who were on the mailing list. This questionnaire (Appendix IX) has elicited only limited response (approximately 30), and these responses are very difficult to categorize, since they tended to reflect individual comments. The questionnaire was divided into a portion dealing with demographic information, conferences and newsletter.

Demographics

The majority of respondents were engineers who were involved in research or teaching. About 20% categorized themselves as architects or planners involved in implementation. Most had spent from 7-10 years in their present capacity.

Conferences

Over 30% of respondents had attended the Albuquerque Workshop, and only 10% the Lima Conference. However, very nearly everyone had read the Proceedings of at least the Albuquerque meeting, and some the Lima proceedings.

The nature of the questionnaire and the responses do not lend themselves to a statistical analysis since they tended to be qualitative, rather than quantitative. The common thread to questions of the effectiveness of the conferences was overwhelmingly positive:

> The mix of participants was regarded as being excellent; there was no disagreement about the effectiveness of broad and interdisciplinary representation.
>
> The Lima Conference was commended for its involvement of local participants.
>
> There were a number of comments urging that in addition to the research finding, that more of the practical (i.e. economic) viewpoints should have been involved.
>
> The format of the conferences; plenary and technical sessions, followed by working group sessions, summarized at the end of the conferences was regarded as being very good.
>
> Both the thematic presentations and group discussions were valued, with respondents understanding that a balance had to be achieved.
>
> The conferences (particularly in Albuquerque) was regarded as being timely and stimulating. Perhaps the most common theme was the value of bringing together such an international and diverse set of participants.
>
> It was obvious from the responses that the Proceedings (and the Conferences) were a unique compilation of information that did not exist anywhere else.
>
> Proceedings were valued as a reference source.
>
> The conferences were most valued for:
> worldwide professional contacts,
> contribution to the body of knowledge,
> lists of attendees and researchers.

Newsletters

Most respondents had received all three (at that time) issues of the newsletter. Based on their self report, an average of four individuals read each edition. Although extrapolation from such a small data base may be questioned, it is indicated that the Newsletter reached a readership which was a good deal wider that the mailing list itself.

Evaluative comments regarding the Newsletter were universally complimentary. Most liked the format, style and mix of news items. Sample reactions include:

> Good compilation of current work
> A unique source for this type of information
> Well-designed for readership

Following is a listing of responses to questions regarding the Newsletter, which give a better picture of readers' reactions than a paraphrasing.

WHAT SHOULD BE INCLUDED?

1. More technical material/research reports.
2. Statistics of damage.
3. Information on new projects, new research, in short note form;
4. More local case studies
5. Reviews of current projects.
6. Relevant publications.
7. Directory of members and their work/field of experitse.
8. Educational materials.
9. Updates on membership list.
10. Information on reinforcement using local materials.
11. Pattern of earthquake damage in earthen buildings.

Comments: Continuation of same basic format.
Features like that of SENA project, and resource information.
Short communications of informal nature from members.
Information on what agencies are willing to fund research on earthen buililidings.
Frank discussions of problems with earth construction.
"Information Request" and follow-up is a very good feature.
Brief description of the work being done at various places; exchange of reports on the work done by individuals.
More on work with the community.
Ensure that published materials can be used/copied for distribution.
More of the same.

IMPROVEMENTS?

1. More "up-market" in presentation.
2. More technical material.
3. Translate papers into English.
4. 50-100 word abstracts of relevant papers.
5. Publish Spanish edition.
6. Expand it; make it larger.

7. More advanced warning on conferences and meetings.

INFORMATION REQUIREMENTS:

1. Review of international funding agencies sympathetic to the subject.
2. Non-technical articles on new ideas, implementation of new techniques.
3. Information on reinforcement using local materials.
4. Annual summary of ongoing work.
5. More statistical data on strength, deformability, overall behavior (performance).
6. Not only technical aspects of non-engineered construction but also social and psychological aspects, e.g., the patterns of design and relation of the buildings within the cultural development of the community.

Comments: Encourage members to notify the newsletter when reports and papers are available.

Need adobe library, information center.

Need funding of projects of demonstrative nature in the Third World so that people could try the techniques passed on via the Working Group and newsletter.

Need more information on implementation strategies.

Need to broaden the base of potential funding agencies/organizations.

SUGGESTIONS FOR FUTURE ACTIVITIES:

1. Coordination of sub-groups to write definitive overviews, reference works, state-of-the-art papers, etc., for example on strength-testing techniques and methods, field evaluation methods for large building stocks, repair and strenghtening manual, etc.
2. More conferences, small regional meetings, in as varied locations as possible.
3. Continuation of newsletter, other publications.
4. Regional short training courses, correnspondence courses.
5. More attention to vernacular design solutions for damage mitigation in earthquake-prone areas.
6. Identification of potential funding parties on international level of donor countries, and preparation of agenda for research and implementation.
7. Preparation of do-it-yourself booklets for rural areas stressing the basic seismic and safety conditions.

Comments: Be prepared for field work in order to collect appropriate statistical data.

Encourage quantitative research work.

As soon as any work is completed, any report could be sent to the interested individuals.

Encourage, support and facilitate people's knowledge of building in seismic areas by a booklet or report, "Building by People in Seismic Areas".

Organize field missions of selected experts from different countries to develop case studies.

OTHER COMMENTS:

1. Information communication in developing countries is a slow and tedious task. Books printed in the west are too costly and beyond the reach of most persons in these countries. One task is to make the information available at minimum cost. This needs special consideration.
   Contributions (articles, photos, slides, etc.) instead of cast for membership.
3. Audiovisual material should be produced and exchanged.
4. Broaden base of readership by sharing copies of newsletter with others.
5. Instead of castigating engineers for lack of interest in low-strength structures, you might inquire about the observations and data from those that have gone to earthquake damaged areas since 1971 through EERI and private observation trips since at least 1952. Several of us are interested, have data, and in our way tried to do something.
6. Architects and architectural students interested in this work, as well as other library users.
7. I think a good beginning has been made and I only wish that we can work together to at least reduce the suffering of mankind due to earthquake and other natural disasters.
8. Very appreciative of efforts of Coordinating Committee of Working Group to coordinate these activities.
9. Keep it coming!
10. Don't let it die!

IV. Conclusions and Recommendations

It is difficult to draw very specific conclusions from the activities supported by this grant, since they were designed to accomplish the quite general objective of increasing availability of adobe construction designs and techniques for seismically active areas of Latin America. Both the Latin American Workshop and the Newsletter were effective in accomplishing that purpose. The Workshop was held in one of the most seismically active areas in South America, where there was a good deal of sensitivity to issues of both providing adequate technical as well as socio-economically acceptable solutions. We know of no

other conference that attempted to bring together participants with such a wide range of interests, and do so successfully. The conference was planned by a diverse committee representing government agencies, University and housing agencies. Some of the most interesting structural research in the world related to vernacular construction is being conducted at the Pontificia Universidad Catolica, which hosted this meeting. Under Prof. Julio Vargas-Neumann, the research laboratory there, with its new structural dynamic testing table, has the potential for continued significant research and collaboration with many Latin American researchers. Finally, we do not often appreciate how very much more difficult communications and technology transfer really are in developing countries. Not only is it expensive and cumbersome to travel, but there are multiplicity of state and local government policies which make it difficult to accomplish effective technology transfer. Regional meeting such as the one in Lima are unique opportunities to bring together these people who would otherwise not do so.

The Newsletter also accomplished a vital role in establishing and nurturing the network of internationals interested in the problem of earthen housing. There is no other such communication instrument in the world, and the AT funding made it possible to sustain the initiatives started at the Albuquerque conference. We believe that the objectives of the Newsletter were met, that the readership was broad and diverse, and that the evaluation showed a very positive reaction to the Newsletter. It complemented the workshops that have been held, and has, we believe, been an effective effort at technology transfer.

Continuation of the Newsletter is problematic. We intend to continue soliciting subscriptions in order to cover some costs so that an occasional letter can be published, and the mailing list maintained. We have some modest response to our solicitations. We intend to continue to publish, on a reduced schedule, as we are financially able.

Another attempt that has been complementary is the Indo-US Program, under which technology transfer is also occurring. A regional workshop in the Middle East has also been recently funded. It will draw together the same mix of participants as in Lima, but from Europe and West Asia.

The problems associated with indigenous housing in vulnerable areas of the world are by definition less focussed and more undefined than most. While there has been much structural research done on engineered building, and these have behaved reasonably predictably in earthquakes, there has been relatively little interest in the problems of

non-engineered buildings. As a country becomes more industrialized, there is more emphasis on engineered structures and the use of materials whose properties are more predictable. There is often an official attitude that vernacular materials are not sanctioned, and hence do not exist. Obviously, this may be so in cities where there are building codes and rigorous enforcement, but such is not the case even in the United States, much less in many developing countries.

Moreover, it is only recently that planners have begun to develop systematic models for factoring in the socio-economic dimensions of vernacular housing. A disaster that demolishes housing, with loss of life, is not the time to devise new strategies for reconstruction. Such plans should be in place before and contingent to the disaster. By the same token, as catastrophic as it may be, an earthquake can often serve to heighten people's awareness about rebuilding, at relatively little incremental cost, more resistant housing. Post-disaster affords a time period when substantial changes in upgrading housing can be effected.

We believe that much remains to be done, and the workshops and information-dissemination that have been supported by this grant have been worthwhile efforts that have had an effect in strengthening the body of knowledge about earthen buildings in seismic areas.

APPENDIX I

Report on September 21-25 Trip to Mexico and South America by Gerald May (University of New Mexico) and Paul Thompson (Intertect)

Mexico

Introduction

Paul Thompson (Intertect) and Gerald May (UNM) visited Mexico City on September 21-23, 1981. The purpose of this trip was to assess the interest in Mexico for a regional meeting of persons in Central America and Mexico, interested in the problems of earthen buildings in seismic areas. They met with personnel from the Universidad Nacional Autonoma de Mexico (UNAM), one of which also represented the Sociedad Mexicana de Ingenieria Sismica (SMIS), and other personnel from the Secretaria de Asentamientos Humanos y Obras Publicas (SAHOP), of the Mexican federal government.

Meeting Results

During the meetings; there was a great deal of discussion on the extent of interest in the subject in Mexico. Although some research in adobe structures has been conducted at UNAM, there is presently nothing active. The feeling of the UNAM representatives was that adobe construction is dying out in Mexico, and that the official posture of the government is to discourage new housing starts of adobe. However, since there still existed many adobe structures both in the city outskirts and the surrounding countryside, that repair of earthquake-induced damage was a topic of some interest. Their point was emphasized by Sr. Amilcar Galindo of SAHOP, the official agency charged with this responsibility. He also expressed the opinion that there was interest in other governmental agencies. In addition, it was agreed by everybody that there was substantially more adobe construction in

the southern part of Mexico, and that there would be potentially more interest elsewhere than Mexico City.

After much discussion, the following was concluded:

• There was sufficient interest in Mexico, including some of the UNAM people, the Direccion de Obras Publicas del Estado (local level public works organization), and SAHOP to make a meeting desirable.

• There is potentially great interest in such a meeting from Guatemalan and Nicaraguan individuals and agencies, and a good possibility of finding interested individuals from Costa Rica, El Salvador, and Honduras.

• Unreinforced masonry is also being extensively used in rural housing, and therefore, it might be advisable to broaden the subject of the meeting to include this topic.

• A meeting of such a scope would be best held outside of Mexico City. There would be more interest in a location with more adobe housing, and logistics are more difficult in Mexico City. The city of Oaxaca, about 300 miles southeast of Mexico City, was subsequently chosen as a more likely host location. The city is smaller (100,000 population), it is in an attractive location, it is a center of adobe construction, and there is a polytechnic university located there, with an individual who is interested (Prof. Alejandro Reyes). There are good airline connections to Mexico City, and good highway connections to the rest of Central America.

• The meeting is best held in the fall, with October 8-9, 1982 identified as being a possible time.

• There will be a need for financial support of at least the Central American participants, since they generally would not have finances from their agencies.

Conclusions

There is enough interest in Central America for the proposed

meeting. The key person from Oaxaca, Alejandro Reyes, was not able to come to the planning meeting but in a telephone conversation expressed his interest in hosting and helping to coordinate the meeting. He was to meet with Dr. Roberto Meli (UNAM) in a few days to discuss the details and confirm his institution's interest. Sr. Galindo will help by garnering official governmental support from his own and other agencies such as the Instituto para el Desarrollo de la Comunidad (INDECO).

If the Polytechnic Institute at Oaxaca is willing to act as the host institution, Dr. Roberto Meli is willing to act as a co-coordinator. He also pledged the support of SMIS, of which he is president this next year. It would be important for an individual from INTERTECT or UNM to travel to Mexico fairly soon to confirm the arrangements and help to plan the meeting.

Key Personnel

Prof. Alejandro Reyes
Instituto Technologico Regional de Oaxaca

Dr. Robert Meli - Dr. Enrique Bazan
Instituto de Ingenieria
UNAM
Cuidad Universitaria
Mexico 20, D.F.
Apdo. Postal 70-427

Sr. Amilcar Galindo
SAHOP
Tajin 280B
Mexico 12, D.F.

PERU

Introduction

Our visit to Lima extended from September 24 to 25. It included meetings with the faculty and administration of the Pontifica Universidad Catolica del Peru (U.C.), Universidad Nacional

de Ingeneria (UNI), Government of Peru Oficina de Investigacion y Normalizacion (OIN) and a private housing consultant.

We also conducted a field trip to become acquainted with examples of adobe construction found in or near Lima. This included recent construction in a rural zone and older adobe buildings within Lima.

Meeting Results

The U.C. Director de la Programa Academico de Ciencias y Ingenieria and the Chief of the Departmento de Ingenieria Civil lent their full support to offering the U.C. as the site of the South American regional conference on earthen buildings in seismic areas.

A meeting among five key people involved in housing and in seismic research concluded that such a conference would be of value and that Lima would be an appropriate site for the conference.

These five people agreed to form the steering committee for the planning of the conference. Prof. Julio Vargas Neumann, Director of Civil Engineering Laboratories at U.C. agreed to act as coordinator for all pre- and post-conference activities.

Initial planning for the conference was begun and included the following recommendations:

- State the objectives for the conference as

1. Define types of earthen buildings, identifying their characteristics and problems.
2. Identify current research on earthen buildings and the research results that can be applied. This should include future lines of research and standarization.
3. Develop recommendations for the transfer of technology, implementation, information sharing and training.

(Item number 3 was strongly expressed as the focus of interest and importance for the conference.)

• To ask OIN and the UNI to act as co-sponsors for the conference. It was felt this would be forthcoming.

• To recommend that the conference be held May 12-14, 1982.

• To consider the number of participants be held to about 40, 15 of whom would be from Chile, Bolivia, Ecuador, Colombia, and Argentina. There is also a specific interest in non-seismic issues of adobe construction by Brazil. The remaining participants would be from several governmental agencies and other institutions that are involved in implementation.

Conclusions

The U.C. is a very appropriate and adequate site to host the conference. They have, in addition to Prof. Julio Vargas N., administrative support personnel available, satisfactory classroom and meeting room facilities, and an ongoing research program in testing materials of low-cost housing. They are currently installing a shaking table which is expected to be operational by next May. In addition to Prof. Vargas, there are 3 or 4 other researchers interested and involved in the subject of earthen buildings.

Prof. Vargas is expected to be a capable and committed coordinator for such a conference. The steering committee will provide a broad perspective and expertise for the planning process.

U.C. and the Department of Engineering are able to provide all support for the planning and holding of the conference except for some financial support for printing and a small amount for local administration. The largest budgetary concern is for providing travel and expenses for all participants except those who live in Lima. It was stated that in South America for conferences of this type virtually all traveling participants require financial support.

Key Personnel

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Raquel Machicao
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Javier Santolalla
Consultant

APPENDIX II

TRIP REPORT:

PARKER/THOMPSON MEETINGS IN LIMA WITH JULIO VARGAS

DECEMBER 6-7, 1982

Paul and I stayed at the Hostel Ariosto in the Miraflores section of Lima, central to shopping, banks, etc. Julio Vargas is suggesting that space be reserved in the Ariosto for all the participants in the May workshop. It is a lovely hostel with sufficient space for our purposes, including a restaurant, lobby area with television, and courtyard. The price is approximately $37 per night for a room with private bath and twin beds, and the restaurant prices are moderate.

We were given a tour of the testing facilities at the Catholic University Laboratorio de Estructuras. They are conducting two main projects now. The first involves the collection of adobe blocks from various parts of Peru to test the differences in strength among the soil types. The second is a program to test the strength and behavior of various types of quincha walls. We watched them set up a test of a quincha wall and then returned later to see the results.

The first day was spent with Julio Vargas discussing the agenda we had put together for the meeting. We had lunch with Julio's research staff and with two visiting Japanese earthquake engineers who expressed interest in the workshop. They were in Lima for one month to work primarily with staff at UNI but were touring Julio's facilities while in town.

We were joined on the second day by the workshop committee: Raquel Machicao and Urbano Tejada from ININVI and Rafael Torres from UNI (Javier Santolalla was ill and unable to attend). With their help we set out the suggested topics for both the technical meeting and the general workshop, and went through the list of potential participants to identify those who should be invited and make a preliminary determination of keynote speakers by topic. We also made a tentative plan for the demonstration component.

At the end of the committee meeting, Paul, Julio and I continued to work until 9:30 that night on the myriad details of workshop administration and division of tasks. A more detailed description of these discussions is attached to this summary.

Paul and I feel that we accomplished a great deal in this brief period in terms of defining the workshop objectives and setting out a plan of activities. The primary problem now is lack of time since invitations and announcements must go out immediately in order to give participants sufficient time to prepare papers and presentations.

Our preliminary schedule is as follows:

Dec. 1982:	Mail announcements/invitations to participants and journals/newsletters.
Jan. 1983:	Request abstracts (in initial mailing) by 1/31/82.
Jan/Feb.:	Select participants from those indicating interest and decide on funding of participant costs.
Feb. 28:	Mail notice of funding, invitations to keynote speakers, administrative forms.
April 1:	Mail reminders if necessary.
May 1:	Deadline for receipt of papers. Airline tickets also must be ordered by this time.
May 23-27:	Technical Meeting and Workshop in Lima.

Respectfully submitted,

Jean W. Parker

Jean W. Parker

JWP:me

SUMMARY OF AGENDA DISCUSSIONS

I. Identification of Topics:

A. Technical Meeting (Request 4 key presentations, 30 min. ea. with another 30 min. for questions/answers; each participant then reports on his own research or knowledge within the round table discussions, approx. 15 min. each):

1. Terminology: Standardization of testing, methodology terms, etc.

2. Assessment of Damage

3. Materials/Reinforcement

4. Codes/Building Types

B. General Workshop (Request 9 key presentations, with brief reports of their experience/programs by participants in work sessions, approx. 10 min.?):

1. Socio-Economic Aspects

a. Social Acceptability (architecture; safety; etc.)

b. Promotion (university; hands-on vocational training; technical training; SENCICO; etc.)

c. Economic and Financial Factors (banks; cooperatives and mutual aid groups; insurance; funding resources e.g. AID; etc.)

2. Technology

d. Historic Preservation

e. Evaluation/Repair/Strengthening

f. Typology (adobe, tapial, quincha, bajareque, etc.)

3. Process

g. Technology Transfer (codes and alternatives to traditional codes; courses; training; training aids development; etc.)

h. Self-help Construction (experience and programs)

i. The Role of the State

II. Identification of Participants: A list of suggested participants is attached. Ideally we should have 20-30 for the technical meeting and a total of 50 for the workshop.

III. Dates: Technical Meeting May 23-24; Workshop May 24-27.

IV. Title: Seminario Latinamericano de Construcciones Sismo-Resistentes de Tierra (Latin American Workshop on Earthquake Resistant Earthen Buildings)

V. Immediate Mailings: INTERTECT will develop announcement and invitation in English for immediate mailing. Vargas will translate for distribution to special guests, etc., in Lima and will send us a copy for our files. Separate invitations will be written for those invited to technical meeting and workshop and those invited only to workshop. Responses will be to INTERTECT. Information on papers/abstracts will be sent out at the same time in order to cut down on mailings and speed responses. Abstracts should be in both English and Spanish; papers may be in either language.

- Administrative format for handling responses, registration, etc. is already set up (see Master List of Participants attached to Lima agenda).

VI. Facilities:

A. Rooms: Workshop will be held at Catholic University of Peru (PUC). Two rooms are available in the Laboratoria de Estructuras, each of which will hold probably 25-30 people or so. One is an open meeting room and the other has fixed seats. Another room is available in the Engineering Building across the walk. Larger rooms are available in another building for plenary sessions. Vargas will make arrangements for use of these rooms as necessary.

The demonstration component will be divided between the testing facilities at PUC and ININVI.

B. Meals: Lunches can be provided at an estimated cost of $4-$5 per person. We can sell tickets each morning for those who wish lunch on the campus, leaving the others free to lunch in town or with friends. Two hours are set aside for the lunch break each day. Coffee breaks will be scheduled in the morning and afternoon and will be provided free of charge under Vargas' budget for workshop costs.

C. Transportation: Transportation will be arranged by Vargas. At present he feels that transport to and from the hostel can be handled by his staff and existing vehicles. Buses must be leased under his budget for the demonstrations and tours.

D. Audio-Visual Equipment: PUC has overhead projectors and some slide equipment (this needs to be confirmed).

E. Exhibit Space: There is some space available in the Laboratoria lobby and upstairs for exhibits. Vargas will need to arrange for small tables for those who say they need exhibit space.

F. Office Space: The workshop can use the existing facilities upstairs (telephone, typewriter, etc.). There is a bookcase available if we decide to set up a small library.

G. Translation: Working language will be Spanish but we must provide translation for English speakers. Vargas will check with UNESCO to see whether translators and/or equipment might be available from them for the plenary sessions. At present it is proposed that the working groups be divided as in Albuquerque, with one English session planned for each topic.

VII. Format:

A. Technical Meeting: The technical meeting will consist of 20-30 researchers, primarily engineers, who will meet in plenary session on Monday morning to hear key state-of-the-art papers and then be divided into two groups to work on the topics set out under I-A above. These groups will produce summaries which will be reported to the entire workshop on Friday. The technical meeting will conclude at lunchtime on Tuesday (1 1/2 days).

B. Workshop: The workshop participants who have not also been invited to attend the technical meeting will be registered on Tuesday morning. The opening session will be on Tuesday afternoon. Nine key papers on the topics listed under I-B above will be presented to give an overview of the topic areas. The participants will then be divided into working groups with session leaders and recorders, and summaries of their discussions will be produced for the Friday morning plenary. The workshop will run for 2 1/2 days total, with demonstrations scheduled during the same period (2 afternoons) in order to give participants a change of pace. Thus the workshop and demonstration together run from Tues. afternoon until Friday evening (3 1/2 days).

C. Demonstration: The demonstrations will include the quincha research/testing currently underway with PUC, UNI and Defensa Civil; the ongoing research/testing of stabilized adobe walls and materials testing at PUC; and a tour of the facilities and projects at ININVI.

VIII Printing: Because of the time and costs involved in printing participant papers in Peru, INTERTECT and UNM will undertake to provide a first volume of the proceedings (papers received by May 1) and distribute it in the place of pre-prints. At the conclusion of the workshop, a second volume will be produced to include the proceedings of the meetings. The amount set aside for publishing in Vargas' budget will be transferred into the UNM budget. At this point, it seems best for us to hand-carry the first volumes to Lima for the workshop.

IX. Participant Packets: Vargas will make these arrangements. PUC can provide paper, information about Lima, tour information, etc. We need to decide whether some kind of worksheet (similar to but shorter than briefing papers) should be included to guide discussions.

X. Transfer of Funds: We will need to work out the details of the participants' stipends, i.e., providing US dollars when they register, similar to Albuquerque. Vargas feels that Latin American participants will require full funding in order to attend. Since our contract funding does not provide sufficient monies for full funding of all these participants, Vargas will look for stipend money for the Peruvians in the interior, possibly from the National Association of Engineering. Thus we are tentatively planning at this time to offer no stipends to this group of participants; however, we would cover their air travel.

As far as Vargas' conference budget is concerned, we suggest that he bill the Univ. of New Mexico for consulting services and workshop costs in February or early March and then do a final billing after the workshop in June. This would give him the cash necessary for transportation costs, etc., for the workshop. In this billing, he should enclose receipts for any large items such as transportation costs, food service, etc. He may be able to set up an account through PUC, or may prefer to handle it on an individual consulting basis. Vargas should send Jerry May the name of his bank and his account number (or that of PUC) so that the UNM payments can be sent via bank-to-bank transfer rather than through the regular mail. This would speed receipt of the money and lessen the chance of loss in the mail.

XI. Participant Travel: If Vargas were to order all airline tickets in Lima for South American participants, he would have to pay immediately upon purchase of ticket, requiring a large advance. In addition, he feels that purchase in South America is more expensive because of the taxes added to the fare. INTERTECT has agreed to arrange the air travel and purchase the tickets for the participants.

XII. General Division of Tasks: INTERTECT and UNM will develop and mail invitations/announcements, receive responses, receive and print papers, order air tickets, and coordinate all administrative details (e.g. need for exhibit space, etc.) with Vargas. Vargas will handle all in-country arrangements for hostel space, audio-visual equipment, participant packets, meal and coffee break service, transportation to and from campus and for demonstrations/tours, demonstration logistics (coordinated with UNI and ININVI), and meeting rooms at PUC.

Initial selection of participants has been made by representatives of INTERTECT/UNM, PUC, UNI and ININVI, including the list provided by Roberto Meli, UNAM. Final selection, based on responses received, and funding decisions will be made in coordination with Vargas via telephone or telex.

INTERTECT will explore the possibility of sending information to Vargas via diplomatic pouch (c/o Eddie Alarcon) in order to speed and simplify long-distance coordination.

APPENDIX III

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APPENDIX IV

SEMINARIO LATINOAMERICANO DE CONSTRUCCIONES SISMO-RESISTENTES DE TIERRA - HORARIO

HORA	L U N E S	M A R T E S	M I E R C O L E S	J U E V E S	V I E R N E S
9.00 a.m.	INSCRIPCION	MESAS REDONDAS III y IV	Ponencias Aspectos Técnicos	Sesiones 3 Talleres	SESION DE CONCLUSIONES Y RECOMENDACIONES.
10.00 a.m.	INAUGURACION				
10.45 a.m.		Café	Café	Café	Café
11.00 a.m.	Ponencias Técnicas	Continuación	Ponencias Aspectos Implementarios	Continuación	
1.15 p.m.	Almuerzo	Almuerzo	Almuerzo	Almuerzo	Almuerzo
2.30 p.m.				Visita Laboratorio de Estructuras - PUC	Visita a las Ruinas de Puruchuco
3.00 p.m.	Ponencias Técnicas	Sesión Apertura de Talleres	Sesiones 3 Talleres	Visita ININVI	
3.30 p.m.	MESAS REDONDAS I Y II	Ponencias Aspecto Socio-Económico			
4.30 p.m.	Café	Café	Café		
4.45 p.m.	Continuación	Continuación	Continuación		
6.00 p.m.		Retorno al Hotel	Retorno al Hotel	Retorno al Hotel	Retorno al Hotel
6.30 p.m.	Cocktail Inaugural				
8.00 p.m.	Retorno al Hotel				
9.00 p.m.				Comida Camaradería "Karamanduka"	

TEMARIO

Reunión Técnica

- Ingeniería Estructural
- Normalización de Ensayos
- Evaluación de Daños y Reforzamiento
- Materiales y Refuerzos
- Códigos y Alternativas

Talleres

- Aspectos Socio-Económicos:
  1. Aceptabilidad Social
  2. Promoción y Entrenamiento
  3. Factores Económicos y Financieros

- Aspectos Técnicos:
  1. Preservación de Monumentos Históricos
  2. Evaluación, Reforzamiento y Reparación
  3. Tipología

- Aspectos de Implementación:
  1. Implementación de Programas
  2. Transferencia Tecnológica
  3. Auto-Construcción

SESION INAUGURAL

1. Palabras de bienvenida:
   Dr. José Tola Pasquel
   Rector, Pontificia Universidad Católica del Perú

2. Intervención sobre los objectivos del Seminario:
   Mr. Frederick C. Cuny
   Director Ejecutivo de INTERTECT

3. Inauguración del Certamen:
   Arq. Javier Velarde Aspíllaga
   Ministro de Vivienda, Perú

SEMINARIO LATINOAMERICANO DE CONSTRUCCIONES SISMO RESISTENTE DE TIERRA

PROGRAMA · DIA LUNES 23 DE MAYO

9.00 a.m. Inscripción de Participantes
Local : Laboratorio de Estructuras

10.00 a.m. Inauguración - Palabras de ·

- Dr. JOSE TOLA PASQUEL (Rector de la Pontificia Universidad Católica del Perú)
- Sr. FREDERICK CUNY (Intertect)
- Arq. JAVIER VELARDE A. (Ministro de Vivienda)

Local : Auditorium del Laboratorio de Física

10.45 a.m. Café

11.00 a.m. Presentación de Ponencias Técnicas
Presidencia : Sr. Frederick Cuny
Relator : Aníbal Díaz

Review of existing options 1

- Técnicas de Prueba para Construcciones de Tierra
  Helmut Krawinkler

2. Cuny · Proposed Method for strengthening Experts Bldg

3. - Normalización de ensayos en Albañilería de Adobe. Estudio Preliminar.
  M. Blondet, G. Ottazzi y F. Ginocchio

- Evaluación Experimental de Procedimientos para reforzar Viviendas de Adobe y hacerla resistente ante la acción Sísmica
  Oscar Hernández

- Propiedades del suelo para elaborar Albañilería de Adobe
  J. Vargas, J. Pariola y M. Blondet

1.15 p.m. Almuerzo

3.00 p.m. - Propiedades Físico-Mecánica de Adobe No Estabilizados Utilizados en el Perú.
  J. Alva y R. Torres

3.00 p.m. - Comentarios a la propuesta para la Norma Peruana de Construcciones de Adobe.
J. Vargas Neumann

3.45 p.m. Mesa Redonda I

Local : Laboratorio de Física
Presidencia : Gerald May
Relator : Javier Santolalla

Ingeniería Estructural y Ensayos Experimentales

Mesa Redonda II

Local : Laboratorio de Minas
Presidencia : Oscar Hernández
Relator : Raquel Machicao

Evaluación de Daños

4.30 p.m. Café

6.30 p.m. Cocktail Inaugural
Local : Laboratorio de Estructuras

PROGRAMA: DIA MARTES 24 Mayo, 1983

9:30 a.m.

- Mesa Redonda III y IV
  Tema: Materiales y Refuerzos + Códigos y Alternativas

  Local: Aula de Física

  Presidencia : Augusto Espinosa
  Relator : Marcial Blondet

- Estabilización del Adobe Tradicional por Granulometría

  Washington Esquivel, Juan Menéndez

- Construcciones de Tierra en el Antiguo Perú

  Marcos Arriola y Washington Esquivel

10:45 a.m. Café

11:00 a.m. Discusión General sobre Normalización de Ensayos.

1:15 p.m. Almuerzos

3:00 p.m. Sesión de Apertura de Talleres

3:15 p.m. Aspectos Socio-Económicos

Presidencia : Scott Luther
Relator : Raquel Machicao

- Aspectos Socio-Económicos de Mejoramiento de Viviendas

  Volker Hartkopf

- Proyecto Créditos Supervisados para Construcción de Viviendas en los Pueblos Jóvenes del Cuzco

  José Becerra

- El Adobe para la Construcción ¿Un Material en Decadencia?

  José Luis Gándara

- Notas sobre la Aceptabilidad de Nuevas Viviendas en Tierra

  Gustavo Riofrío

5:00 p.m. Observaciones sobre el Terremoto de Popayán

- Experiencias derivadas del Sismo de Marzo 31, 1981 Cajibío, Cauca

  Alvaro Losada

  Panel con la participación de:

  - Alvaro Losada
  - William Castillo
  - Pilar Piedad Varona
  - Augusto Espinosa
  - Julio Vargas

6:30 p.m. Cocktail

8:00 p.m. Retorno al Hotel

PROGRAMA : MIERCOLES, 25 MAYO 1983

9:00 a.m.

ASPECTOS TECNICOS

Presidencia : Abel Ibañez
Relator : Urbano Tejada

- Preservación de las Estructuras de Edificios Históricos.

  Roberto Samanez

- Dificultad del Refuerzo Antisísmico de Monumentos Históricos..

  Augusto Espinosa

- El Reforzamiento Estructural de Edificaciones de Tapia. Un Caso de los Andes Venezolanos.

  William Castillo

- Experiencias con los Métodos de Campo de Clasificación de Suelos para la Construcción con Adobe.

  Juan Bariola

10:45 a.m. Café

11:00 a.m.

- Evaluación Experimental de Procedimientos para Reforzar Viviendas de Adobe y hacerlas Resistentes ante la Acción Sísmica.

  Oscar Hernández

- Mejoramiento de Tecnologías con Tierra.

  Urbano Tejada

- Construyendo con Tierra.

  Alain Hays

- Experiencias del Proyecto COBE

  José Meza Cuadra

1:15 p.m.		Almuerzo
3:00 p.m.	-	Taller Monumentos Históricos Local: Aula Minas Discusión General Presidencia : Roberto Samanez Relator : William Castillo
	-	Taller Tipología y Reparación Local: Auditorio de Física Discusión General Presidencia : Oscar Hernández Relator : Alain Hays
5:00 p.m.	-	Presentación CESPAC y otros videos Local : Laboratorio de Estructuras
7:00 p.m.	-	Retorno al Hotel

PROGRAMA : DIA JUEVES 26 MAYO, 1983

9:00 a.m. ASPECTOS DE IMPLEMENTACION

Presidente : Piedad Varona
Relator : Isabel Moromi
Local : Auditorio de Física

- Secretaría de Desarrollo Urbano y Ecología

  Abel Ibañez

- Actividades del Consejo Inter-Institucional para la Coordinación de Programas de Viviendas

  Scott Luther

- Evaluación del Comportamiento de un Proyecto de Viviendas de Adobe Estabilizado. CAYALTY. Chiclayo.

  Tomás Cruzado

- Papel del Adobe en Programas de Autoconstrucción de Viviendas

  Juan Manuel Patiño

10:45 a.m. Café

11:00 a.m.

- Diseño y Tecnología para un Asentamiento Rural en Zonas Desérticas de la Costa Peruana

  Leonidas Machicao

- El Adobe de Cajamarca

  Baltazar Sáenz

Julio Kuroiwa
UNI Quinela Santiz

12:00 m.	Discusión General sobre Aspectos de Implementación.
1:15 p.m.	Almuerzo
2:30 p.m.	Visita Laboratorio PUCP
3:30 p.m.	Visita Local ININVI
5:00 p.m.	Visita Local Junta del Acuerdo de Cartagena
6:00 p.m.	Retorno al Hotel

APPENDIX V

CONCLUSIONES Y RECOMENDACIONES:

REUNION TECNICA

1. MATERIALES Y REFUERZOS

Se ha constatado un importante avance en la definición de procedimientos para seleccionar el suelo a utilizar para la confección de barro para adobe, tapial, quincha o bahareque.

Han sido expuestos procedimientos que dan pautas para combinar los componentes de los suelos con el fin de obtener mezclas que producirán mamposterías sismo-resistentes.

Se presentaron detalles de la tecnología de construcción de unidades de adobe por métodos de compactación (CINVA RAM, CRATERRE, etc.).

Quedó establecido que estos sistemas no mejoran la resistencia del bloque ni la mampostería, pero sí aumentan la velocidad de producción, reducen el tiempo de secado y mejoran el acabado de los bloques.

2. NORMALIZACION DE ENSAYOS

Aunque los países latinoamericanos que han estado realizando ensayos han mantenido un buen nivel de coordinación (especialmente México y Perú), se ha hecho evidente que todavía sigue existiendo diferencias en los procedimientos de ensayos que es necesario uniformizar. Por lo expuesto, los participantes se abocaron a la tarea de bosquejar un cuadro que resuma el estado del arte, en términos de realización de ensayos, tanto a diferentes niveles de complejidad de las pruebas como en relación a que si se trate de materiales, componentes y estructuras. Esta tarea se continuó durante la realización de los talleres (ver Cuadro No. 1).

Este cuadro recoge las principales ideas vertidas en la reunión. Sin embargo, se trataron adicionalmente otros temas de interés:

— Necesidad de normalizar ensayos para sistemas contínuos de vivienda (quincha y bahareque).

— Necesidad de definir la solicitación dinámica para ensayos seudo-dinámicos y para mesa vibradora, etc.

Lo recomendado en el cuadro obedece a ensayos estudiados en laboratorio y los más simples han sido co-relacionados con los más sofisticados a fin de garantizar su precisión y validez.

CUADRO No. 1

BARRO PARA MAMPOSTERIA DE ADOBE Y TAPIAL

	MATERIAL	COMPONENTES	ESTRUCTURAS
Ensayos de campo para difusión	- Prueba de Botella (Granulometría). - Prueba de Pastilla (Indice de Plasticidad). - Control de Humedad (Caída de Bola).	- Flexión con peso de 1 hombre. - Adhesión en emparedados de 2 adobes y mortero (Rotura con cincel). - Inmersión en agua (Durabilidad).	
Ensayos de campo para Ingenieros	- Granulometría (ASTM). - Límites Atterberg.	- Penetrómetro (Suelos Compactados).	- Evaluación técnica. - Esclerómetro (Bloques).
Ensayos de Laboratorio	- Granulometría (ASTM). - Límites Atterberg. - Absorción en depósito con 1 cm. de agua. - Proctor standard (suelos compactados). - Vicat modificado (trabajabilidad suelos no compactados).	- Compresión en cubos. - Pilas de albañilería a compresión. - Ensayo de corte con 2 bloques y 2 medios bloques. - Compresión diagonal.	- Corte en muroso módulos. - Flexión en muros o módulos. - Compresión en muros o módulos. - Mesa inclinable.
Ensayos sofisticados de Laboratorio	-----	-----	- Muros o módulos seudo dinámicos. - Muros o módulos en mesa vibradora.

3. CODIGOS Y ALTERNATIVAS

Pocos son los países que han adoptado Normas de Adobe Sismo-Resistentes. La reciente experiencia peruana, cuyo Código actual rige desde Abril de 1977 y cuya propuesta de actualización acaba de ser aprobada, fue la base de las discusiones y comentarios realizados durante el Seminario.

Fue concenso que la Norma es un instrumento útil a nivel profesional y por tanto complementariamente deben desarrollarse otros esfuerzos de estandarización y difusión a nivel de técnicos y usuarios urbanos y rurales. Se comentaron las experiencias obtenidas con el uso de cartillas, video-tapes, cursos, prácticas, etc.

Se tomó conciencia de la dificultad de llenar el vacío de la difusión tecnológica en los pueblos aislados de mínimos conocimientos técnicos.

En cuanto a refuerzos, se dieron recomendaciones incluídas en la propuesta de modificación de la Norma Sismo-Resistente Peruana de Adobe que se limita a lo referente a materiales compatibles con la mampostería de adobe (madera, caña, alambre, etc.).

Quedó claramente expresado que aunque existen algunas experiencias de construcciones masivas de viviendas de adobe, reforzadas con elementos de concreto armado, todavía no se cuenta con experiencias de laboratorio o de observación de construcciones resistentes post-terremoto. Por lo tanto, no deben aún ser difundidos, ni recomendados, los detalles constructivos.

4. REPARACION Y EVALUACION DE DAÑOS

— En relación a la evaluación de daños, se sugirió la difusión y aplicación de algunos documentos existentes (Cartillas).

— En cuanto a la primera parte se consideró que debiera recomendarse la reparación y evaluación como línea de investigación permanente, con tecnología apropiada y con materiales simples y elementales. Se confeccionarían cartillas simples que permitan evaluar fácilmente los daños y si es el caso repararlos eficientemente.

— Quedó establecido que una de las mayores fallas es la ausencia de un seguimiento del problema después del desastre (siempre se siguen haciendo casas con las mismas técnicas conocidas antes del sismo). No se cuenta en cada país con los equipos humanos para capacitar o adiestrar a la población. En ese sentido se recomendó tomar acciones

dirigidas a subsanar esta deficiencia, entrenando personal no necesariamente muy calificado, para realizar las evaluaciones (personal de instituciones oficiales, universidades, etc.).

— Se expresó que debiera tenerse una metodología que permita decidir con rapidez lo que debe demolerse, restaurarse y/o reforzarse, evitando la subjetividad en la evaluación. Debe estudiarse no solo construcciones dañadas por sismos, sino también las construcciones mal hechas. Se recomienda la evaluación sistemática de viviendas existentes, como labor preventiva.

— Se propugna la realización de programas masivos de reforzamiento de viviendas existentes.

— Asimismo, debe prepararse un Manual dirigido a quienes tienen el poder de decisión ("manejar los bulldozer").

— En casos de monumentos históricos, deberá conformarse equipos técnicos con participación de especialistas en restauración y conservación de monumentos.

— Se identifica la necesidad de realizar un futuro Seminario sobre evaluación de daños y reparación o reforzamiento, por ser éste tema basto y complejo. Asimismo, realizar cursos para capacitar técnicos de evaluación, en base a la experiencia internacional existente.

TALLERES

1. ASPECTOS SOCIO-ECONOMICOS

En cuanto a la aceptabilidad de las construcciones mejoradas con tierra, en base a la aplicación de resultados de investigaciones realizadas, las ponencias presentadas han mostrado que hay aceptación por la población beneficiaria y que los profesionales que diseñan y construyen y las instituciones públicas y privadas han comenzado a considerarlas como alternativas de solución.

Se ha presentado diferentes experiencias de prevención y entrenamiento para la aplicación de las tecnologías mejoradas de tierra, pero sólo como casos aislados que no han podido lograr el efecto multiplicador que debieran tener; especialmente por la falta de una financiación contínua de ayuda hasta que se garantice su uso permanente.

Todos los ponentes han coincidido en la necesidad de tener en cuenta no sólo los aspectos tecnológicos, sino también los

socio-económicos y los otros implícitos en el problema de vivienda. Se manifestó la preocupación de que la justificada inquietud de dar capacidad sismo-resistente a las edificaciones con tierra, ha inclinado los estudios sólo a lo tecnológico. Se reiteró la necesidad de recomendar incluir un marco referencial que sirva como una guía cada vez que se trate o trabaje ese tema.

2. ASPECTOS TECNICOS

Con relación a los monumentos históricos se recomienda:

— Que la aplicación de la nueva tecnología obtenida para mejorar los sistemas de construcción con tierra, se haga respetando la identidad de cada pueblo a fin de no alterar su tradición y su forma de concebir la vivienda.

— Que la investigación que se viene llevando a cabo sobre las propiedades mecánicas del adobe y la tierra en general, para solucionar el problema de la vivienda, se aplique y se haga extensiva al campo de la preservación de los monumentos históricos construídos con esos materiales.

— Que las experiencias llevadas a cabo para preservar los monumentos de tierra se den a conocer a los centros de investigación y universidades donde también se está estudiando el adobe y la tierra a fin de intercambiar experiencias y conocimientos que eviten duplicidad de esfuerzos y permitan aprovechar resultados.

— Investigar la interacción de los elementos construídos con tierra y estructuras de refuerzo de otros materiales para obtener en los edificios históricos resultados más confiables ante solicitaciones sísmicas, permitiendo a su vez una mejor utilización sobre esas edificaciones.

— Difundir y sistematizar los conocimientos y experiencias sobre los materiales y procedimientos constructivos en base a la tierra, en el nivel universitario.

En relación a la tipología de reforzamiento se acordó distinguir:

a) Las viviendas.

b) Las edificaciones especiales (aulas, almacenes, etc.).

c) Los monumentos históricos.

Cada una de éstas tendrá que atenderse con características propias de reparación.

CUADRO No. 2

REFORZAMIENTO DE VIVIENDAS DE ADOBE O TAPIA

MODALIDAD	DETALLE
Forma estructural natural	Esquemas de distribución uniforme de muros. Subdivisión de espacios (muros o contrafuertes).
Refuerzo con otros materiales	<u>Muros</u> - Recubrimiento reforzado (mallas de acero electrosoldada). - Collar superior contínuo con rigidez lateral adecuada y conectado a la cimentación por tirantes. - Collar superior contínuo con cierta conexión adecuada a los muros y eventuales diagonales en las esquinas. - Tirantes de acero horizontales templados en la parte superior de los muros (ambas caras) con o sin tirantes verticales. - Limitar altura de muros o eliminar tímpanos. <u>Cimientos</u> - En casos de ausencia, protección contra la humedad (recubrimientos cementados en la parte inferior de los muros). <u>Cubiertas</u> - Rigidizantes y complementación de elementos para evitar cargas horizontales en los muros, cargas concentradas no previstas y desprendimientos parciales de la cubierta. - Aligerar el peso de la cubertura general.

CUADRO No. 2

REFORZAMIENTO DE VIVIENDAS DE BAHAREQUE O QUINCHA

MODALIDAD	DETALLE
Forma estructural natural	Esquemas de distribución uniforme de muros. Subdivisión de espacios (muros o contrafuertes).
Refuerzos con otros materiales	- Reforzamiento especial de elementos deteriorados. - Tratamiento para garantizar durabilidad. - Revisión y refuerzo de conexiones. - Iguales recomendaciones para las cubiertas que en el caso de adobe.

NOTA: Para el caso de edificaciones especiales, además de las recomendaciones para viviendas que en general son aplicables, se justificaría realizar confinamientos verticales u horizontales embebidos adecuadamente.

En diferentes ponencias se pudo apreciar los avances alcanzados con relación a procedimientos constructivos (adobe, quincha o bahareque, etc.) y se recomendó su aplicación gradual en programas experimentales y masivos, según los casos. (Ver Cuadro No. 2).

3. ASPECTOS DE IMPLEMENTACION

Se concluyó que:

Es importante realizar proyectos no sólo en casos de emergencia, sino preferentemente en forma permanente a fin de prever las consecuencias de un desastre y a la vez mejorar las condiciones de habitabilidad de la población de bajos recursos.

Es imprescindible que las soluciones que se plantean se adapten a la capacidad técnica de los pobladores, que utilicen recursos locales y que sean de bajo costo.

Por otro lado es necesario que los resultados de los estudios e investigaciones realizadas puedan transmitirse a los usuarios, sin lo cual, todos los esfuerzos serán estériles.

Los proyectos deben ser integrales, no sólo el de la previsión de viviendas sino el desarrollo de la comunidad, a fin de que puedan desenvolverse sin el apoyo permanente de un grupo técnico.

Debe incentivarse la participación de la población en todas las etapas del proyecto.

Debe tenerse especial cuidado en la transmisión de los conocimientos y logros alcanzados, realizándose una difusión que considere: la evaluación de lo que se requiere enseñar, a quiénes se dirige, qué "barreras" se debe vencer (linguísticas, prejuicios, "vicios" constructivos, etc.), qué medios y métodos se debe utilizar; así como, con qué recursos se cuenta. Esta metodología debe prever la elaboración de los medios de difusión apropiados y las acciones a realizar (conferencias, publicaciones, cursos, construcciones prácticas, etc.).

Se enfatizó como principal conclusión la necesidad de concientizar y apremiar a los diferentes niveles (profesional, técnico, académico, auto-constructor, etc.) y en especial a los gobiernos y organismos de cooperación técnica internacional, para vencer el abismo que existe entre la investigación y la aplicación masiva de sus resultados.

Finalmente, se recomendó implementar una red de intercambio de datos e información a niveles local y regional, utilizando las organizaciones existentes.

APPENDIX VI

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APPENDIX VII

International Newsletter:

EARTHEN BUILDINGS IN SEISMIC AREAS

February 1984

Earth is the predominant building material in many countries of the world and a large percentage of earthen construction occurs in seismically-active regions. During this century alone, more than one million people have died in earthquakes with more than 80% of these deaths occurring in collapsed unreinforced masonry and earthen buildings.

In an attempt to address the problems and issues involved in a concerted manner, an International Workshop on Earthen Buildings in Seismic Areas was convened in May 1981 in Albuquerque, and a subsequent Latin American Regional Workshop was held in May 1983 on the campus of the Pontificia Universidad Católica del Perú in Lima.

Both of these Workshops concluded that there was a need to establish a network of people and institutions involved in this field in order to stimulate further interest and to maintain the linkages and information exchanges established during the Workshops.

This newsletter seeks to further these aims by keeping open the lines of communication among researchers and implementers around the world who share a concern to improve the performance of earthen and low-strength masonry buildings in earthquake-prone regions of the world --

- to bridge the gap between research and implementation;
- to facilitate transfer of technology to the grassroots level;
- to facilitate a sharing of information from one region of the world to another;
- to bring to the attention of others the importance of this subject.

The newsletter will publish original articles on all aspects of earthen buildings in seismic areas, and will describe current and planned projects, training courses, upcoming conferences, publications and other network news. All readers of this first newsletter are encouraged to send in news they would like to share in the next newsletter.

CIB/W-73 CONFERENCE: CALL FOR PAPERS

The International Council for Building Research, Studies & Documentation (CIB) has set a tentative date of October 8-11, 1984, for an "International Conference on Natural Hazards Mitigation Research and Practice: Small Buildings and Community Development", to be held in New Delhi, India. The conference will examine the architectural, construction, socio-economic and planning aspects of human settlements, focusing especially on the smaller-scale built environment of housing, community infrastructure and rural development. Issues will be organized under four interdisciplinary topic areas: (1) Architectural Aspects; (2) Material & Construction Aspects; (3) Social & Economic Aspects; (4) Community & Site Planning Aspects.

Contributed papers accepted by the review committee will be published in the proceedings and authors will be designated as panelists in workshop sessions. Authors are requested to submit for review seven (7) copies of a 250-word abstract by May 1, 1984. For additional information, contact: Chairman, CIB/W-73 International Conference, Building Research Council, University of Illinois at Urbana-Champaign, One East Saint Mary's Road, Champaign, Illinois 61820, USA.

PUBLICATIONS

"Casa de Tierra" is a special edition (dealing exclusively with building rural earthen homes) of MINKA, a Peruvian magazine dedicated to rural science and technology. An interesting historical perspective is given on the social and cultural process of how homes are traditionally built along with useful "how to" information. Written in conjunction with CRATERRE (Center for Investigation and Application of Earth), copies (Spanish only) are available from:

Grupo Talpuy
Apartado 222
Jr. Cusco No. 327-40 Piso
Huancayo, Peru

Shelter After Disaster (UNDRO) is a comprehensive study on disasters and shelters encompassing the entire disaster spectrum: preparedness, relief, post-disaster reconstruction and prevention. It is designed to provide policy and program guidelines on emergency shelter and post-disaster housing for disaster management personnel within the governments of disaster-prone countries, non-governmental voluntary and relief organizations, donor governments, the U.N. system, and other international organizations. The study is unique in that it analyzes post-disaster shelter problems from the point of view of the survivor rather than that of the donors and other assisting groups. Available through:

Office of the U.N. Disaster Relief
Co-ordinator (UNDRO)
Palais des Nations
1211 Geneva 10, Switzerland

La Vivienda Popular en Guatemala Antes y Despues del Terremoto de 1976 (Hermes Marroquín and José Luis Gándara G., study coordinators) is a two-volume study providing a detailed overview of the characteristics of traditional Guatemalan housing, especially in rural areas, an analysis of the damage to these houses in the 1976 earthquake, and descriptions of the reconstruction programs that were carried out. The study includes recommendations for future reconstruction programs. For information on availability, contact:

Arq. José Luis Gándara G., Coordinador,
Programa de Investigaciones Tecnológicas
Facultad de Arquitectura
Universidad de San Carlos
Ciudad Universitaria, Zona 12
Guatemala City, Guatemala, C.A.

Adobe and Rammed Earth Buildings: Design and Construction, Paul G. McHenry, Jr. (1984), is a lavishly illustrated compendium of earthen construction techniques, materials, etc., with examples from field studies around the world. It includes a chapter on structural engineering for earth buildings by Dr. Gerald W. May, Dean, UNM College of Engineering. Published by John Wiley & Sons/New York.

CALENDAR OF MEETINGS

March 1-2, 1984: The Architect and Planner in Third World Development, Oxford. For information contact Disasters & Settlements Unit, Dept. of Architecture, Oxford Polytechnic, Headington, Oxford OX3 OBP, U.K.

March 27, 1984: Earthquake Ground Motion and Building Damage Potential, San Francisco. For information contact: Applied Technology Council, 2471 E. Bayshore Road, Suite 512, Palo Alto, California 94303.

March 28-30, 1984: International Symposium on Earthquake Relief in Less Industrialized Areas, Zurich. For information contact: SIA Swiss Society of Engineers & Architects, Postfach, CH-8039 Zurich, Switzerland.

July 21-28, 1984: 8th World Conference on Earthquake Engineering, San Francisco. For information contact: EERI-8WCEE, 2620 Telegraph Avenue, Berkeley, California 94704.

October 8-11, 1984: Natural Hazards Mitigation Research and Practice: Small Buildings and Community Development, CIB/W-73 international conference to be held in New Delhi, India. For more information see "Call for Papers" on first page of this newsletter.

JOINT INDO-U.S. RESEARCH PROGRAM

A cooperative research effort between Indian and U.S. earthquake engineering researchers has been initiated to improve the seismic resistance of low-strength masonry. The program seeks improvement techniques that are not only technically successful but also economically affordable and feasible within the cultural context of the society.

The total collaborative research program is intended to have a duration of about 3 years. Principal investigators are the University of Roorkee and Central Building Research Institute (CBRI) in India and Dames & Moore, Stanford University, California State Univ., the Univ. of New Mexico and INTERTECT in the U.S.

Low-strength masonry (handmade fired bricks and unfired bricks or blocks of clay) as used in housing applications presents a very complex problem for seismic resistance investigation because of the many variables involved. Many of these are not amenable to well-defined analytical solutions, so that a large number of experimental tests is required. Realistic testing of such constructions requires shake tables of sufficient size and load capacity to simulate earthquake motions of sufficient intensity to take the model specimens to their ultimate failure state.

During the first year of the program, the following activities will be carried out:

a. Field study conducted by the Univ. of New Mexico, INTERTECT and the Univ. of Roorkee to identify basic data regarding buildings, construction techniques, and socio-economic constraints to housing modification and vulnerability reduction efforts.

b. Tests on a unique rolling stock (railway wagon) shake table facility at Roorkee Univ. which is capable of testing half-size as well as full-size models through "shock" type loading. Comparative scale model tests on the "small size" programmable shake table at Stanford Univ. will be conducted simultaneously in order to calibrate the Roorkee table and develop equivalencies with reference to programmable tables.

c. Tests on the Roorkee table at different scales to study the "scaling effects" on test results of low-strength masonry buildings and to optimize the scale to be adopted for a large number of tests.

d. A large number of tests at Roorkee and a small number of tests on an adequate size programmable shake table at the Earthquake Engineering Research Center in Richmond, California, to obtain unambiguous scientific test results for final recommendations of the strengthening methods to be adopted.

These research efforts are being jointly funded by the Indian Government, the National Science Foundation, and the USAID Office of U.S. Foreign Disaster Assistance.

LOCAL CONSTRUCTION TECHNIQUES: PAKISTAN

Charles White has recently returned from Pakistan where he spent part of his time documenting indigenous building methods and materials, in particular the widespread use of mud ("katcha"), low-fired brick ("pakka"), and various combinations of these with other materials. In a report entitled "Ahmed Pur East Model Village", he discusses various traditional types of mud plasters, typical foundations, wall and roofing systems, the cultural and environmental factors taken into consideration in designing the project, and the building methods chosen for construction of the model villa e.

The report provides useful background data on indigenous skills and materials. For information, contact:

Charles W. White
c/o Insha Company
8,000 I.H. 10 West, Suite 960
San Antonio, Texas 78230

POST-EARTHQUAKE TRAINING PROJECT IN POPAYAN, COLOMBIA

On March 31, 1983, an earthquake occurred in the vicinity of Popayán, Colombia. Its magnitude was 5.5 on the Richter Scale, with an epicenter west of the urban area at a relatively shallow depth. The duration was 19 seconds, long enough to cause massive damage to the urban area and extensive damage to rural housing in the Municipio of Popayán and surrounding municipios. An INTERTECT team of architects and engineers made a site visit in May-June 1983 to survey and assess the damage, identify priorities and problem areas of reconstruction, and discuss what measures could be taken to safely rebuild and repair damaged houses.

There was widespread damage in virtually all sectors of the urban area, particularly with regard to schools, hospitals, churches, public buildings and especially housing. The greatest damage occurred in the 53-block area designated as an historic zone, virtually all of the low-income neighborhoods, and all construction in the lowlying areas between the rivers. Heavy damage was sustained by many engineered buildings throughout the city as well. Although estimates of the damage to the housing sector varied widely, the figure generally used by the team was 72% of the approximately 20,000 houses in Popayán, valued at approx. US$90,000,000. In addition, it was estimated that in the historic area there were 1,200 living units located on the second floor above commercial establishments that were destroyed, representing a replacement cost of US$135,000,000. The extraordinarily high cost was based on the assumption that the earthen structures would be restored to their pre-disaster character and construction technology.

The greatest concentration of problems was in the old, low-income neighborhoods where construction is primarily of adobe, brick, and mixtures of the two. Housing in the rural areas is predominantly of adobe and bajareque construction. Houses were damaged or destroyed up to approximately 30 km away from the city.

With funding from the AID Office of U.S. Foreign Disaster Assistance, a training program was devised for the safe repair of earthen and masonry housing in low-income neighborhoods of Popayán and was extended to include anti-seismic methods of construction, materials and design of new low-income housing oriented to self-help construction. An INTERTECT technical assistance team consisting of Frederick C. Cuny, Eduardo Perez, Jim Viets (training aids specialist), and Daniel Torrealva (an engineer from the Catholic University in Lima, Peru) initiated the project in August 1983 in close collaboration with SENA (Servicio Nacional de Aprendizaje), a Colombian organization which provides a variety of vocational training throughout the country, including courses in self-help construction. Augusto Espinosa of Areas, Ltd. in Bogotá worked with the team as soils engineer.

A series of training aids was designed and produced to facilitate the diffusion of information on seismic resistant construction techniques, and these aids were utilized in courses held for instructors (who conduct courses for local carpenters, masons and self-help builders), persons in the construction industry, municipal building inspectors and representatives of financial institutions. Four "model house repairs" construction demonstrations were also undertaken -- two for adobe houses and two for masonry houses.

The project introduced simple and cost-effective methods for repair and strengthening of damaged buildings. Of particular interest was the introduction of chicken wire mesh to strengthen adobe houses, a technique which instilled much confidence in the homeowners regarding their "old adobe" homes. Other details emphasized included: rebuilding walls above horizontal and vertical cracks; repairing areas around shear cracks; reinforcing or rebuilding the roof truss system; anchoring roof trusses to ring beams; replacing brick gable ends with lightweight construction; replacing heavy clay tiles with lightweight roofing; replacing bad wood members of the roof system; improving bracing and design of trusses; and lowering the total height of walls over 2.5 meters.

The INTERTECT team and SENA also worked with two key financial institutions -- the Banco Central Hipotecario (BCH) and the Instituto de Crédito Territorial (ICT) -- in developing minimum seismic resistant construction standards that were incorporated into the training aids.

The training materials developed for this program were combined and bound to form an "Instructors' Manual for Seismic Resistant Construction". SENA is conducting classes in Popayán and the surrounding area utilizing the materials developed in this project and, because it has many regional offices scattered throughout the country, the materials are also being distributed in other seismic areas. The SENA newspaper, "El Autoconstructor", is also publishing a series based on the highly illustrated booklets, showing improved methods of repair and new construction, aimed at building craftsmen and self-help builders.

The technical assistance project served to complement and upgrade the existing SENA reconstruction program which is low-cost, labor-intensive, uses locally-available materials, and generates local employment and business. The goal of this long-term program is to ensure that the commuuities are able to repair or reconstruct houses that will be safer (less vulnerable to future earthquakes) than before the earthquake. In addition, the program trains personnel who can replicate the self-help construction process in other communities not directly participating in the SENA program, and the trainees will have subsequent opportunities to seek employment in the construction industry.

During the course of the project, discussions were also held with SENA and the Association of Colombian Engineers on the need for a comprehensive hazard management program for the country.

More detailed information about the SENA program may be obtained by contacting:

Gustavo Wilches Chaux
SENA (Servicio Nacional de Aprendizaje)
Apartado 623
Popayán, Colombia

FIRST CARIBBEAN SEISMOLOGICAL MEETING

The First Seismological Meeting of the Caribbean was held in May 1983 in Santo Domingo, Dominican Republic, hosted by the Dominican Ministry of Public Works & Communications. Countries represented included Cuba, Guadalupe, Haiti, Jamaica, Mexico, Puerto Rico, Trinidad & Tobago, the United States and Venezuela. The conference examined the seismic problems common to the region such as lack of adequate equipment, shared scientific information, and prevention and emergency programs. Final recommendations included:

- that historic and actual seismic data should be exchanged;
- that periodic training courses should be conducted for agency personnel;
- that a Caribbean Seismology Center should be created;
- that a Caribbean Disaster Week should be established, designed to raise the awareness of the general public regarding disasters;
- that technical training should be sought on damage assessment and repair of buildings and public infrastructure.

For more information, contact:

Arq. Milagros Nanita
Sub-Directora General
Depto. de Normas, Reglamentos y Sistemas
Secretaria de Estado de Obras Públicas
y Communicaciones
Santo Domingo, Dominican Republic

INTERNATIONAL NEWSLETTER:
EARTHEN BUILDINGS IN SEISMIC AREAS

Edited by: INTERTECT
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Dallas, TX 75207, USA

Published by: College of Engineering
University of New Mexico
Albuquerque, NM 87131, USA

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ADAUA EARTHEN CONSTRUCTION TECHNIQUES

Carlos R. Lola

Washington, D.C.

Sept. 8, 1983

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INTRODUCTION

Implementation of earthen construction projects is a critical element to promote low cost earthen construction projects throughout the world. In Africa, ADAUA stands out as an implementor and innovator of earthen construction technologies. The purpose of this article is to present a brief appraisal of the ADAUA Earthen Construction Techniques in Ouagadougou, Upper Volta. At the beginning a description of ADAUA is presented, followed by stabilized adobe bricks, structural system overview, creation of collectives and ADAUA's interesting features.

Upper Volta, with about 274,000 square kms. and about 6.6 million inhabitants is situated in the heart of Western Africa and on the edges of the Sahara Desert (see Map 1). The climate is Sudano-Sahelian (arid region) and Ouagadougou has a precipitation of less than 900 mm/year. Upper Volta became independent from France on August 5, 1960 and its annual per capita income (World Bank 1978) was 160 dollars.

In the construction project presented in this article, soil cement stabilization principles and a Belgian machine technology production are used to improve earthen construction in Upper Volta.

ADAUA: DESCRIPTION

ADAUA is an international non-profit organization headquartered in Ouagadougou, Upper Volta (see Map 1). It was founded in the early 1970s with central offices in Geneva, Switzerland. When projects began to spread particularly in West Africa, it moved to Ouagadougou. ADAUA (Association pour le Developpement d'une Architecture et d'un Urbanisme Africains) aims at

facilitating low cost construction techniques with stabilized adobe. The principal elements are the use of locally available soils, the adaptation of an innovative roofing technology, and the creation of collectives by training and supporting local artisans.

The staff of ADAUA and its various national affiliates is composed of African engineers, architects, social promoters, head masons, brickmakers, local artisans and administrative officers.

STABILIZED ADOBE BRICKS

o **Production**

At the present time portland cement type I is the only stabilizer in use at the various construction projects. ADAUA produces five different types of bricks as follows:

29.5 cms x 14 cms x 9 cms
22 cms x 14 cms x 9 cms
29.5 cms x 14 cms x 5 cms
21.5 cms x 10.5 cms x 5 cms
40 cms x 20 cms x 10 cms

A five to six man crew using a manually operated Belgian machine can produce from 800 to 1200 bricks per day. The cost of the machine is 800,000 CFA (350 CFA = $1) of which 40% represents transport costs.

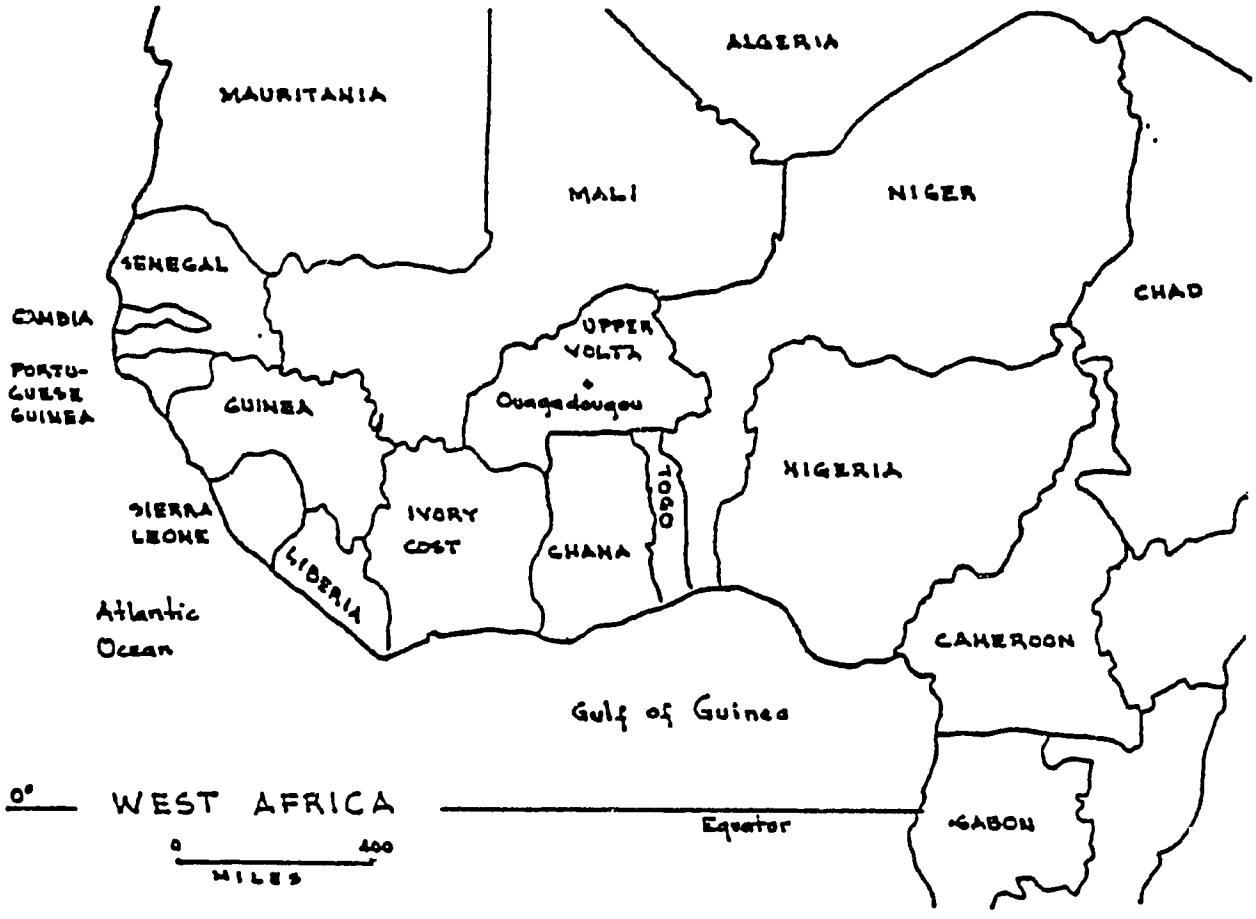
The amount of cement used ranges from 4% to 6% based on bearing or non-bearing wall function in the structural design.

Extensive testing programs were undertaken in November 1977 for the popular housing project in Rosso, Mauritania. Procedures for simplified soil classificaiton methods, determination of proper amout of stabilizer, and stabilizer selection were established for future projects.

o **Physical Mechanical Properties**

The average compressive strength has been found to be from 40 kg/cm^2 to 70 kg/cm^2 using 4% to 6% of cement. Brick water absorption, durability tests, diagonal compression or direct

MAP OF AREA


ALGERIA
MAURITANIA
MALI
NIGER
SENEGAL
CHAD
GAMBIA
UPPER VOLTA
Ouagadougou
PORTU-GUESE GUINEA
GUINEA
NIGERIA
TOGO
SIERRA LEONE
IVORY COST
GHANA
LIBERIA
Atlantic Ocean
CAMEROON
Gulf of Guinea
0°
WEST AFRICA
Equator
GABON
0
400
MILES

shear data are not available. A full scale test to determine the ultimate strength for a dome 3.55 mt x 3.55 mt was conducted in November 1978. These results are now used as parameters for the structural design in new projects.

STRUCTURAL SYSTEM OVERVIEW

Foundations

In the three different projects visited in the Ouagadougou area, a very hard laterite layer was present at approximately 20 to 30 cms from the surface, making ideal the use of shallow foundations. A 5 cms sand layer is generally placed on the bottom of the foundation trench. The foundation consists of quarry-stone bonded with a mortar with a cement content of 250 kg/m^3. Four layers of stabilized adobe (sub-base) with 6% cement are then placed on top of the quarry stone base. The thickness of the sub-base is a function of the wall thickness.

Walls

The bearing structure is integrated essentially by cement stabilized adobe loading walls, arcs, and domes. The minimum compressive strength of the bricks is usually 20 kg/cm^2. The cement content of the bricks is 6% (by weight). In general, thickness of non-loading walls is 14 cms and loading walls in 29 cms and 20 cms. The mortar is a mix of sand, soil, and cement content of 225 kg/m^3.

Arcs

The thickness of the arcs placed on top of the wall openings is generally 29 cms.

Roof Systems

ADAUA has adapted and extend the vaulting and dome roof technologies rediscovered by the Egyptian architect Hassan Fathy. Six percent stabilized adobe bricks are used for the vaults and domes.

Vaults:

The vault thickness if 10.5 cms. The height of the vault is directly related to the radius and circular sector width. See Fig. Coupe C-C and Coupe E-E.

Domes:

The thickness of the domes is usually 10.5 cms. The domes are built with bricks of 21.5 cms x 10.5 cms x 5 cms, which are composed of 6% cement stabilized adobe.

The domes are built without using wooden forms. A unique technique using a wooden pole fixed to a central point on the floor of the room, and with a rotating capability is the only guide used in making the regular curve of the dome. Particular attention has to be given to the brick-laying in order to achieve an aesthetically pleasing appearance on the interior surface of the dome. When domes are to be used as floor systems for a two-story section, light-weight materials such as empty glass bottles are used to reach a level surface upon which the flooring of the second story is laid.

The exposed exterior surface of vaults and domes is covered with various types of weatherproofing layers, including:

1) "colle + ecran" (asphalt emulsion; adhesive and water resistent);
2) a second layer "special toiture", an imported waterproofing substance.

ADAUA has made considerable effort to find a local sealing product but results have been negative.

CREATION OF COLLECTIVES

ADAUA has created collectives in Senegal, Mauritania and Upper Volta and is currently in the preparation phase to create one in Mali. ADAUA is also undertaking a cooperative effort with ALAHUA (Latin American Association for the Promotion of Habitat, Architecture and Urbanism), a Latin American Collective beginning to function in Ecuador. The ADAUA collective is usually

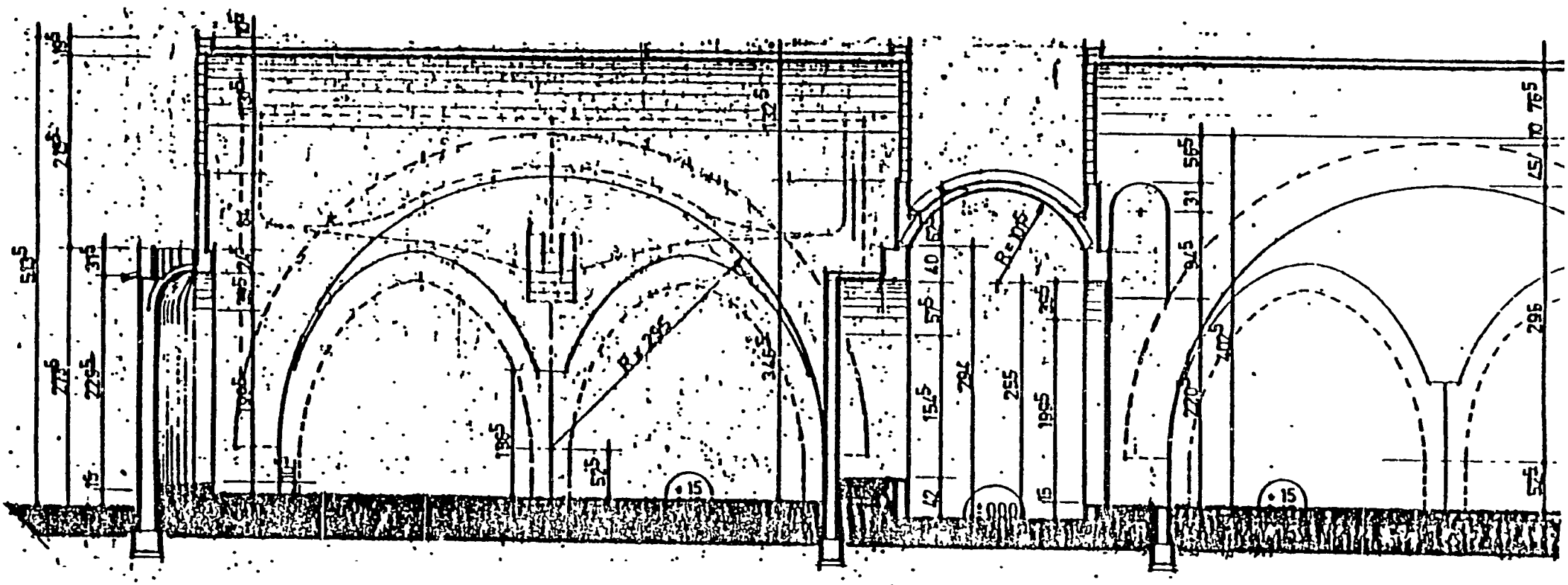
ADAUA

Design: Gerard Wobai

Architect: Djibril Diagne

Engineer: Ladji Camara

May 1983 Upper Volta



.COUPE : E-E

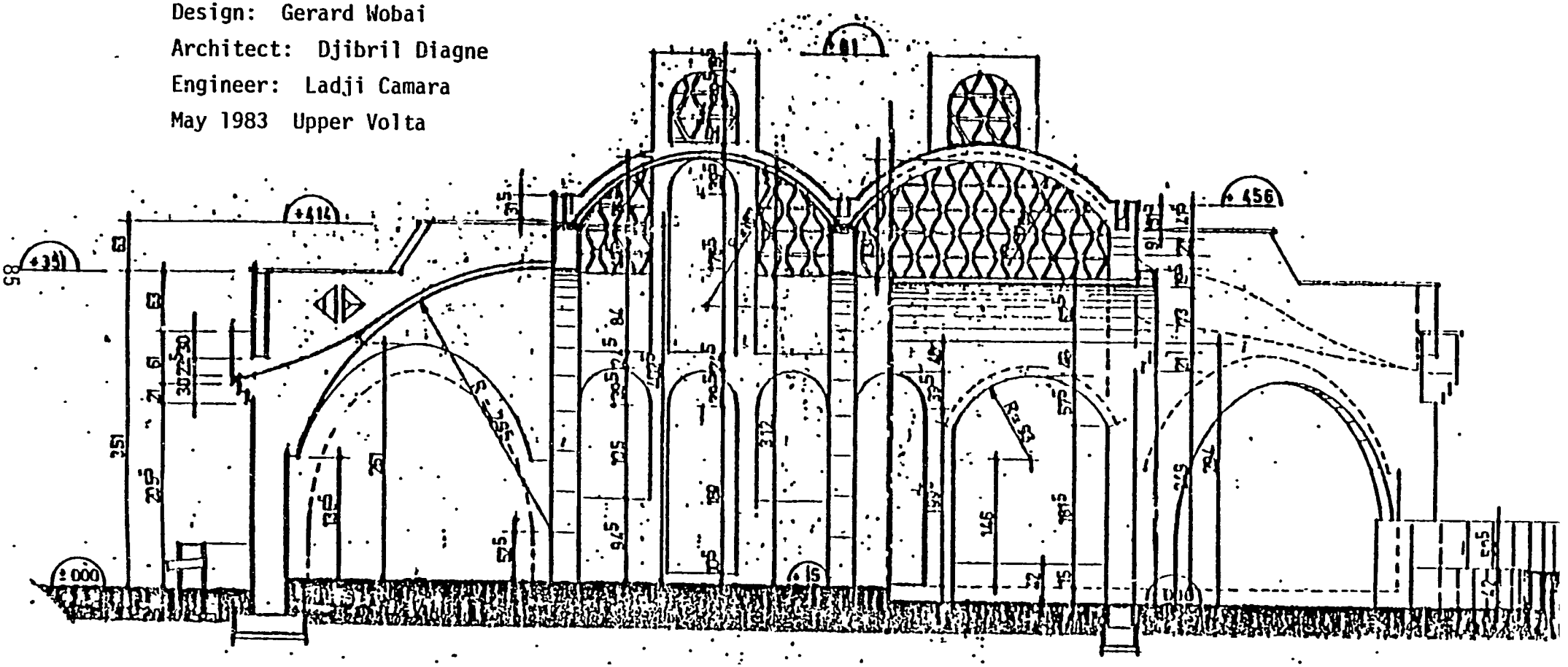
ADAUA

Design: Gerard Wobai

Architect: Djibril Diagne

Engineer: Ladji Camara

May 1983 Upper Volta



COUPE C-C

constituted by a core staff of an architect, engineer, community coordinator, masons, brickmakers, and administrative officers. They are usually trained at other ADAUA work sites and then are assisted in training other members and in undertaking building programs with the community. The masons and brickmakers are developed into independent enterprises.

ADAUA: INTERESTING FEATURES

o **Structural Design**

By using stabilized adobe bearing walls, the use of reinforced concrete frames is eliminated with considerable savings in total cost. Introducing the efficient use of vaults and domes (designing them to work under compressive stresses) makes the use of steel reinforcing unnecessary.

o **Imports Reduction**

Upper Volta and several countries in West Africa depend greatly on imports to have access to cement, lime, steel bars, timber and other construction materials. The use of these essential building materials is reduced to a minimum by introducing the structural design described above.

o **Use of Local Raw Materials and Uskilled Labor**

The primary raw materials is the locally available soil; and the simplified techology allows unskilled labor to be incorporated into the construction process.

o **Architectural Design in Harmony with Cultural Pattern**

ADAUA's building architecture presents an outstanding example of introducing local cultural elements into construction design. ADAUA utilizes earthen construction which has a long historical tradition in West Africa, circular and square volumes and vaults and domes all with an appropriate Islamic touch.

o **ADAUA Training for Architects and Engineers**

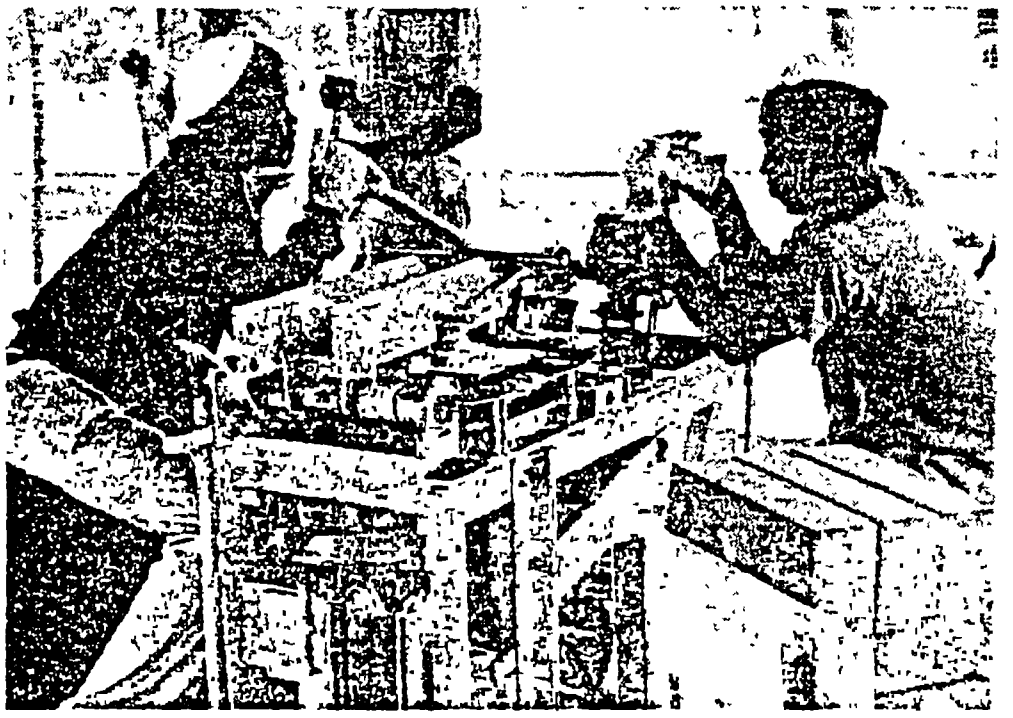
ADAUA contributes to training of architects and engineers in earthen design and construction techniques. The program is

carefully structured to provide trainees with actual field experience in on-going projects.

- **Development of Small Enterprise for Production of Low Cost Building Materials**

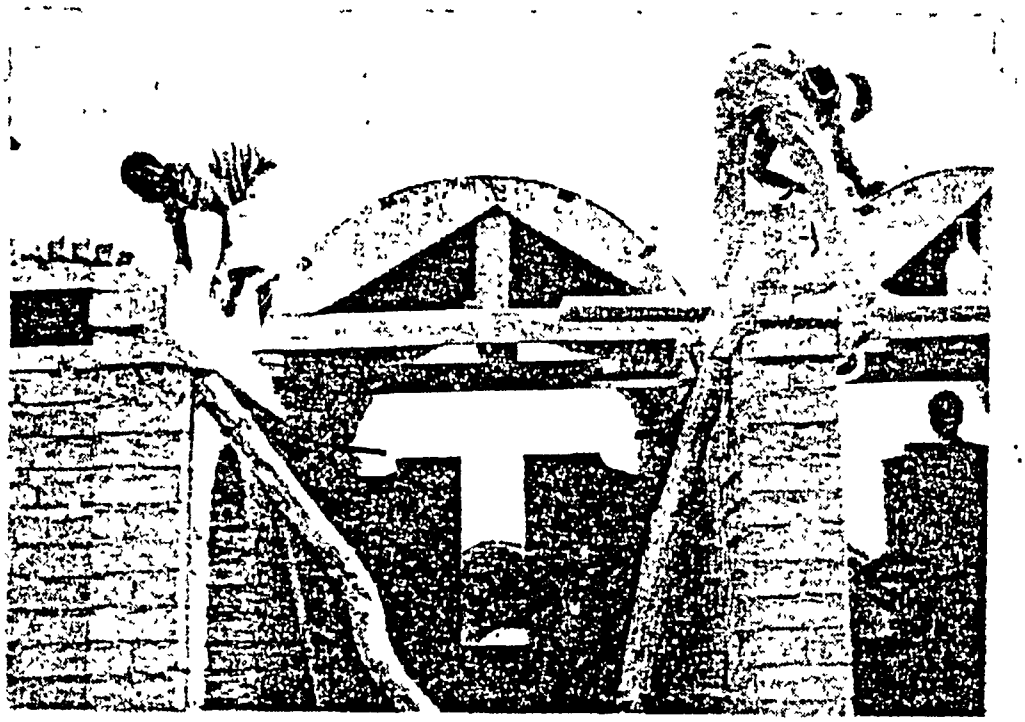
The projects incorporate local residents on the worksites as masons and brickmakers and encourage them to develop into small enteprises. Once the training phase is completed and they have costituted a small enterprise they become building materials suppliers for ADAUA projects.

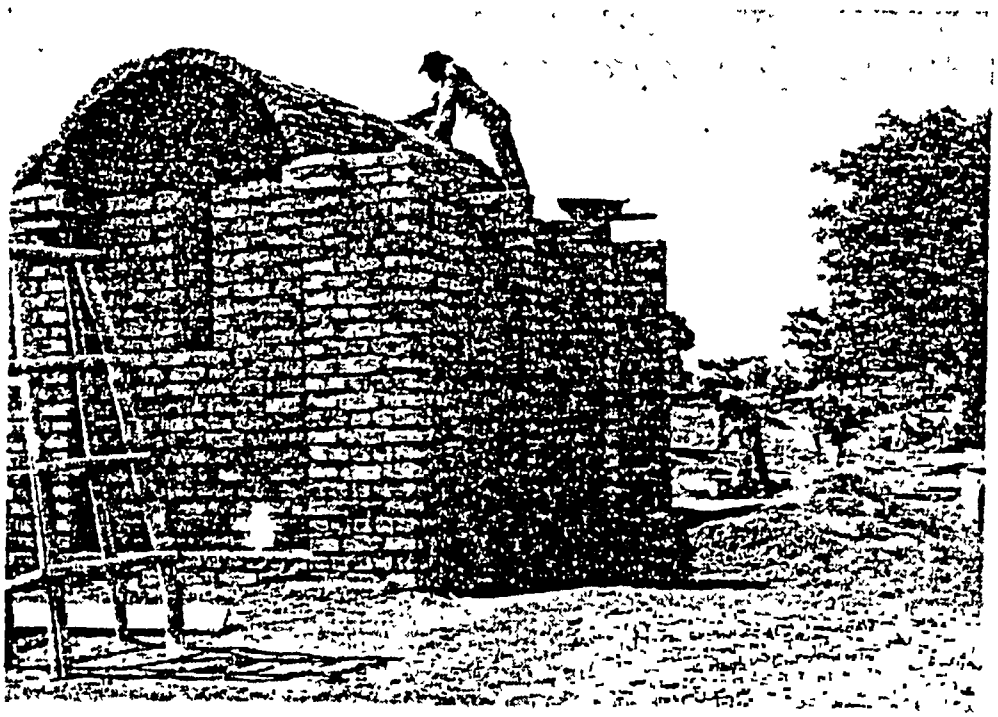
ADOBE PRODUCTION



CONSTRUCTION: GENERAL VIEW

CONSTRUCTION OF VAULTS





International Newsletter:

EARTHEN BUILDINGS IN SEISMIC AREAS

JUNE 1984

8WCEE and Earthen Housing Network Meeting

In July, approximately 2,000 people will travel to San Francisco for the 8th WCEE, including many members of this network of people involved in earthen housing research and implementation activities. More than 850 technical papers are scheduled for presentation during the meeting, again many of them authored by members of this network. Because of the number of people coming from all regions of the world, we have scheduled a meeting of the network members and any other interested participants on the day following the conference closing. The meeting is set for July 28th at the Empire Room of the Fairmont Hotel, from 9:00 am to 1:00 pm. We hope all of you who are planning to attend the conference will be able to join us to discuss future directions for the network. If you have any questions, please do not hesitate to contact Jinx Parker or Fred Cuny at INTERTECT, P.O. Box 10502, Dallas, Texas 75207, USA (Tel: 214-521-8921) or at the Fairmont Hotel during the conference week.

Earth Building Conference IV

More than 300 people attended the 4th Earth Building Conference, April 20-23, 1984, in Albuquerque, New Mexico. It was sponsored by Earth Systems, the New Mexico Solar Energy Institute, and the New Mexico Energy Research & Development Institute. Major features of the conference included a workshop, lectures, trade show, earth building demonstrations, and a tour of earth homes. The conference audience reflected diverse backgrounds, including architects, designers, builders, prospective owner-builders, and manufacturers and suppliers for the industry. Cassette tapes were available of the lecture presentations.

The workshop consisted of a series of lectures, with question and answer sessions, by speakers who are specialists in a number of fields related to earth building. P.G. McHenry, Albuquerque architect, gave a slide presentation for a world overview on historical and present uses of earth as a building material and its increasing importance for the future. Thomas Caperton, Director of the Monuments Division/Museum of New Mexico, spoke and showed slides of adobe preservation projects in the Southwest. Dr. Richard Ferm, chemist and Executive Director of the new International Foundation for Earth Construction, spoke on the physical characteristics of clay and the use of asphalt waterproofing agents for soils. Pliny Fisk, ecologist and Director of the Center for Maximum Potential Building Systems (Austin, Texas), gave an excellent lecture on adaptive use of common materials in conjunction with adobe. Robert Barnes, architect and builder of Tucson, Arizona, gave an informative presentation on adobe construction techniques for the handling of mixed mud materials, including his innovative "Ablobe" plaster system.

The second day of the workshop began with Roberta Lienau, Secretary of the Pressed Block Association, who described this new type of adobe brick, pointing out that these manufacturing methods have far-reaching effects on the industry which have been unavailable in the past. She was followed by Dr. Wayne Dunlap, soils

(Cont'd)

scientist at Texas A&M, who demonstrated practical soil testing methods and stabilizers of earth materials with cement. Dr. Michael Belshaw, economist and anthropologist, presented a revolutionary adobe construction technique with poured blocks of adobe mud, where special shaped forms can be easily achieved. David Easton, engineer and designer-builder in rammed earth from Wheysville, CA, gave detailed explanations of forming and building methods which have met with great success in California. A flexible forming system was the highlight of his presentation, with thoughtful metaphysical considerations of earth architecture. Edward Mazria, author of "The Passive Solar Energy Book", architect and authority on passive solar design, pinpointed the importance of thermal mass storage and heat control in passive solar design. Alternative means, using adobe, concrete, water and other materials to accomplish this, were presented in detail.

In a lighter vein, Magnus Berglund, freelance writer and photographer, discussed the trials and tribulations of the owner-builder with a keen insight to the problems, solutions and attitudes which make for a successful project. Betty Rachkowski, Albuquerque real estate broker, addressed marketing strategies and peculiarities of passive solar adobe homes.

Sunday was hands-on day, open to the public, with more than 2,000 attending. Demonstrations were shown of many of the techniques covered in the workshop lectures. Conferees were encouraged to participate actively in the work, and many accepted. Well-known author Ken Kern, guru of the owner-builders, had an interesting display.

Monday was tour day, with two busloads of conferees visiting five adobe homes, featuring technical innovations such as gravel foundations, mud brick domes and vaults, and solar features.

The Earth Exposition is planned as an annual event. Earth Expo V is scheduled for March 1985 in Albuquerque, New Mexico.

[The editors are grateful to P.G. McHenry, Jr., AIA, for this conference report.]

International Conference in Ric

An international conference on research and applications of low-cost and energy-saving construction materials will be held July 9-12, 1984, in Rio de Janeiro, Brazil, sponsored by the Pontificia Universidade Católica do Rio de Janeiro, Lehigh University, Financiadora de Estudos e Projetos (FINEP), Banco Nacional de Habitação (BNH), Conselho Nacional de Desenvolvimento Científico e Tecnológico, Coordenação de Aperfeiçoamento do pessoal de nivel superior (CAPES), Comité Internacional de Desenvolvimento de Materiais Não Convencionais (UCMT), and The Sulphur Institute. Cooperating institutions are the Asian Institute of Technology (Bangkok), The University of New South Wales, Pontificia Universidad Católica del Perú, Hong Kong Polytechnic, Building & Road Research Institute (Ghana), Texas A&M University, Instituto de Pesquisas Tecnológicas do Estado de São Paulo (IPT/SP), and Laboratório de Computação Científica. Julio Vargas N. of PUC in Lima has sent the following list of papers to be presented at this meeting which will be of interest to those involved in earthen construction:

"Perspectives for Utilization of Bauxite Mud and Additive to Binders for Soil Conditioning", F.J.C.O. Castro (Univ. Federal do Rio de Janeiro).

"Low-Cost Reinforced Earth Designs for Saving Energy", K.R. Datye (Bombay, India).

"Ground Improvement with Low-Cost Bamboo-Mat" and a case study, Z.X. Hu, S.L. Tan (Tongji Univ., China) and H.Y. Fang, (Lehigh University).

"Use and Potential of Ground Improvement Materials Technology in Atypical Applications", A. Gupte (Lee Turzillo Contracting Co., Ohio) and N. Pandit (Woodward & Clyde Consultants, Ohio).

"Analysis of the Soil Construction Before and After the Improvement by Means of an Electronic Microscope", L.G. Shen (Tiangsu Archi. Design Institute, China).

(Cont'd)

"Land Shaping and Protecting by Low-Cost Earthwork", P. Scharle (Epitestudo Manyi Intezet, Budapest, Hungary).

"Low-Cost Foundation Structures with Limestone and Sand Piles", Z.X. Hu, S.L. Tan & S.M. Yuan (Tongji Univ., China) and H.Y. Fang (Lehigh University).

"Paperboard Reinforced Poured-in-Place Stabilized Adobe Soil", L.D. Webb and G.L. Sorensen (Texas A&M University).

"Low-Cost Earth Shelters Utilizing a Natural Arch", L. D. Webb and G.L. Sorensen (Texas A&M University).

"Adobe: A Modern Solution Based on Ancient Art", L.D. Webb and G.L. Sorensen (Texas A&M University).

"Aditivos Naturales y Dosificaciones de Suelos para Construcciones de Adobe", J. Vargas N., J.B. Bariola and M.B. Saavedra (Pontificia Univ. Católica del Perú, Lima).

"Bamboo-Lime-Rice Husk Ash Composite Construction Material", H.Y. Fang, R. Dongre and S. Chen (Lehigh University).

For more information on the conference, contact:

Prof. H.Y. Fang, Co-Chairman
Department of Civil Engineering
Fritz Engineering Laboratory #13
Lehigh University
Bethlehem, Pennsylvania 18015, USA
Telephone (215) 861-3549
TWX: 710-670-1086 UD

or:

Prof. Khosrow Ghavami
Depto. de Engenharia Civil - PUC/RJ
Rua Marques de São Vicente, 225
Gávea - CEP 22 453
Rio de Janeiro - RJ - Brasil
Telephone (021) 274 9922

Vulnerability of Low-Income Housing in Earthquake Areas

A collaborative research program has been established between the Martin Centre for Architectural & Urban Studies of Cambridge University/U.K., the Earthquake Research Institute of the Turkish Ministry of Resettlement & Reconstruction, and the Earthquake Engineering Research Institute of Middle East Technical University (METU) in Ankara. The objective of this research, which is being jointly funded by the Turkish Government and the Overseas Development Administration (ODA) of the British Government, is to develop methods of assessing vulnerability to earthquakes and of evaluating the benefits of modification in construction techniques in high risk areas.

As a first stage of the work, a joint field study with ERI, METU and Cambridge was carried out in August 1982 in the Bingol region of eastern Turkey. Three villages that were damaged in the 1971 earthquake and subsequently reconstructed were surveyed in order to identify the factors contributing to their vulnerability to future earthquakes, and also to assess the effectiveness of government housing provision following the 1971 earthquake.

After the first year of the research program, certain conclusions concerning methods of study were reached, in particular:

(a) Existing data on damage collected from past Turkish earthquakes are rather coarsely defined and unrelated to ground motion measurements. It is not possible to obtain from them vulnerability assessments of different building types in any detail. Methods are being discussed to make damage information collected after future earthquakes more useful for defining vulnerability.

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(b) An alternative way to define vulnerability is to assess the level of seismic loading that can be resisted by representative structures of different types, based on their structural form and material properties and crude representation of the earthquake forces involved; this method also enables the effect of modifications in construction technique on seismic resistance to be estimated.

(c) Laboratory testing of scale models is one approach often advocated as a supplement to calculation for assessing seismic resistance of structures; however, it is clear from field studies that the details and quality of construction techniques are one of the major factors influencing earthquake performance, and it is now felt that these cannot be well-enough simulated in small-scale models built in the laboratory for testing purposes. It is, however, strongly believed that full-scale testing of typical buildings in the field could be possible, and would yield very valuable results.

(d) It is evident that, in eastern Turkey at least, the traditional forms of building will continue to be used for some time to come, and one of the most important tasks is to examine simple ways of modifying the construction methods used, without altering the basic form, so that earthquake resistance is improved. There are few examples of such modified traditional houses in existence at present; consequently, if the benefits of introducing such modifications are to be measured, some prototypes will have to be designed, built and subsequently tested.

More specific conclusions from the Bingol field study included:

In the emergency period after the 1971 earthquake, a number of inappropriate decisions on re-siting of settlements had been taken, contributing to a low level of acceptance of the new settlements.

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- The choice of very lightweight prefabricated systems for reconstruction was also inappropriate in this region; these buildings suffered from very poor performance climatically and functionally which contributed significantly to lack of acceptance of government-provided villages.

- Traditional construction using heavy stone walls and mud roofs is still widely practiced and is well-adapted to the social and climatic needs of the people, but in most cases this heavy and weak construction is very vulnerable to earthquakes.

- A much more effective policy of construction would be to encourage the villagers to continue building in their traditional ways and to assist them to improve the earthquake resistance of their traditional houses. Advantages would be seen in the greatly reduced cost of permanent reconstruction, the acceptability of the housing and the more rapid return to normal life.

- The major requirements for a policy of this kind are the provision of technical advice at village level and possibly some cash subsidy for the building materials needed to improve the earthquake resistance of traditional buildings. Studies are needed both of the methods by which earthquake resistance can best be improved and of the way such methods can be communicated to the villagers involved in construction.

As a result of the Bingol field study, it is considered that the most important next stage of the work is to investigate in greater detail the problem of modifying the traditional housing of this region to improve its earthquake resistance. The objective is to develop designs which incorporate significant improvement in earthquake resistance but at the same time (1) require only a small extra financial cost; (2) do not reduce existing levels of insulation and thermal mass; (3) do not significantly alter traditional patterns of use of the house; (4) are within the

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capability of local builders: and (5) have improved durability.

It is proposed that one or more of these designs should be built and subsequently evaluated in terms of both its improved earthquake resistance and its fulfillment of the other stated objectives. The proposed procedure is as follows:

1. The modified house(s) will be built in or near existing villages.

2. Only local builders will be employed for the construction and all materials will be obtained locally.

3. If possible, it will be arranged that the house is subsequently occupied and used in a typical fashion, and its performance monitored.

4. Full-scale "mock-ups" of unmodified and modified traditional housing will be built in the same manner and location for testing under simulated earthquake loading, to assess the increase in earthquake resistance due to the modifications.

For further information on this project, contact:

Dr. Robin Spence
Cambridge University
Faculty of Architecture and History of Art
1 Scroope Terrace
Cambridge CB2 IPX, U.K.

Publications

Glosario Mínimo de Terminos de Arquitectura Virreynal en el Área Andina by José de Mesa (1980) is a well-illustrated dictionary of architectural/construction terminology used during the Viceroyalty period, developed for architects and restoration specialists working in the Andean area. Published in Spanish by the Centro de Investigación y Restauración de Bienes Monumentales, Instituto Nacional de Cultura/Región Cusco, Apartado Postal No. 289, Cusco, Peru.

MIMAR: Architecture in Development is a quarterly design magazine covering contemporary work in developing countries. Its primary editorial objective is to provide critique and commentary on the unification of modern building and design techniques and theory with cultural traditions, especially those of Islam, throughout the industrializing world. Individual subscription rate for one year is $36.00, through:

MIT Press Journals
28 Carleton Street
Cambridge, Massachusetts 02142, USA

Architecture and Community: Building in the Islamic World Today features architectural plans, photographs and commentary on the fifteen winners of the 1980 Aga Khan Award for Architecture. Among the articles of interest to newsletter readers are "Conservation of the Historic Environment for Cultural Survival" by Dogan Kuban, "Urban Housing in the Third World: The Role of the Architect" by Charles Correa, and "Islamic Architecture and the Poor People of Islam" by Mahbub ul-Haq. The cloth edition is $40.00 and the paper edition is $20.00, available from:

APERTURE
Elm Street
Millerton, New York 12546, USA

"Appropriate Technologies" in the Conservation of Cultural Property is No. 7 in a series of technical handbooks for museums and monuments on protection of the cultural heritage, published by The UNESCO Press in 1981. The soft-cover book brings together four papers dealing with the use and development of "appropriate technologies" in the conservation of cultural property in Nepal, Rome and Egypt, India, and Peru; and it concludes with a chapter on the relationship between technology and tradition, the benefits and constraints of "appropriate" technology transfer, and the need for understanding the level at which a culture can absorb knowledge. Available from:

UNESCO
7 place de Fontenoy
75700 Paris, France

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La Restauración de Estructuras de Adobe en los Monumentos Históricos de la Región Andina del Perú, by Arq. Roberto Samanez Argumedo, is the Spanish version of "The Restoration of Mud-Brick Structures in Historical Monuments of the Andean Region of Peru", one of the papers published in the above-referenced UNESCO book. The highly-illustrated booklet describes the historic structures which have been undergoing preservation and restoration under a special UNESCO project, the methods utilized, and the specific adaptations necessitated by the materials and designs. The soft-cover book was published in 1983 by La Oficina de Asuntos Culturales de COFIDE, Lima.

Report of the Indian Earthquake Engineering Mission to Yemen Arab Republic on Dhamar Earthquake of Dec. 13, 1982, by A.S. Arya, L.S. Srivastava and Satyendra P. Gupta, examines the impact of the earthquake on existing local buildings (primarily stone masonry and mud or adobe block construction), records the points of failure, and recommends aseismic construction features that can be used for repair, strengthening and new construction. The report includes recommendations for development of a seismic building code and for training of engineers and building craftsmen. It was published by the Indian Society of Earthquake Technology and the Department of Earthquake Engineering, Univ. of Roorkee, India (March 1983). For information on its availability, contact Dr. L.S. Srivastava, Dept. of Earthquake Engineering, University of Roorkee.

Calendar of Meetings

July 9-12, 1984: International Conference on Development and Applications of Low-Cost and Energy-Saving Construction Materials, Rio de Janeiro. See article in this newsletter for more information.

July 21-28, 1984: 8th World Conference on Earthquake Engineering, San Francisco. For information contact: EERI-8WCEE, 2620 Telegraph Avenue, Berkeley, California 94704.

July 28, 1984: Meeting of members of the International Network for Improvement of Earthen Buildings in Seismic Areas, 9:00 A.M. - 1:00 P.M., Fairmont Hotel, San Francisco, immediately following the close of the 8WCEE. Tentative meeting place: the Empire Room.

July 23-27, 1984: Design, Technology and Logistics for Large Housing Projects, the Aga Khan Program Seminar Series #5 for professionals concerned with design and management of the urban environment, to be held at MIT in Cambridge, Massachusetts. Major topics include: Planning & Design; Building Technology; Alternative Approaches in Low-Cost Housing; and Implementation & Management. Project presentations focus on Iraq, India, Malaysia, Mali, Singapore, Bangladesh and Saudi Arabia. The seminar is jointly organized by the MIT School of Architecture & Planning and the Harvard Graduate School of Design. For registration information, contact:

Dr. Mona Serageldin or Mr. Akhtar Badshah
Aga Khan Program, Room 10-390
Massachusetts Institute of Technology
77 Massachusetts Avenue
Cambridge, Massachusetts 02139, USA
Telephone: (617) 253-1400

September 15-27, 1984: Exhibition: Building with Limited Means, a Union of International Architects (UIA) exhibit for the Berlin IBA 1984 International Exhibition, focusing on the development of energy-sparing solutions, use of traditional building materials and techniques, making full use of local initiative, skills and labor, etc. The exhibition will be located in the International Congress Center (ICC), AMK Building, Hall 14B. Contact for more information:

Prof. Fritz Bornemann
Bozenerstrasse 13-14
1000 Berlin 62, West Germany

October 8-11, 1984: Natural Hazards Mitigation Research and Practice: Small Buildings and Community Development, CIB/W-73 international conference, to be held in New Delhi, India. For more information

(Cont'd)

contact Chairman, CIB/W-73 International Conf., Building Research Council, University of Illinois at Urbana-Champaign, One East Saint Mary's Road, Champaign, Illinois 61820, USA.

November 1984: International Colloquium on "Earth Construction Technologies Appropriate to Developing Countries", hosted and organized by The Belgian Ministry of Development Cooperation in cooperation with UNCHS (Habitat), the Post Graduate Centre on Human Settlements, Katholieke Universiteit Leuven, and the Centre of Recherches en Architecture, Université Catholique de Louvain-La-Neuve, Belgium. Participation is restricted to those actively involved in the development and use of earth as a building material in developing countries. A limited number of fellowships are available. For information, contact:

AGCD - ABOS
Place du Champ de Mars, 5
Boite 57
Bureau 1925
1050 Brussels, Belgium

November 5-10, 1984: International Conference on Low Cost Housing for Developing Countries, Roorkee, India, organized by the Central Building Research Institute (CBRI), Roorkee. Topics to be covered include: Space and Environmental Standards for Low-Cost Housing Programs; Locational Aspects of Housing for Low-Income Groups in Metropolitan Situations; Structural Systems and Innovative Construction Techniques; Development of New Materials for Mass Housing; Shelter Project Design and Analysis; Policies and Approaches for Mass Housing Programs; Financial, Institutional and Construction Management of Mass Housing Programs; Low-Cost Housing - New Concepts; Energy Conservation Strategies in Housing Projects; Low-Cost Housing - Case Studies from Developing Countries. For more information, contact:

T.N. Gupta
Secretary, Housing Conference
Central Building Research Institute
Roorkee, U.P., India
Telephone: 2608

November 12-16, 1984: International Conference on Disaster Mitigation Program Implementation, Kingston, Jamaica, organized by the Center for Development Studies, Virginia Polytechnic Institute & State University, and hosted by the Office of Disaster Preparedness & Emergency Relief Coordination, Government of Jamaica. For information, contact:

Dr. Frederick Krimgold
Associate Dean for Research & Extension
College of Architecture & Urban Studies
Virginia Polytechnic Inst. & State Univ.
Washington - Alexandria Center
101 North Columbus Street
Alexandria, Virginia 22314, USA
Telephone (703) 548-0099

Research Activities in Peru

Peru is the center for a great deal of ongoing research on earthen structures. The Catholic University, National Engineering University and ININVI/Instituto Nacional de Investigación y Normalización de la Vivienda in Lima (as well as many of the universities in other regions of the country) all have a strong commitment to research and testing programs in adobe, and assisted in preparation for the Latin American Workshop on Earthen Buildings in Seismic Areas hosted by the Catholic University in May 1983. Organizations such as CRATERRE, PREDES, CESPAC, CIDAP, SENCICO, and ENACE are involved in different ways in the application of the data resulting from various research and testing activities to local situations. Much work in preservation and restoration of earthen structures is being done in Cuzco, Cajamarca and other areas. For a full picture of the extent of ongoing interest and involvement, you may wish to order the proceedings from this Latin American Workshop (see order form attached to this newsletter) which include many papers from the Peruvian participants.

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This article focuses on activities at the Department of Engineering, Catholic University (Pontificia Universidad Católica del Perú/PUC). Their current projects in this field include:

Durability of Adobe Constructions: studies of different types of plaster to protect walls in rainy areas (Researcher: Ernesto Heredia; Advisers: Juan Bariola and Julio Vargas N.).

Dynamic Stability of Adobe Walls: stability tests of walls on vibrating slab - simulation of real earthquakes (Researcher: Juan Bariola).

Straw as an Additive to Control Microcracking of Mortar in Joints of Adobe Masonry: corroboration of results previously accomplished (Project: Adobe Construction in Seismic Areas) using six different types of soils (Researcher: Francisco Ginocchio; Adviser: Julio Vargas N.).

Adobe Inca Technology: study of the influence of technologies used by the Inca population on the strength and durability of adobe constructions (Researcher: Angel Soto; Adviser: Juan Bariola).

Restoration of Adobe Constructions: research on the most adequate type of reinforcement used to repair adobe buildings affected by earthquakes or rains (Researcher: Percy Quiñones M.; Advisers: Daniel Torrealva D. and Julio Vargas N.).

Financial assistance supplied by the U.S. Agency for International Development allowed PUC to undertake a research program aimed at relating earth composition with adobe masonry earthquake resistance. The work originated from a cooperative investigation (U.N. Development Programme - UNESCO) carried out in 1980 by the PUC Engineering Dept. and the Engineering Institute of the Universidad Nacional Autónoma de México. This program detected remarkable differences in shear strength between the Mexican and Peruvian masonry, even though the adobe blocks had similar strength.

Adobe samples from different areas of the country and some from abroad (Mexico City and Illinois) were collected and analyses were made of the mechanical, physical and chemical properties of the soils in order to correlate them and study the effects of such properties in the masonry behavior. Several research projects have dealt previously with the adobe block itself, but this was the first time that the masonry quality as a whole has been studied.

The project was directed by Ing. Julio Vargas Neumann; the main adviser was Dr. Povindar K. Mehta (Univ. of California, Berkeley); and the principal researchers were Dr. Marcial Blondet and Ing. Juan Bariola. The research project, which lasted one year, was completed in November 1983.

The following are some of the main conclusions of the project:

- Physical characteristics (size, distribution, plasticity, etc.) of the soil are the most significant properties in relation to the seismic strength of the masonry.

- The most important component of the soil is the clay, which provides the strength to the adobe.

- Clay presence produces microcracking of mortar in joints and weakens the masonry, thus the need to control these fractures was noted.

- Natural straw and coarse sand are efficient natural additives to attain such control.

- Very simple field tests were developed to guarantee the minimum clay presence and to optimize the quantity of additives required for each soil in order to obtain a good quality adobe masonry.

- A basis for a diffusion strategy among users at the community level was developed.

A report on this project, entitled "Seismic Strength of Adobe Masonry", is included with this issue of the newsletter.

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A second one-year investigation, "Adobe Construction in Seismic and Rainy Areas", has now been initiated, again with financial support from the Office of U.S. Foreign Disaster Assistance, Agency for International Development, to explore appropriate methods of enhancing the durability of adobe construction without affecting its strength capacity. During this period a model project will also be conducted within the disaster area of northern Peru to advise and teach people the new technology developed for building and/or rebuilding with adobe. Ing. Julio Vargas N. is responsible for the project; the main adviser is Dr. Povindar K. Mehta; and the primary researchers are Ing. Juan Bariola and Ing. Daniel Torrealva D.

Julio Vargas is acting as a regional focus for information for this newsletter and we are grateful for his contributions to this issue. For more information on these projects, or on the testing facilities at PUC, contact:

Ing. Julio Vargas Neumann
Laboratorio de Estructuras
Departamento de Ingeniería
Pontificia Universidad Católica del Perú
Apartado 12534
Lima 21, Perú

Review of Current Literature

McHenry, Paul Graham, Jr., Adobe and Rammed Earth Buildings: Design and Construction. New York: Wiley-Interscience, 1984. 217 pp. $35.00.

McHenry's handsome treatise on this ancient and enduring building material will be of great value to those having a contemporary adobe house built in the US as well as to architects and builders undertaking such a task in this country. The book is well-organized and provides the novice a good introduction to the characteristics of the structural elements as well as examples of the great variety of architectural styles and indigenous adaptations from various regions of the world, spanning centuries. It should also give sufficient detail to those in the building profession who want a convenient handbook to review specific issues or serve those who are new to the material.

Gerald May, Dean of the College of Engineering at Univ. of New Mexico, provides a brief but most important review chapter on structural engineering for earth buildings which is essential to an understanding of the limitations of the material under various stresses which should influence design features of the building. This is the only chapter in the book that deals with the earthquake hazard and structural considerations (an entry curiously missing from the index) and leads this reviewer to the one complaint about the volume.

To be of information value outside of building interests for the wealthy (at 32-47 cents per brick, a typical adobe house in the Western US uses between $192,000 and $282,000 for brick alone), systematic treatment should have been afforded the vulnerability to earthquakes and atmospheric deterioration. What is missing here are drawings giving design features that counter these forces of nature which -- in the larger picture -- influence the lives and welfare of the great majority of the peoples on this earth living in earth buildings. Photographs illustrating the failure of structural elements and drawings showing remedies which could have prevented the collapse would have been helpful. It is estimated that 80% of the lives lost in earthquakes occur in the collapse of earthen buildings which are non-engineered, owner-built, vernacular architecture. Some very excellent work is being done today by researchers on different continents testing local materials and structural components under stress, working with natural additives for stabilization and optimum design and siting considerations to provide safer buildings that are stronger in all respects.

One of the objectives of the International Workshop on Earthen Buildings in Seismic Areas (Albuquerque, May 1981) was to disseminate knowlege on how to improve low-quality earth and masonry construction.

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The resultant 3-volume proceedings cover the state-of-the-art as of that date. A regional seminar for Latin America held in Lima in May 1983 also produced one volume of proceedings. Reference to these storehouses of knowledge would have given a wider dimension to the book and provided access to a world of exciting literature and know-how to the serious aficionado from whatever corner of the world. A bibliography at the end of the book would have been helpful. As there is much to be learned from an analysis of the failure of these often deadly structures, perhaps the greatest challenge in the future is in the uncovering of the mysteries of a lost building technology that made some buildings survive in earthquake zones for centuries despite severe stresses of nature. I would have liked to have seen some focus on indigenous building techniques of Peru and mention made of the studies by Hartkopf of Carnegie-Mellon University and INTERTECT.

But McHenry packs a lot into the fifteen chapters. History and evolution of earth construction; examples of earth architecture (Western and Eastern US, Mexico and Latin America, Europe, Africa, Middle East); soil selection; adobe brick manufacturing; adobe brick wall construction; rammed earth wall construction; window and door detailing; earth wall finishes; foundations; floor and roof structures; insulation and thermal mass values; mechanical considerations; structural engineering for earth buildings; repair and renovation of earth buildings; building codes for earth construction; New Mexico Building Code for Adobe 1983 and excerpts from the 1982 edition of the Uniform Building Code; Index.

Despite the limitations noted, this handsome volume should be welcome to many who wish to rediscover the qualities of this ancient building material for contemporary — albeit affluent -- applications.

Reviewer: Gudrun H. Huden
Office of US Foreign Disaster Assistance, Agency for International Development

(Cont'd)

[Editorial Note: The references cited in this review are: Proceedings: International Workshop on Earthen Buildings in Seismic Areas, Univ. of New Mexico and INTERTECT, 1981; Memorias: Seminario Latinamericano de Construcciones de Tierra en Areas Sísmicas, Univ. of New Mexico and INTERTECT, 1983; Indigenous Building Techniques of Peru and Their Potential for Improvement to Better Withstand Earthquakes, Carnegie-Mellon University and INTERTECT, 1981 (Prepared for Agency for International Development, Washington, D.C.; currently being translated for a Spanish edition).]

Courses on Asphalt-Stabilized Adobe Construction

Five practical courses on construction with asphalt-stabilized adobe have been offered in low-income areas around Piura, Peru, a region greatly damaged by rains and floods in 1983. The courses included the building of five cooking and dining rooms as a pilot project and the training of 125 workmen who can continue to act as disseminating agents of the techniques in Piura. Several institutions participated in this initiative, among which the following took active part: Comité de Damas para la Reconstrucción de Piura, CORPIURA, ININVI, CARE and CESPAC. ININVI (the National Institute for Housing Investigations and Standards) was in charge of the technical aspects of the project.

INTERNATIONAL NEWSLETTER: EARTHEN BUILDINGS IN SEISMIC AREAS

Edited by: INTERTECT
P.O. Box 10502
Dallas, TX 75207, USA

Published by: College of Engineering
University of New Mexico
Albuquerque, NM 87131, USA

Network funding provided by Appropriate Technology International (ATI), AID Office of U.S. Foreign Disaster Assistance, and the National Science Foundation.

PROCEEDINGS OF THE LATIN AMERICAN WORKSHOP ON EARTHEN BUILDINGS IN SEISMIC AREAS

Lima, Peru
May 23-27, 1983

The Latin American Workshop on Earthen Buildings in Seismic Areas was a regional follow-up to the International Workshop held in Albuquerque, New Mexico (1981), and provided an opportunity for those involved in research and testing, structural design, repair and reinforcement, training and program implementation to share their experience and to begin the process of responding to and applying to regional needs the research agenda and recommendations produced in the 1981 Workshop. A brief Technical Meeting was held prior to the Workshop for intensive discussion on the topics of structural engineering, standardization of testing, evaluation of damage and methods of reinforcement, materials and reinforcement, codes and alternatives.

The Workshop agenda included: Socio-Economic Aspects (Social Acceptability; Promotion & Training; Economic and Financial Factors); Technical Aspects (Preservation of Historic Structures; Evaluation, Reinforcement, & Repair; Typology); Implementation Aspects (Program Implementation; Technology Transfer; Self-Help Construction). Its timing also provided an opportunity to examine the impact of the Popayán, Colombia, earthquake which occurred two months previously, in a special session with presentations from Colombian, Venezuelan, and Peruvian architects and engineers.

The Workshop was organized by the College of Engineering/University of New Mexico and INTERTECT, and was sponsored by the Office of U.S. Foreign Disaster Assistance/Agency for International Development, the National Science Foundation, and Appropriate Technology International (ATI). It was hosted by the Pontificia Universidad Católica del Perú.

The 718-page proceedings contain 39 papers, as well as the conclusions and recommendations emanating from the Technical Meeting and Workshop. The volume is published primarily in Spanish, with a few papers in English. The proceedings will be of interest to planners, engineers and architects, implementers of earthen construction, housing funding organizations, government officials, and post-disaster reconstruction personnel.

ORDER FORM

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SEISMIC STRENGTH OF ADOBE MASONRY

Julio Vargas Neumann*
Juan Bariola Bernales*
Marcial Blondet*

SUMMARY

This paper presents the main conclusions and recommendations of the Research Project "Earthen Buildings in Seismic Areas", developed in the Catholic University of Peru (PUCP) in 1983.

The most important soil characteristics from the viewpoint of the strength of adobe masonry are first studied. Subsequently, based on the acquired knowledge, the effect of some natural additives to the soil is investigated. Simple field tests, devised to identify the most adequate materials for adobe construction and to be easily transmitted to the potential adobe builder, are then proposed. Finally, some ideas about the possibility of disseminating techniques for improved adobe construction in Peru are discussed. These techniques, adapted to local conditions, could be applied to other Third World Countries.

1. INTRODUCTION

Most of the loss of life and material damage caused by earthquakes occur in earthen buildings in Third World Countries. The scientific and technical communities of these countries can significantly contribute to control of this problem by finding ways to increase the strength of their traditional buildings and efficient means to disseminate the improved construction techniques among the builders, the majority of whom are impoverished, isolated and culturally destitute. This work intends to be a contribution in that sense.

2. BACKGROUND AND OBJECTIVES

It was only in the nineteen seventies that consciousness was raised in Peru about the need of studying the problem of seismic strength of adobe buildings. Significant efforts in experimental research were made in the Catholic University of Peru (PUC) and in the National University of Engineering (UNI). Initially, research at PUC was oriented towards the study of different types of reinforcement, using rural materials (Refs. 1, 2, 3 and 4). Subsequently, the effect of some additives in the mortar was studied (Ref. 5).

In 1979, PUC and the National Autonomous University of Mexico (UNAM) developed a Joint Research Project to study the strength of adobe masonry. Differences of about 500% in the strength of adobe masonry specimens made with

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adobe bricks of similar strength were then detected. The cause of such high difference in strength could not be explained at the time.

Most of the research performed on adobe masonry had been based on the study of the relationship between the properties of the materials used and the strength of the adobe brick (Ref. 7) and little or no attention was paid to the actual strength of the adobe masonry, which depends mainly on the integration between the adobe bricks and the soil mortar used to join them.

This work aims first to detect and study the soil properties fundamental to the seismic strength of adobe buildings, and then to investigate the effect of some natural additives and construction techniques to improve the strength of these buildings. Another objective is to develop strategies for the dissemination of the obtained results. Some simple constructive recommendations have therefore been developed.

This paper presents only the most important conclusions and recommendations obtained during the Research Project "Adobe Building in Seismic Areas". All the information generated during the research is contained in Reference 8, which includes a detailed description of the techniques used and the results obtained.

3. SELECTION AND ANALYSIS OF SOILS

Six zones of Peru where adobe construction is traditional were selected for this study. Soil samples from these areas were collected, in order to correlate their physical, chemical and mineralogical characteristics with the seismic strength of adobe masonry made with these soils.

The physical properties of the soils were studied mainly by the evaluation of their granulometric characteristics and their Atterberg Limits. A number of tests were performed to determine the chemical composition of the soils and of water samples brought from each location. The mineralogical characteristics of the clays present in each soil were evaluated through X-ray diffraction analysis performed at the University of California, Berkeley.

4. SPECIMEN CONSTRUCTION AND MECHANICAL TESTING

In order to guarantee a small dispersion in the test results, special care was taken in the manufacturing of adobe bricks and masonry test specimens. All masonry specimens were manufactured by the same person. A soil mixer was used to make the soil-water mixture. The workability of all soil mortars was maintained at a standard level, controlled by means of a modified Vicat apparatus (Fig. 1). Both adobe bricks and specimens were dried in the shade, in order to prevent cracking due to drying shrinkage.

After performing a large number of tests with different techniques, the diagonal compression test (Fig. 2) was adopted for the evaluation of the seismic strength of the adobe masonry. The simpler indirect tension test (Fig. 3) was devised in order to conduct preliminary studies, or for cases of limited availability of material. Other simpler tests, such as the direct tension test, were discarded since they led to unacceptably large dispersion in the results.

The strength of the adobe bricks was evaluated through compression tests on cubes.

The experimental effort of this project consisted of 128 cube compression tests, 509 indirect tension tests, and 246 diagonal compression tests.

5. SIGNIFICANT FACTORS IN SEISMIC STRENGTH OF ADOBE MASONRY

A. Drying Process

One of the most important conclusions drawn from the analysis of the test results is that the strength of adobe masonry greatly depends on the degree of microcracking of the soil mortar due to drying shrinkage. Figure 4 shows a clear correlation between the volumetric drying shrinkage of adobe bricks -- which also indicates the capacity for drying shrinkage of the mortar -- and the strength of the masonry. In order to obtain a strong masonry it is therefore indispensable not only to have a material with high dry strength, but also to guarantee the integrity of the brick-mortar ensemble by preventing or controlling microcracking of the mortar.

The study of the drying processes of adobe bricks and mortar was very illustrative in understanding the behavior of the masonry. A correlation was found between the rate of drying and the level of microcracking due to drying shrinkage. This was relatively easy to discover in the case of the adobe bricks, since bricks dried in the shade were significantly less cracked than those dried in the sun.

The drying process of mortar placed between dry adobe bricks occurs in two well defined stages. Most of the microcracking occurs during the first very rapid stage, due to the sudden loss of mortar water caused by absorption by the drier bricks or, to a lesser extent, by the action of gravity. The second stage is much slower; the loss of water is associated basically with evaporation of mortar moisture towards the exterior (Fig. 5).

This result reveals that any method of exterior curing would be inefficient; conversely, any method which tends to reduce the rate of transfer of water between mortar and bricks would be beneficial in improving the quality of adobe masonry.

B. Material Properties

The characteristics of the soils which have most influence on the strength of adobe masonry are those related either to the shrinking process during drying or to the dry strength of the material.

No correlation was found between the chemical composition of the soils or the water and the strength of adobe masonry.

X-ray diffraction mineralogical analysis of the clay fractions revealed that adobe masonry strength relates better to the amount than to the type of clay minerals present in the soils.

As expected, granulometric properties of the soils were found to be very important with regard to the seismic strength of adobe masonry.

Soils with high clay content generally have also high dry strength, measured in compression tests on cubes carved from adobe bricks. Adobe masonry made with these soils has, however, poor strength, since high levels of microcracking due to drying shrinkage are caused precisely by the presence of clay in the mortar. This phenomenon is apparent in Figure 6, which shows a seemingly negative correlation between the compressive strength of adobe cubes and the diagonal compression strength of the adobe masonry.

The presence of clay in soils is, however, fundamental to adobe construction, since clay provides for the soil the dry strength, adhesion, plasticity and moisture demand.

No definite relationship was found between the strength of adobe masonry and the silt or sand contents of the soil. Coarse sand content, however, shows a better correlation with strength, due probably to the restraining effect of coarse material, which reduces mortar microcracking due to drying shrinkage.

A standard mortar consistency (or workability), corresponding to 10 mm penetration in the modified Vicat apparatus, was maintained throughout the research. It was observed that, in general, stronger masonries required less water in the mortar in order to reach the standard consistency. The water content for standard consistency is therefore a characteristic parameter of the soil. This parameter, which evaluates the plasticity of the soil and is also a measure of the adhesion between mortar and brick, does not have good correlation with the ability to restrain microcracking due to drying shrinkage, which is governed by the coarse material.

Atterberg Limits are essentially useful for standard soil classification. Unfortunately, they are not good indicators of the seismic strength of adobe masonry. For instance, the Plasticity Index is computed using only the soil fraction smaller than #40 mesh, and not with all the soil; therefore its value does not necessarily reflect the actual plasticity of the soil used for adobe construction.

C. Effect of Some Additives

In general, the addition of agglutinant agents to the soil was not very efficient in improving the strength of the adobe masonry. Addition of lime actually decreased the strength of the masonry. Addition of cement -- in amounts larger than 10% and mixed with sand — led to some increase in strength. Previous research had shown that addition of a mixture of cement and sand to mortar only is advantageous (Ref. 5).

Small amounts of sodium carbonate, a dispersive agent, led to some increase in the compressive strength of adobe bricks.

Addition of small amounts of manure to the mortar increased masonry strength, since fibers in manure help restrain growth and propagation of microcracks in the mortar. Larger amounts of manure led to smaller strengths, due perhaps to the presence of organic matter or other components.

D. Construction Process

Quality of workmanship plays an important role in obtaining a strong adobe masonry. For instance, diagonal compression tests made with specimens built

with traditional techniques showed a strength of 0.23 Kg/cm^2, whereas samples built with high quality of workmanship resisted 0.47 Kg/cm^2 (Refs. 6 and 8).

Masonry quality was noticeably improved by wetting the adobe bricks, letting them sit for approximately 10 minutes in a container with 1 cm of water, before placing the mortar. This procedure reduced microcracking and improved mortar-brick integration. The use of dry but workable mortars was found to be advantageous, since the number and width of cracks due to drying shrinkage were reduced (Fig. 7).

It was also found that adobe bricks attained sufficient strength to be manipulated one week after their manufacturing and that the strength of adobe masonry stabilizes at about two weeks after fabrication.

The positive effect of "sleeping" the mud (storing it for one or two days) before the fabrication of adobe bricks or mortar, a traditional practice in Peru, was confirmed. It seems that this procedure allows for a better dispersion and thus for a more uniform action of clay particles.

6. IMPROVEMENT OF ADOBE MASONRY

Based on the results described above, it was decided to attempt improving the strength of adobe masonry by reducing the level of microcracking of the mortar through:

- Restraining of drying shrinkage by addition of coarse sand to the natural soil.
- Control of growth and propagation of cracks by addition of straw to the mortar.
- Reduction of the drying rate of the mortar by decreasing the difference in moisture between brick and mortar.

The effect of the addition of coarse sand (size of particles comprised between #4 and #40 mesh) to the six selected soils was investigated. The amounts added varied between 30% and 300% in volume. Sand was added in some cases to both mortar and bricks, and in other cases only to the mortar. In both instances the drying process, the degree of microcracking of the mortar, and the strength of the masonry were studied. Additionally, the effect of previous wetting of the adobe bricks was investigated.

Addition of coarse sand led, in general, to a decrease in the number and average width of the cracks in the mortar (Fig. 8), to a better integration between mortar and brick, and to a significant increase of the strength of the masonry, especially in the cases where the natural soil had a high clay content (Fig. 9, notice Cajamarca and PUC soils). It was found that there is an optimum amount of coarse sand corresponding to the elimination of the visible cracks in the mortar (Fig. 10). Smaller amounts of coarse sand produced mortars with excessive cracking; addition of larger amounts of sand led to masonry with poor strength due to the decrease in clay content (clay provides the dry strength).

Addition of coarse sand also affected the type of failure observed in the specimens tested. In most of the specimens made with natural soils, the cracks

followed the mortar-brick joints. When coarse sand was added to the soil, the cracks also cut the adobe bricks, showing the loss in strength of the bricks due to the diminution of clay. This phenomenon was corroborated with compressive tests of cubes (Fig. 11).

Two types of straw were used as additives: common grass leaves about 5 cm long, and "ichu", a straw from the Andes, chopped in pieces of about 10 cm in length. Some of the traditional Peruvian techniques for the manufacturing of adobe bricks call for the addition of straw to the soil in percentages smaller than 0.5% in weight. The amounts of straw used in this investigation varied between 0.5% to 8%. The effects of addition of straw on mortar workability and strength of adobe masonry were studied.

Addition of straw was found to be even more efficient than addition of coarse sand in improving the strength of adobe masonry (compare Figs. 10 and 12). Practically the same results were obtained with both types of straw. The increase in strength can be explained by the "sewing" action of the brick-mortar interface produced by the straw fibers in the mortar. This effect helps to improve the integration, and thus the strength, of adobe masonry. The compressive strength of the brick was not found to decrease, as in the case of addition of coarse sand. However, the water demand of the mortar to reach an adequate workability increased with the addition of straw. Therefore, addition of very large amounts of straw is not convenient. The optimum amount to be added to a given soil is then controlled by the workability of the soil-straw-water mixture used to make the adobes and mortar.

Simultaneous addition of coarse sand and straw was not efficient in improving the strength of adobe masonry.

Full-scale shear tests on adobe walls were performed to corroborate the observed beneficial effects of addition of coarse sand or straw to the natural soil. Figure 13 shows the test set-up. The improvement of strength obtained was in this case on the order of 100%, with respect to walls made with natural soil (see Fig. 14). This implies an increase in strength on the order of 400% with respect to traditional adobe masonry.

7. CONCLUSIONS AND PRACTICAL RECOMMENDATIONS

The main conclusions drawn from this investigation regarding the seismic strength of adobe buildings are:

--- The most important component of the soil is clay, since it provides dry strength. Unfortunately, clay also causes drying shrinkage of the soil.

--- In order to obtain strong adobe masonry, it is indispensable to control the microcracking of the soil mortar due to drying shrinkage.

--- Straw and, to a lesser extent, coarse sand are efficient natural additives which can be used to control microcracking of the mortar due to drying shrinkage, and therefore to improve the quality of adobe masonry.

Based on these conclusions, the following practical recommendations were established in order to select adequate soils and additives and to improve the construction techniques to obtain stronger adobe buildings.

A. Procedure for Selection of Materials

— Select an available soil as a candidate for adobe construction.

— Perform the dry strength test, consisting of making three or more little balls (of about 2 cm diameter) of mud made of the selected soil. Once dry after at least 24 hours each ball is crushed between the thumb and the index fingers. If all balls are so strong that none can be broken, the soil has enough clay to be used for adobe construction, provided that microcracking of the mortar due to drying shrinkage is controlled. If some of the balls can be crushed, the soil is inadequate since it lacks clay and should be discarded.

— Add to the mud, especially when preparing the mortar, the maximum amount of straw which allows for an adequate workability.

— If straw is not available, perform the microcracking control test. This test consists of making two or more sandwiches (two adobe bricks joined with mortar) using existing adobe bricks and mortar made with the soil under study. After 48 hours of drying in the shade, the sandwiches are carefully opened and the mortar examined. If the mortar does not show visible cracking, the soil is adequate for adobe construction. Otherwise, use coarse sand (0.5 to 5 mm approximately) as an additive to control microcracking due to drying shrinkage. If coarse sand is unavailable, the soil should be discarded.

— The most adequate soil-coarse sand proportion is determined by performing again the microcracking control test with at least eight sandwiches made with mortars with different proportions of soil and coarse sand. It is recommended that the soil:coarse sand proportions vary between 1:0 (no sand) to 1:3 in volume. The sandwich with less amount of sand which shows no visible cracking after opening 48 hours after manufacturing indicates the soil:coarse sand proportion to be used for adobe construction.

B. Construction Process

Some constructive recommendations drawn from the experience acquired during this investigation are:

— To wet the adobe bricks before laying, putting them over about 1/2 to 1 cm of water, or to moisten them by any equivalent procedure. At least the two horizontal faces should be wetted for 10 to 15 minutes.

— To use the bricks as soon after manufacturing as they are able to be manipulated, since the more humid bricks will be less prone to absorb water from the mortar.

Other general recommendations which should be mentioned in this report are: to eliminate all foreign matter from the soil; to mix the mud as thoroughly and uniformly as possible; to dry the adobe bricks in the shade; to clean the bricks before laying; to make uniform and complete mortar joints; and to check the verticality of the walls.

8. DISSEMINATION STRATEGIES FOR ADOBE TECHNOLOGY

In order to reformulate the ideas about dissemination of technology for adobe construction, a team of sociologists and anthropologists from PUC developed field surveys in three urban and four rural zones in Peru.

It was found that, in general, it is not possible to define any one solution to the problem, since the dissemination possibilities are extremely varied and seem to complement each other, and in every case, they would depend on the local conditions. Nevertheless, the following general recommendations could be reached.

A. Urban Zones

Within the urban context, adobe construction is used mainly in the so-called "Pueblos Jovenes" (Young Towns) or shanty towns around the main cities or in the smaller cities. Adobe dwellings are generally regarded as signs of low economic and social status. The dissemination methodology seems to be uniform, since it would be oriented towards a basically literate public.

Masons are usually employed to build the adobe houses; therefore the dissemination programs should be geared mainly towards improving the level of acceptance in the communities of construction with adobe based on a better, innovative technology. The proposed dissemination methods are:

- Radio and television programs, complemented with a system of consultation by mail.
- Courses for adobe masons. Distribution of a specialized booklet. Institutionalization of some kind of official certificate for qualified masons.
- Communal courses in adult schools, technical schools, neighborhood associations, etc. Distribution of a "popular" booklet.

B. Rural Zones

In rural zones, construction with adobe is performed either by the dwellers or by communal work. The dissemination methodology seems to be in these cases more varied, since it would depend on the organization and traditional customs of each particular community. The following alternatives are proposed:

- Courses for adobe masons and for the general public through Agricultural or Cooperative Associations, developed in co-ordination with existing educational programs. Distribution of technical booklets.
- Radio Programs.
- Distribution of simple technical booklets through governmental, religious or educational institutions.

It seems that the most effective dissemination of improved adobe construction technology could be performed in places with high construction potential. Particularly, it would be especially convenient to develop accelerated educative programs in rehabilitation zones after natural disasters.

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Many thanks are due to Research Assistants Gladys Villa-Garcia and Juan Ginocchio for their effort and dedication, and to the personnel of the Earthquake Engineering Laboratory of the Catholic University of Peru.

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FIG.1 MODIFIED VICAT APPARATUS

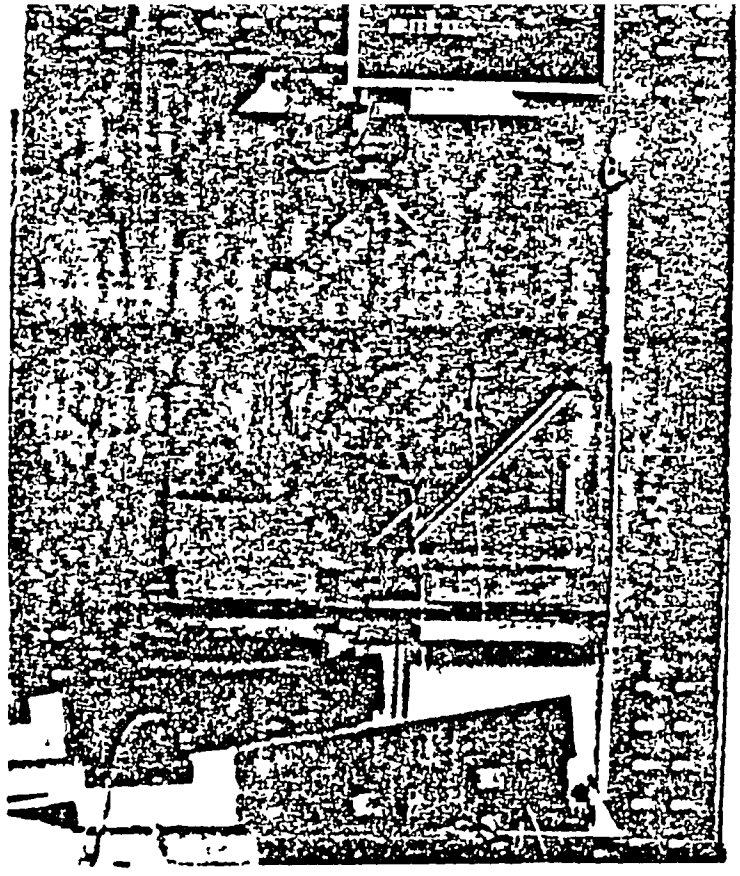


FIG.2 DIAGONAL COMPRESSION TEST

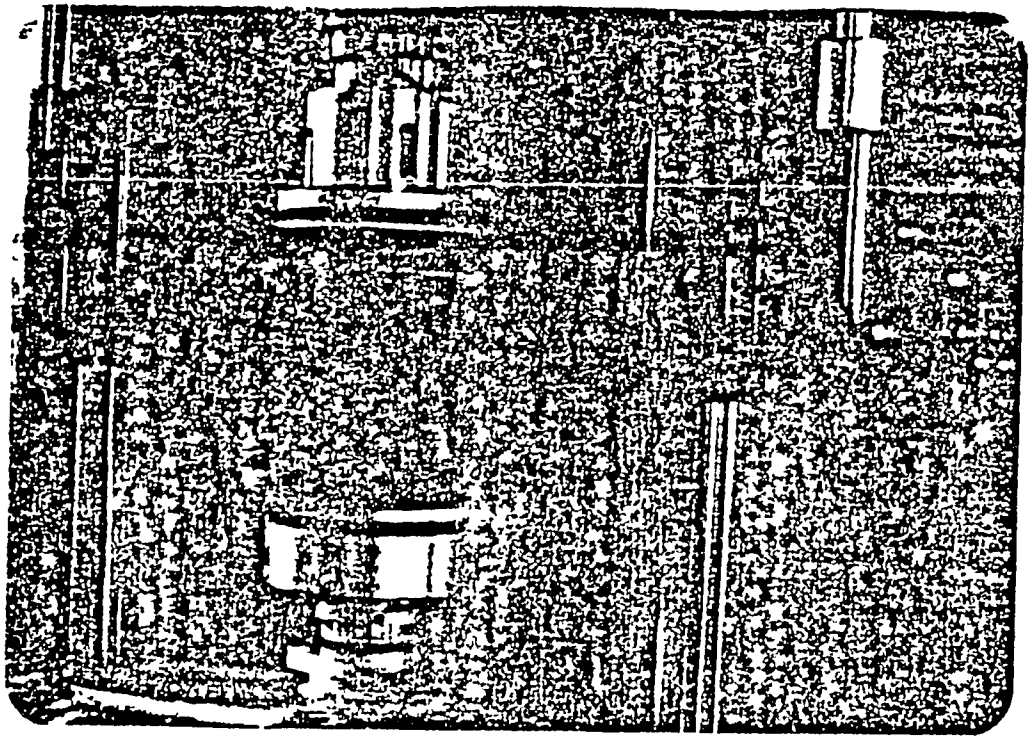


FIG.3 INDIRECT TENSION TEST

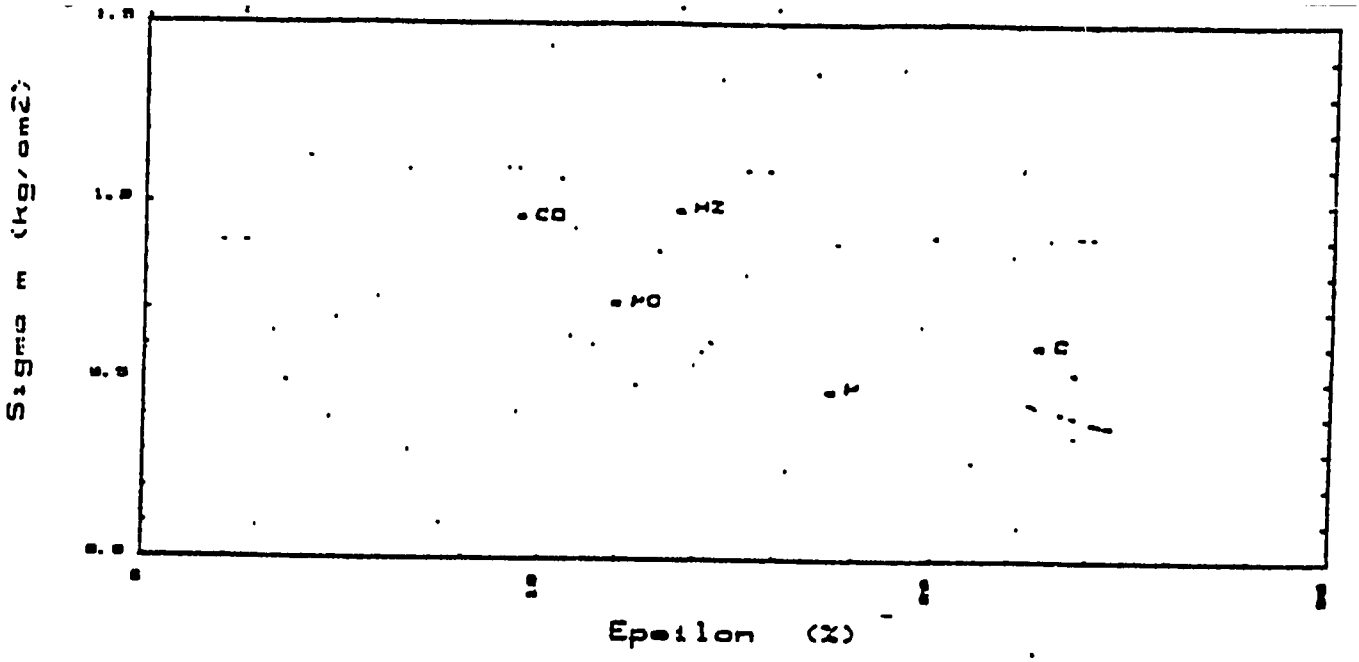


Fig. 4 DIAGONAL COMPRESSION STRENGTH vs VOLUMETRIC-SHRINKAGE OF BRICK

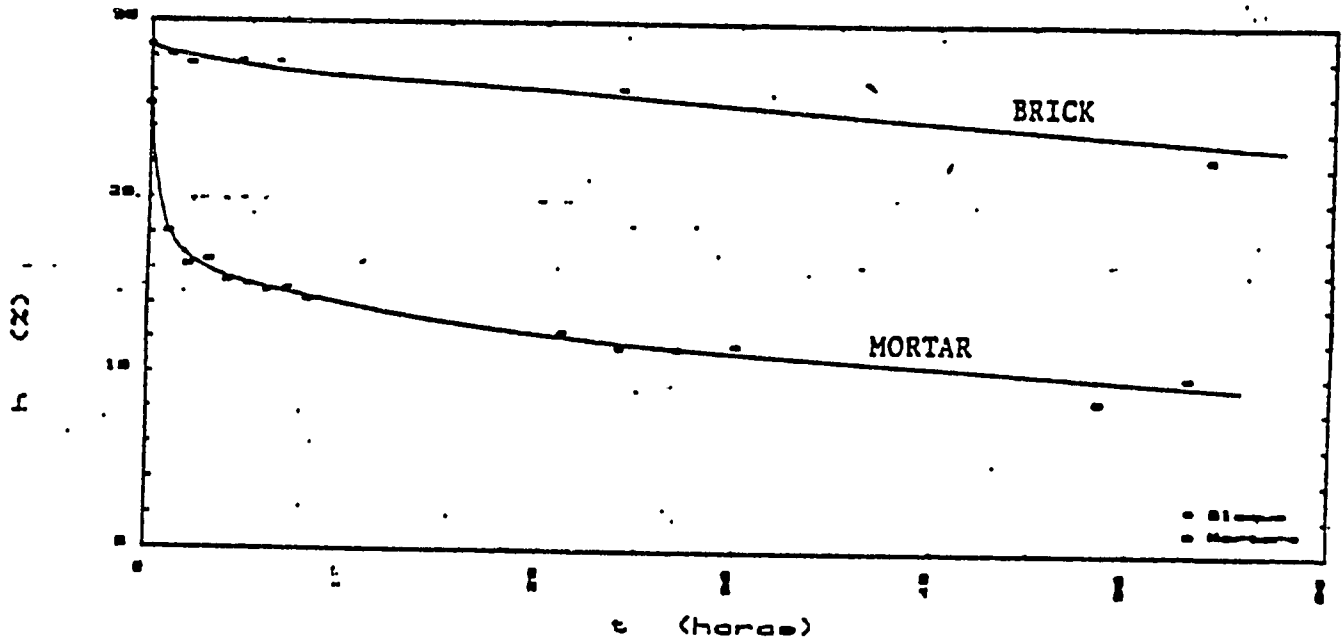


Fig. 5 WATER CONTENT vs TIME

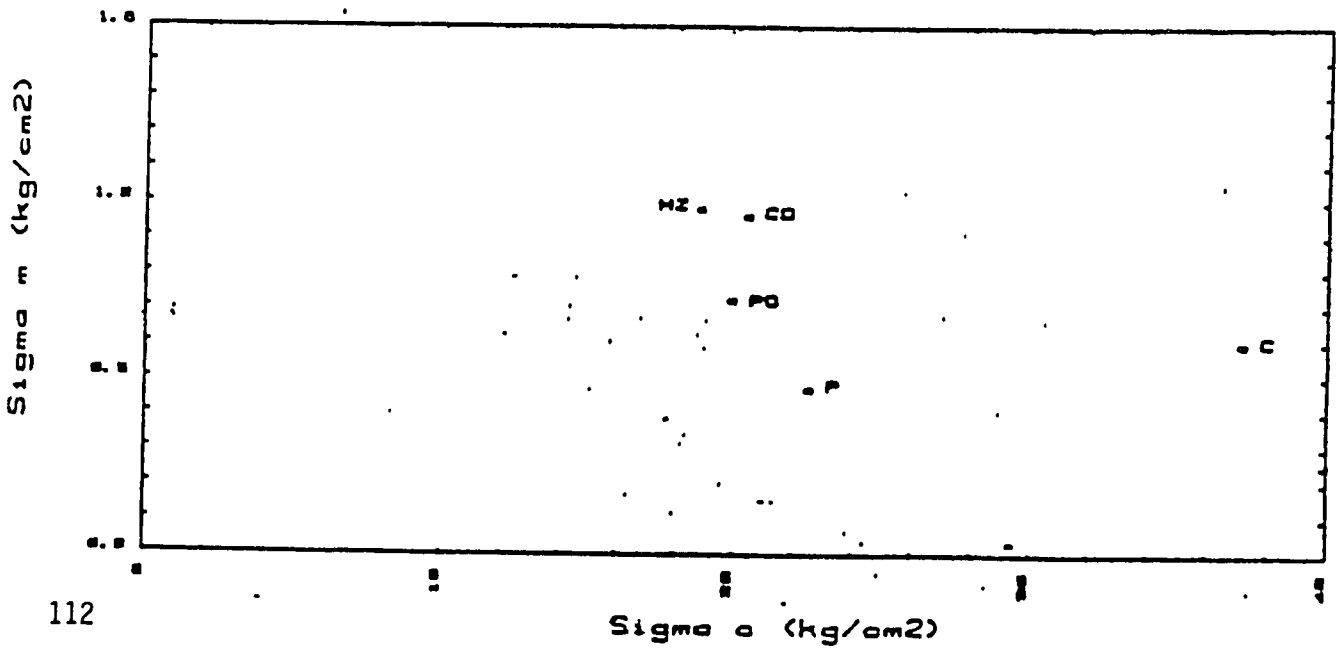


Fig. 6 DIAGONAL COMPRESSION STRENGTH vs COMPRESSIVE STRENGTH

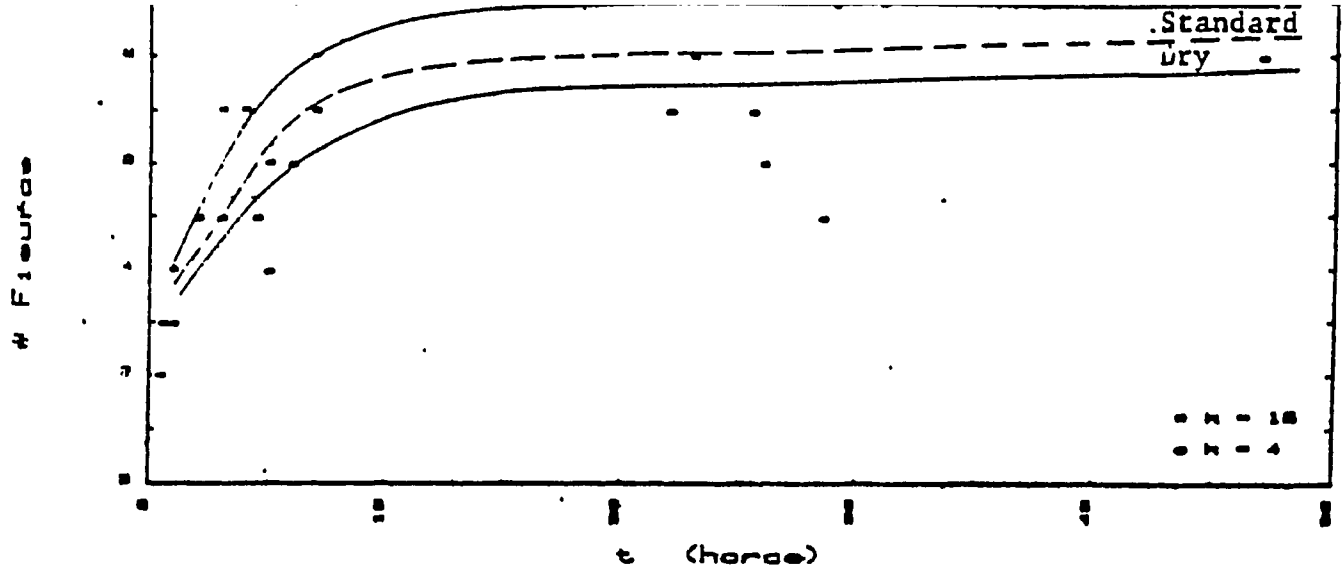


Fig. 7 AVERAGE NUMBER OF CRACKS vs TIME
Effect of Initial Consistency of Mortar

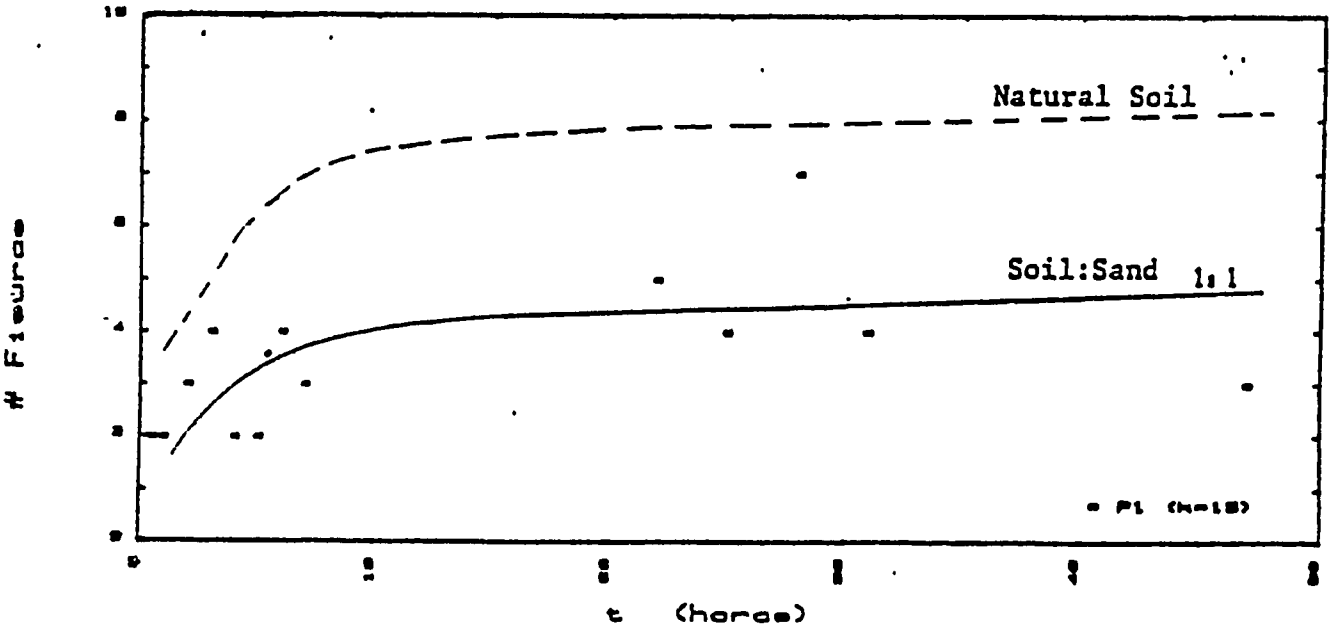


Fig. 8 AVERAGE NUMBER OF CRACKS vs TIME
Effect of Addition of Coarse Sand to Mortar

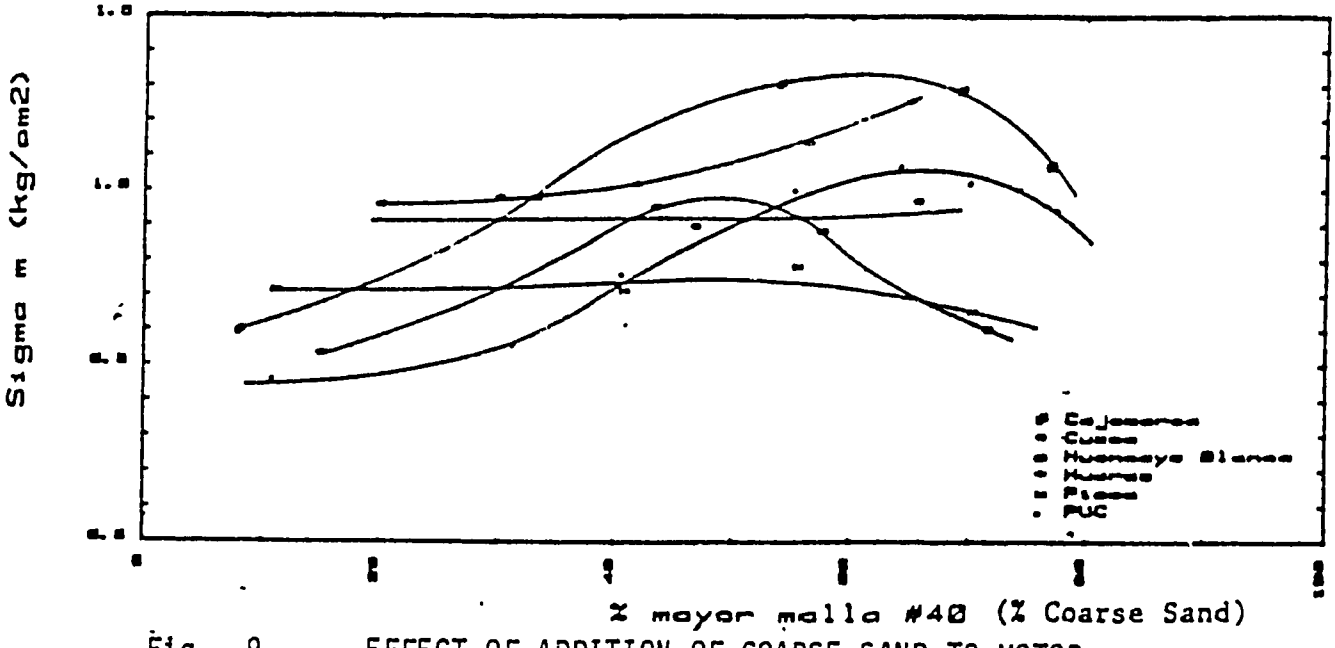


Fig. 9 EFFECT OF ADDITION OF COARSE SAND TO MOTOR

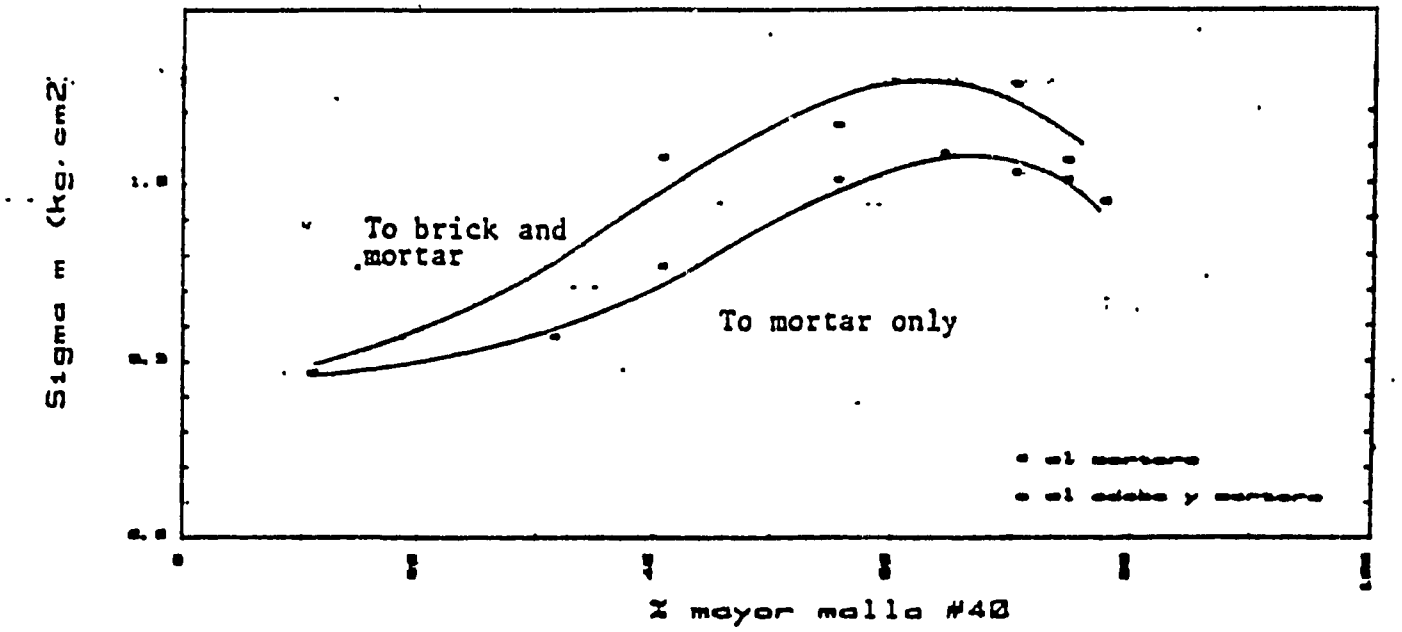


Fig. 10 EFFECT OF ADDITION OF COARSE SAND TO PUC SOIL

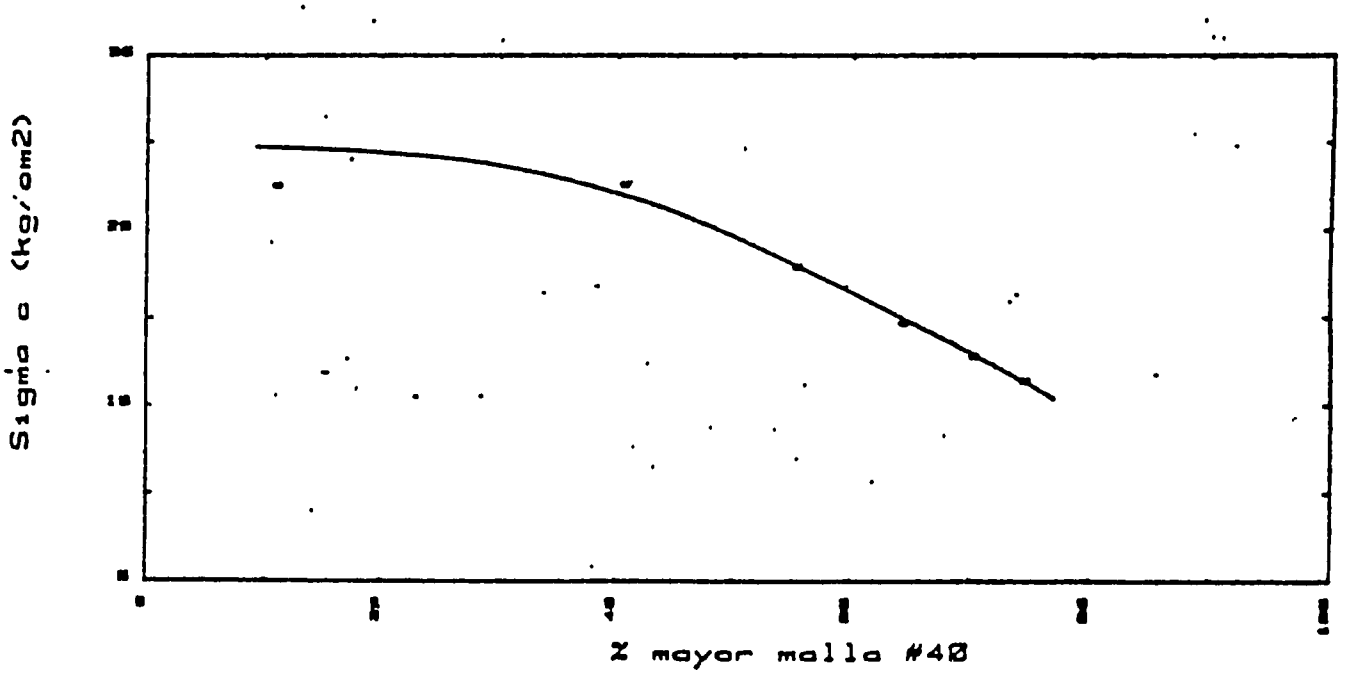
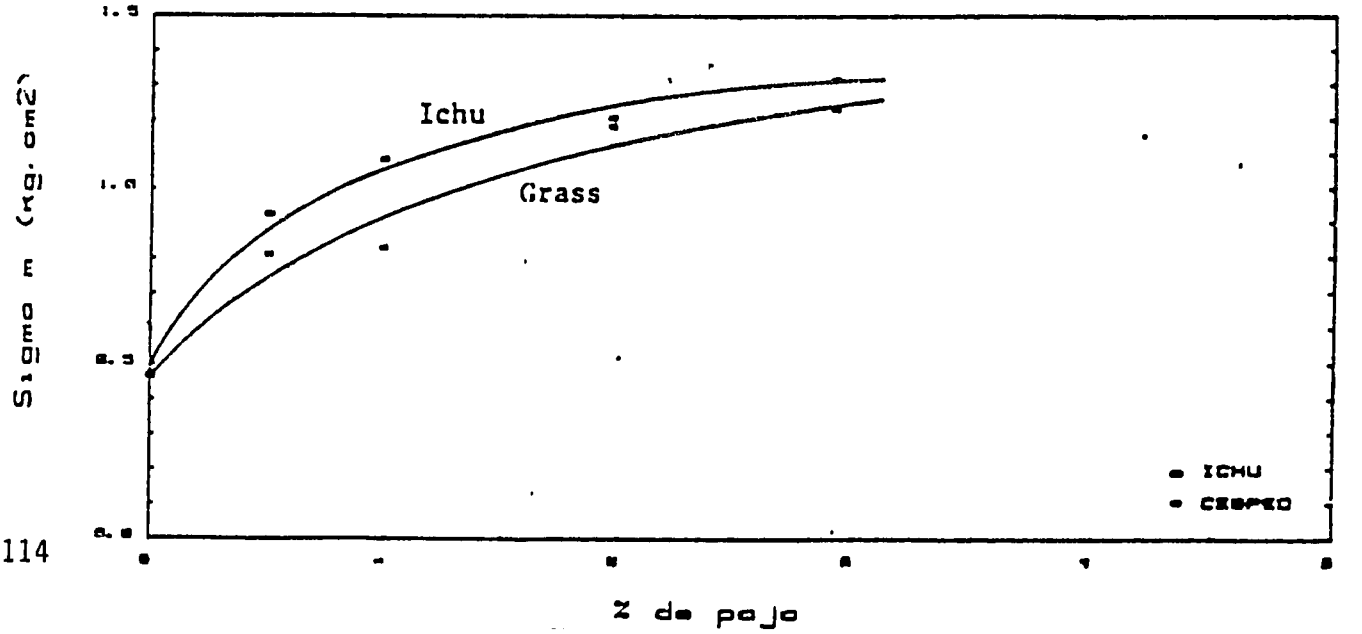
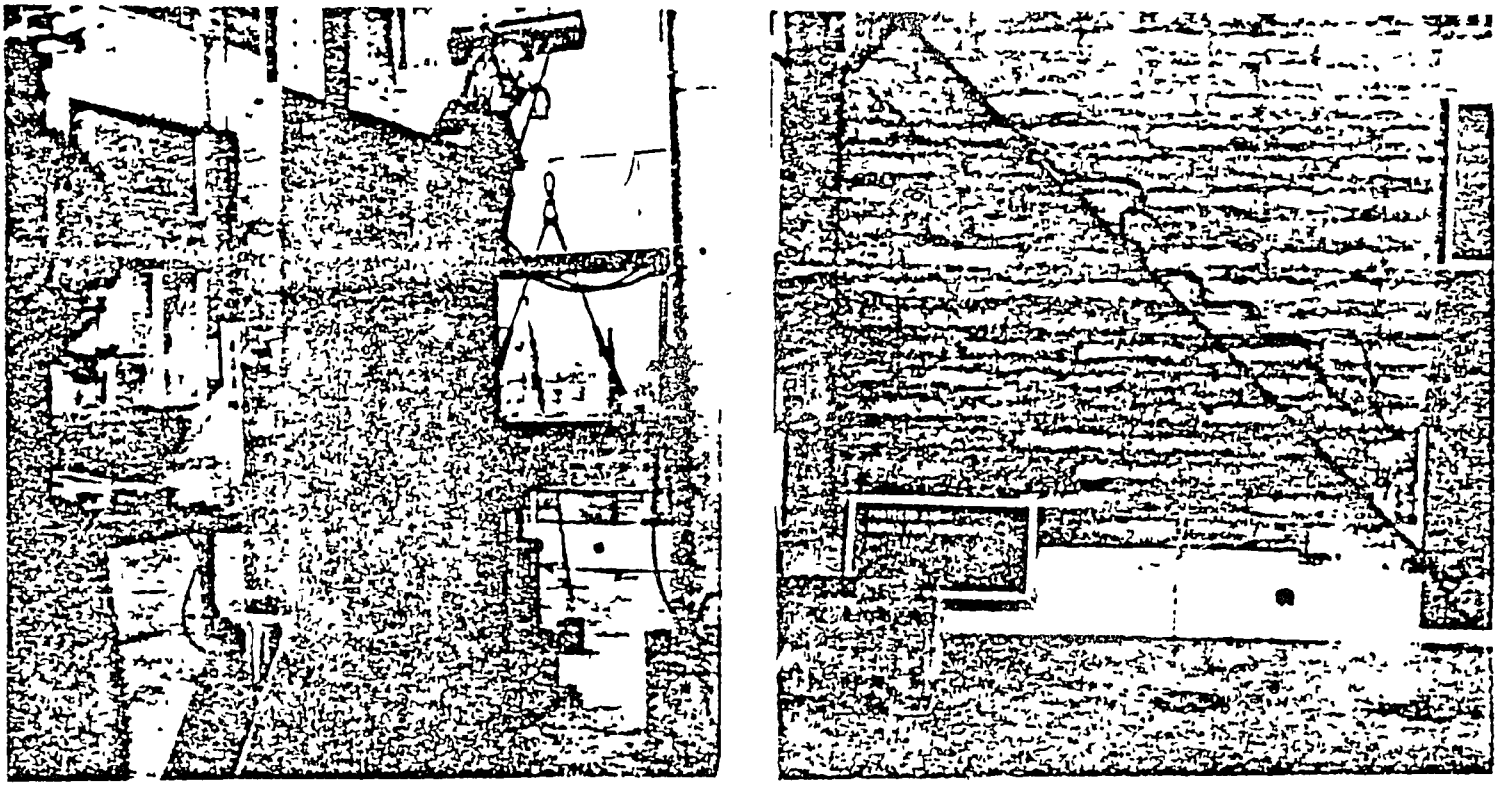


Fig. 11 EFFECT OF ADDITION OF COARSE SAND IN COMPRESSIVE STRENGTH OF BRICK





(a) (b)

FIG.13 SHEAR TESTS ON FULL SCALE WALLS

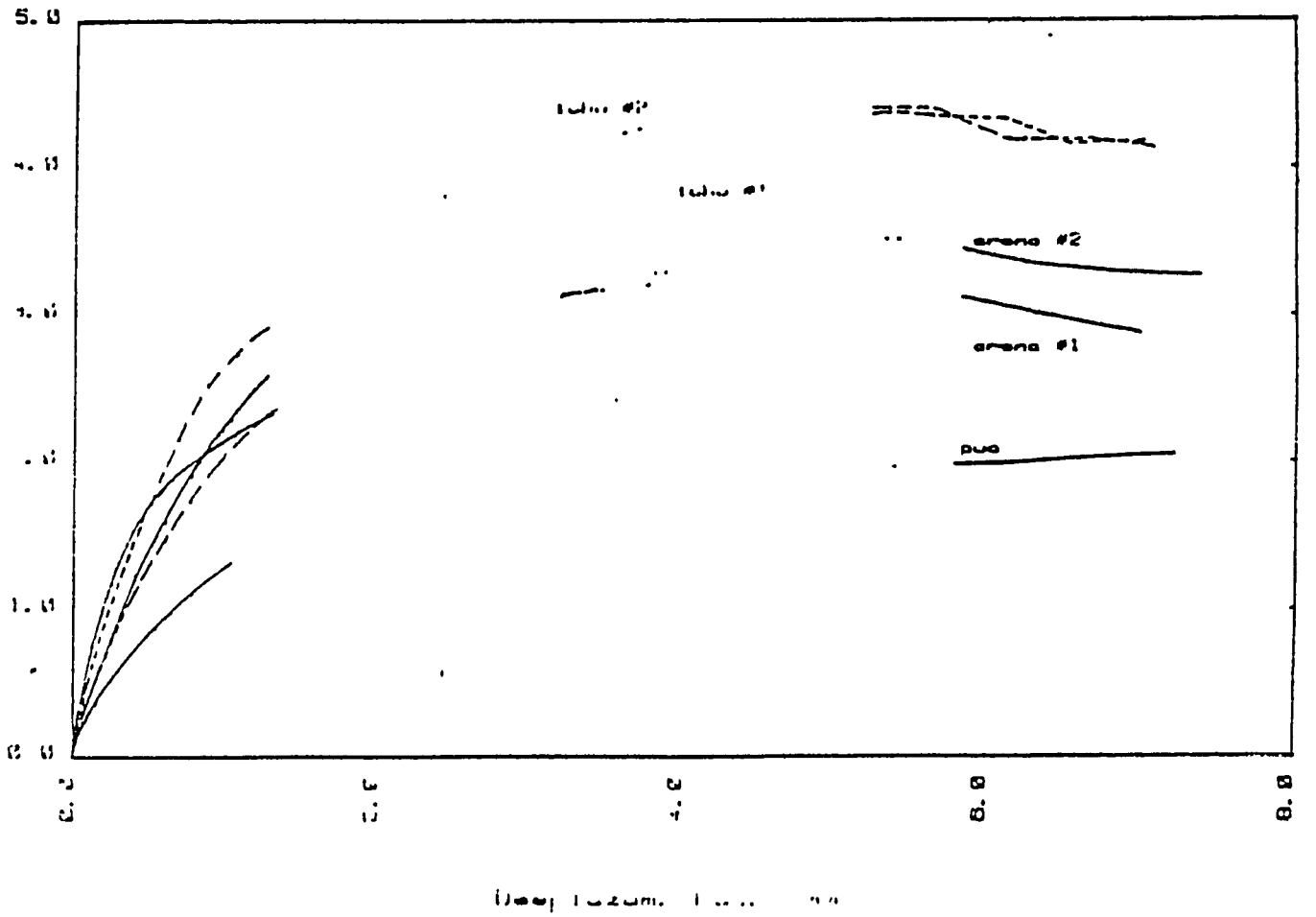


FIG.14 FULL SCALE WALL TEST RESULTS

International Newsletter

EARTHEN BUILDINGS IN SEISMIC AREAS

OCTOBER 1984

Editorial

On July 28, 1984, a meeting of Working Group members was held following the end of the 8WCEE. This meeting ran more than two hours over schedule because of the enthusiasm and interest of the attendees. Eleven countries of origin were represented and some of the 33 or more participants also represented projects in several other parts of the world. We also gained 23 new members during this week, some of whom were able to stay on for this Saturday meeting.

To us, perhaps the most important result of this opportunity to meet was seeing the growing awareness that research and implementation must build upon each other in order to be of real value in hazard mitigation. While this was the guiding principle for our original planning of the 1981 Workshop in Albuquerque, the gap between implementation and research was quite obvious at that time. With each successive meeting and each project undertaken, what is now obvious is that the gap has been narrowing over the past 3 years -- researchers, engineers, architects, planners, sociologists, staff of international and local organizations, training specialists, building craftsmen, housing program administrators, and representatives of the adobe industry here and abroad are active and concerned members of this Working Group, and we are beginning to see the fruits of the information exchange begun in Albuquerque, continued in Lima and supported through this newsletter.

As examples of the collaboration which the Albuquerque Workshop hoped to foster, the Indo-U.S. Joint Project on Improvement of Low-Strength Masonry Buildings in Seismic Areas resulted from discussions held during the 1981 Workshop between U.S. and Indian participants. The collaboration between Cambridge University, METU and ERI in Turkey grew out of conversations between Robin Spence and Mustafa Erdik in Albuquerque. The inclusion of Augusto Espinosa of Colombia, Gianfranco Ottazzi and Daniel Torrealva of Lima in the post-earthquake reconstruction and repair training project undertaken by INTERTECT and SENA in Popayán was made possible at least in part by contacts made and discussions held during the Regional Workshop held in Lima last year. Many information exchanges have taken place between individual participants to further their own particular involvements in this field and, as you can see from the growth of this newsletter during its brief life and of the Working Group membership, more and more interest is being shown from many perspectives.

With this issue, our newsletter funding ceases. However, participants in the July Working Group meeting voiced the unanimous opinion that this means of keeping in touch was of great value and should be continued. A later article describes more fully the discussions held on future directions for this network, but the editors of the newsletter want at this point to express their great appreciation to Appropriate Technology International (ATI) which has supported both the Albuquerque and Lima workshops (jointly with AID/OFDA and NSF) and the organization and publication of this newsletter. Their assistance has been invaluable in many ways, but most specifically in giving us this opportunity to firmly establish both the newsletter and network.

Working Group Meeting at 8WCEE

A meeting of members of the Working Group who were able to attend the 8th World Conference on Earthquake Engineering was held in San Francisco at the conclusion of the conference. The meeting was attended by over 30 members of the network and a full range of issues and ideas was discussed.

Fred Cuny of INTERTECT opened the meeting with a brief review of the history of the Working Group and the increased interest in this field since 1976. For the benefit of the many new members present, he also reviewed the goals of the Working Group, defined at the 1981 International Workshop in Albuquerque:

> to establish a network of individuals and organizations involved at all levels in the improvement of earthen and low-strength masonry construction in earthquake-prone areas, in order to continue to address the problems and needs defined during the Albuquerque Workshop;
>
> to establish a permanent center for the collection of information about earthen buildings in seismic areas;
>
> to establish a newsletter for members of the network in order to continue and expand the exchange and dissemination of information;
>
> to initiate a series of regional workshops, structured along the same lines as the Albuquerque Workshop, which would enable researchers and practitioners to address the agenda compiled in Albuquerque and to apply the information and techniques gained from this exchange to specific regional needs.

Announcements were made of several upcoming conferences and seminars including the proposed regional workshop on repair of damaged earthen and low-strength masonry buildings, planned for September 1985 in Ankara, Turkey. The workshop would be held under the auspices of the Working Group and hosted by the Earthquake Engineering Research Center/ Middle East Technical University and the General Directorate of Building Materials & Earthquake Research/Ministry of Public Works & Resettlement (Government of Turkey). In response to the suggestion (and general agreement) that all members of the Working Group should meet to identify our progress on the Albuquerque research agenda and to pull together the information gained in the regional workshops, an invitation was extended by Mr. Ye for the Working Group to hold a major conference on rural construction in China in 1987.

Several members outlined work in progress or planned in other areas:

Ing. Julio Vargas N. gave a slide presentation on the various testing programs underway at the Catholic University in Lima (see the June 1984 newsletter for descriptions of their projects).

Dr. Anand Arya (who is currently involved not only in the joint Indo-U.S. research project at the University of Roorkee but also in implementation of earthquake resistant reconstruction in Yemen) spoke of the importance of social considerations in recommending earthquake resistant construction techniques. In India approximately 50% of the people live in earthen housing, 35% in stone or masonry, 9% in wood, and only about 1% in concrete housing; thus the work being done by members of our Working Group is of great interest and concern, but the primary focus must be on how to use the information within the traditional social and cultural context.

Dr. Charles Scawthorn of Dames & Moore gave a brief description of the Joint Indo-US Project on Low-Strength Masonry in Seismic Areas, introducing other members who are participating in the project. Fred Webster showed slides on his testing of reinforcing for adobe, rammed earth, etc. Dr. Satwant Rihal of California Polytechnic State Univ. described his work on the use of non-structural elements (interior walls, partitions) for reinforcement, for example, as buttresses

to improve the strength of housing. In his portion of the project, Dr. Helmut Krawinkler of Stanford Univ. is looking at questions of transferability and assessing different experimental activities (underground explosions, shake table tests, shock table/rolling stock facility, etc.) to correlate with earthquake excitations; he is also exploring which materials and configurations can be tested statically or dynamically. Fred Cuny described the inventory of housing types being carried out by INTERTECT, giving a preliminary estimate of past seismic performance and recommendations for improvement. (The objectives of the joint project were described in the February 1984 newsletter.)

Ing. Daniel Torrealva D. of the Catholic University in Lima used slides and transparencies to describe the use of wire mesh screening for repair of damage to earthen buildings that were moderately damaged in Popayán, Colombia (project described in more detail in the February 1984 issue of the newsletter). A copy of one of the training aids used by SENA/Popayán, showing this technique, is attached to this newsletter.

Andrew Coburn of Cambridge Univ. described the work underway on earthquake vulnerability in eastern Turkey (more fully described in the June 1984 newsletter) where they are completing an inventory of the architectural detailing of buildings, documenting building types and recommending a "menu" of improvement techniques that can be adopted at different income levels. Richard Hughes of the International Disaster Institute spoke on his work using historical buildings as "field tests" in identifying climatic and animal factors causing deterioration and affecting building maintenance.

At the conclusion of the reports and announcements, the floor was opened to suggestions for future activities of our network. Among the ideas identified were:

STANDARD PROCEDURES FOR ANALYZING NON-ENGINEERED BUILDINGS

Andrew Coburn suggested that it was important to develop standard procedures for analyzing non-engineered adobe and other earthen buildings in developing countries. It was noted that several members of the organization have recently undertaken field investigations of the vulnerability of housing in seismic areas and, while the techniques used have been similar, there are some marked differences.

The group decided that a standard methodology for assessing these houses should be developed and Dr. Coburn was asked to develop a model methodology to circulate to members for their comments. Ing. Julio Vargas offered to assist with a Spanish translation.

EMERGENCY LIBRARY AND TECHNICAL ROSTER

It was suggested that useful existing materials should be compiled into a small library and that a roster of housing specialists, willing to go to a disaster to provide technical information about earthen buildings, be made available to AID/OFDA, UNDRO and other organizations active in earthquake response. It was decided that members of the Working Group should be asked to submit recommendations on the key publications for the reference library, that these could be compiled under the auspices of the University of New Mexico, and that the Working Group could enter into an agreement with funding agencies in a stand-by arrangement similar to that that which NSF has developed for rapid reconnaisance so that our members can respond to disaster needs. It was pointed out that essentially this is what happened after the Popayán earthquake and that the experience gained by the different members who participated in that project not only benefited the project but expanded their own understanding of implementation issues.

Persons who are interested in volunteering to work with the group should send their names and applicable experience to the newsletter editors, so that a list of personnel can be compiled. Also, anyone who has information they feel would be critical in the aftermath of a disaster should send copies to be reproduced and included in the emergency library.

EERI RECONNAISANCE

Several members discussed the EERI earthquake reconnaisance missions that are carried out with funding from the U.S. National Science Foundation. It was pointed out that the usual reconnaisance reports are focused primarily on engineered structures and that the teams need to be broadened to collect information about earthen buildings in seismic areas. It was decided that the Working Group should approach EERI and NSF about including our members on future reconnaisance missions. Fred Webster and Helmut Krawinkler offered to discuss this with EERI and to follow up on any other activities that can be coordinated with them.

APPROPRIATE TEACHING MATERIALS

Dr. Fred Krimgold raised the issue of developing a text on appropriate construction methods for earthen buildings in seismic areas for use by architectural and engineering students. It could be prepared along the lines of the EERI text book series and could be provided to architectural and engineering faculties at universities throughout the world, as well as to the University of Wisconsin Extension Disaster Management Center for use in the disaster management self-study courses currently under development.

It was felt that funds might be obtained to translate the book into local languages from the International Office of NSF, from AID/OFDA or from other groups. Several of the members said that they would be willing to participate in the translations once the English text is completed.

A group headed by Fred Krimgold was formed to develop a suggested table of contents and a proposal for funding the book. Persons who wish to participate in the development of the text or who have information they feel should be included should contact Fred Webster or Daniel Torrealva.

FILM ON EARTHQUAKE BEHAVIOR

Dr. Krimgold suggested that a brief film showing how earthen buildings can be strengthened against earthquakes be developed as a means of convincing government and private agencies that earthen and low-strength masonry houses can be strengthened and made relatively safe. It was suggested that the film might be built around the videotape of shake table tests being conducted at the Catholic University in Lima.

CATALOG OF TRADITIONAL RESPONSES AND IMPROVEMENTS TO HOUSING

Several members pointed out that people throughout the world have made interesting adaptations to earthquake threats in housing construction (e.g., roof designs, configurations, use of different types of materials in innovative ways, etc.). It was decided that some of these "popular" techniques might offer low-cost, socially acceptable options for housing improvement and should be explored and/or tested.

Members of the Working Group are asked to identify interesting or unique adaptations of housing to the earthquake threat and send photographs/drawings and descriptions of these features to the newsletter editors for cataloging and compilation into a booklet to be distributed to the membership. Following distribution we would ask for information about these or similar adaptations and for reports on their seismic performance. Any which seem to have particular promise can then be selected for testing.

Both Ramesh Manandhar of Nepal and Richard Hughes of IDI/U.K. have done some work in this field and have offered to help compile the booklet.

COMPARATIVE TESTING

Dr. Helmut Krawinkler pointed out that one of the critical needs (defined clearly in the Albuquerque Workshop research agenda) is to standardize testing procedures and develop baseline data that can be used by all those currently carrying out static or dynamic tests. He offered to help draw up preliminary guidelines, with assistance from Ing. Vargas and Dr. Arya, and to circulate the draft for comments from members currently involved in structural testing.

DISASTER PREPAREDNESS ACTIVITIES

Dr. Scawthorn proposed that one of the major efforts of the Working Group now and in the future should be to work with various governmental agencies and international organizations to keep them updated on the current state-of-the-art for modification and repair/reconstruction of earthen buildings. He suggested that the Working Group develop a "white paper" describing the risk from earthquakes, the mechanics of failure, and methods of improving the performance of these structures. It was also suggested that the Working Group might obtain funds to develop an audio-visual presentation which could be used to conduct a series of briefings for housing personnel in different countries on the current state-of-the-art. The presentation could depict the latest in earthen and low-strength masonry improvement techniques, standard program methodologies, and techniques for teaching untrained and semi-literate builders and tradesmen how to construct or repair buildings to improve their earthquake resistance. Working Group members from a particular region or country could then work with local agencies or governments, using the "white paper" and/or audio-visual presentation to make disaster preparedness and housing officials aware of opportunities for mitigating future disasters during reconstruction programs.

Dr. Scawthorn offered to develop an outline for the content of the presentation and has asked that members of the Working Group contact him with any information or materials (films, slides, etc.) they feel would be useful. Any information contributed will be kept permanently on file in our network library at the University of New Mexico.

INCLUSION IN EERI ANNUAL MEETINGS

Several members noted the need to make the U.S. engineering community more conversant with earthen building issues. It was suggested that sessions on earthen buildings in seismic areas be scheduled at EERI annual meetings and that presentations be made in each of the main sessions on this topic.

EMPOWERMENT OF PEOPLE TO ADAPT THEIR HOMES TO SEISMIC ENVIRONMENTS

Ramesh Manandhar proposed that the network give more attention to exploring some of the social, economic and political constraints to poor people improving their homes prior to and reconstructing safely after earthquakes. He pointed out that technical assistance by foreign experts is often an obstacle rather than an aid in housing modification. He suggested that that there are many different ways that people can be empowered to make the improvements that are necessary and that more information needs to be gathered and exchanged on ways that social, economic and political action can accompany physical improvements to buildings.

Members of the network are invited to submit articles or other information about social, economic and cultural aspects of technical assistance for inclusion in the newsletter.

IAEE REVISIONS

It was noted that a revised version of the IAEE manual on guidelines for earthquake resistant non-engineered construction is being prepared. Dr. Roberto Meli is working on revisions to the section on repair/strengthening, and Ing. Vargas on the codes section. If anyone has new information that should be included in the revisions, they should contact Dr. Anand Arya. In addition, the Coordinating Committee of the Working Group was asked to review the library collection to determine whether there are new materials that would be of interest to the revision committee. Dr. Augusto Espinoso of Colombia suggested that it was important that information about the wire mesh repair process used in Popayán be sent to the revision committee as soon as the testing of the process, proposed by the Catholic University in Lima, is complete.

[A separate article follows on the discussions held concerning the future of this networking effort and publication of this newsletter.]

Future Directions for Working Group and Newsletter

At the July 28th meeting, it was announced that funding for the publication of this newsletter would cease after the third issue and that the Coordinating Committee would like to explore with members options for continuing its publication, if indeed it had proven to be valuable in the opinion of those members present. In this context, we wished as well to look at future directions for the Working Group as a network.

Some discussion was held regarding the possibility of affiliating with another group or organization; however, it was decided that the Working Group would prefer to remain basically autonomous in order to retain our somewhat unique focus on all facets of the topic. We agreed to continue as we are currently constituted -- as a formal ad hoc group, if there is such a thing -- and to seek to influence other organizations from this perspective.

We also agreed to attempt to schedule Working Group meetings whenever a conference or workshop is being held which would be of general interest to our membership, in other words, to take advantage of opportunities where many of our members might be present in any case (for example, world conferences on earthquake engineering). Together with the regional conferences we have held or propose to hold, we hope this may provide adequate opportunities for many of the members to get together on a fairly regular basis. The value of meeting face-to-face to discuss problems and sift through new information and approaches was very definitely confirmed.

It was also pointed out that the efforts of the Coordinating Committee to help members obtain funding where appropriate were much appreciated and that we should continue that effort. It was suggested that members with specific research or implementation ideas might send these to the committee and request assistance in locating sources of funds for projects.

In regard to continued publication of this newsletter, we discussed the possibility of obtaining institutional funding, and this avenue will be explored by the Coordinating Committee. However, funding proposals take a great deal of time, and the need for funding is immediate if we are to continue the momentum of the Working Group.

We agreed that members would be willing to pay a subscription fee which would help defray the costs of publication and mailing. However, exchange problems and limited funds make it difficult for members in many developing countries to pay the full price, and we do not wish to limit our membership on the basis of affordability.

Thus it was decided to charge a sliding scale of rates: $5 per year for members from the developing countries; $25 per year for members from the industrialized countries, and $40 per year for institutional subscriptions. A minimum of three issues and maximum of four will be published each year.

A questionnaire will be mailed out in October which will allow us to evaluate the effectiveness of the newsletter and will request ideas/suggestions from our members to increase our responsiveness to information needs via the newsletter. With this questionnaire we will send a subscription form and request that it be returned to us as soon as possible. We will assume that those who do not respond no longer wish to receive copies of the newsletter.

Working Group Membership

At the request of many members, we are attaching to this issue of the newsletter a current list of Working Group member organizations and individuals. We hope it will assist all of you in maintaining files and personal contacts.

If there are any additions or corrections to be made to this list, please send the complete information to the editors.

Notes on the 8WCEE

Once every four years, the International Association for Earthquake Engineering sponsors a conference for earthquake specialists from around the world to share the latest research, ideas and information about this field. The July 1984 meeting was hosted by the Earthquake Engineering Research Institute in San Francisco, and was the largest conference yet in terms of attendence; almost 2,000 people attended, representing at least 54 countries. Dr. Frank Press, President of the U.S. National Academy of Sciences, opened the meeting with comments on the roles of scientists, engineers and governments in hazard mitigation. He proposed the implementation of an International Decade for Natural Hazard Reduction by the earthquake engineering community, an idea which was later enthusiastically endorsed by the IAEE Executive Committee and the Assembly of National Delegates.

Exhibits of instrumentation and technical literature were set up by a number of companies, and special poster sessions were held during the first three days, giving participants an opportunity to see visual displays of projects or design concepts and to speak with the display authors. Special tours were planned to the Earthquake Engineering Research Center at the University of California/Berkeley; Stanford's John A. Blume Earthquake Engineering Laboratory; the U.S. Geological Survey Office of Earthquakes, Volcanoes and Engineering; and the San Andreas and Hayward Faults.

The technical sessions gave presenters just enough time for brief summaries of their papers and allowed for only a few questions. Thus the real value of the conference lay in the opportunities for individual contact and information exchange in-between sessions, at meals and in the evenings, when the lobby of the Fairmont was crowded with hundreds of attendees discussing their work and ideas for future collaboration or exchange. Most of the information presented in the sessions focused on the use of reinforced concrete and on urban situations. The proceedings of the conference include approximately 850 papers in 7 volumes, under the following topics: Seismic Risk and Hazard; Repair, Strengthening and Retrofit of Structures; Development and Enforcement of Seismic Codes and Standards; Ground Motion and Seismicity; Soil Stability, Soil Structure Interaction, and Foundations; Response of Structures; Analysis of Structures; Design of Structures and Structural Components; Non-Structural Systems and Building Contents; Experimental Methods and Tests of Structures and Components; Special Structures and Critical Facilities; Lifelines: Utility, Telecommunication, and Transportation Systems; Urban Design, Socioeconomic Issues and Public Policy.

We do not have space here to report on all the presentations, but we would like to mention several that were particularly useful. The first was by Dr. E.L. Quarantelli of the Disaster Research Center at Ohio State University (soon to move to the University of Delaware), entitled "The Preparations of Citizen Groups for Earthquakes: The Atypical Nature of Such Groups and the Conditions for Their Emergence". Dr. Quarantelli dealt with the reasons why local citizen groups do not emerge naturally in response to the threat of earthquakes and the implications of this fact for earthquake preparedness planning. He discussed the problems of organizing citizen groups around disaster preparedness issues prior to a disaster and pointed out the many difficulties that are encountered in keeping such groups in operation. Since implementation of the work being carried out by members of this Working Group often involves the participation of local citizen groups of this type, it is important that some of the obstacles and limitations to community organization be recognized; the study done by Dr. Quarantelli and the Disaster Research Center provides a good starting point for understanding some of these problems.

A presentation by R.K. Yin entitled "The Utilization of Natural Hazards Research" (by R.K. Yin and G.B. Moore of the COSMOS Corporation, Washington, D.C.) explored how and why ideas developed in research are utilized in policy and practice. He discussed some of the practical ways whereby researchers can improve the

chances that research results will be utilized, the differences between natural science and social science research, and the importance of communication between investigators and users. Further information about their study may be obtained from the authors at the COSMOS Corporation 1730 K Street N.W., Suite 1302, Washington, D.C., 20006, USA.

A third paper of particular interest was entitled "Vulnerability and Seismic Risk Reduction for Rural Housing in Turkey" by A. Coburn, J. Kubin, and R.J.S. Spence, presented by Andrew Coburn. Their study has focused on the consistently high damage levels for earthquakes in predominantly rural eastern Turkey which are due to the extreme weakness of the typical random-rubble stone and adobe masonry buildings found throughout the region. The paper includes a suggested method for assessing the economic cost and benefit of housing modification strategies.

In addition, a very useful paper entitled "A Methodology for Surveying Earthquake Damaged Vernacular Buildings" was presented by Richard Hughes, Research Fellow at the International Disaster Institute.

In terms of earthen housing issues, the 8WCEE did not include many presentations of specific relevance to our work. The focus was clearly on engineered reinforced concrete and steel construction and on sophisticated testing techniques, when in fact the majority of lives lost in earthquakes worldwide result from failure of earthen and low-strength masonry buildings. The responsibility lies with us to bring to the attention of the earthquake mitigation community the fact that only a small amount of time and money is devoted to resolution of the problems faced by low-income residents of earthquake-prone regions and that ways must be developed to use and expand the existing knowledge to help these most vulnerable people protect themselves and their property.

In conclusion, we would like to share with you some general impressions voiced by two Working Group members who attended both the 8th World Conference and the Working Group meeting on Saturday. In an excerpt from a longer report, Fred Webster comments: "What struck me most about the 8WCEE, even before it began, was the fact that here were to be some 1600 engineers, scientists, and specialists in earthquake engineering and related fields from all over the world...and yet only one session was to include papers on low-strength masonry in seismic areas. In fact, less than one percent of all the papers addressed this issue.... As it turned out, a parallel, more informal "world conference" on earthen buildings in seismic zones was taking place on the sidelines. There were meetings with the people from the US-India project, discussions with adobe researchers from Peru and other countries, 8WCEE attendees visiting the John Blume Earthquake Center at Stanford University and discussing (among other things) an earthen wall racking test program and a scale model shake table test program at the Center, viewings of the videotape replays of full-scale shake table tests on unreinforced and cane-reinforced adobe block structures in Peru, and a meeting with international network people on Saturday after the conference to discuss future activities of the network and newsletter....This meeting, as reported elsewhere in this newsletter, gave me the impression that interest and enthusiasm in the subject of earthen buildings in seismic areas is alive and well all over the world, although not much appreciated by the vast majority of 'high-tech' engineers and researchers...."

Ramesh Manandhar also passed on a report to us, including these comments: "This is a strange world. I am supposed to be in a world conference and I have been hearing for the last 4 days about earthquake engineering from various international experts but their application is most unlikely for 3/4 of the world's population. How can we call this, then, a world conference if we blind ourselves to the needs of this majority of the people who become victims of earthquake?...It is my contention that if we are to reach these 3 billion people or more, then we must learn how these people have been coping with earthquakes....People can build earthquake resistant houses...."

Micro-computers and Database Management Systems

[Several members of the Working Group have suggested that we look at the potential for standardizing micro-computer hardware and software to improve communication and information access. Roy Tolles of Stanford University offered to write the following article on his own experience with personal computers and the available software. We would like to hear from other members about the type of equipment they use, why it was selected, and what software they have found that will accomplish the stated tasks.]

The purpose of this article is to recommend a micro-computer system and a database management system for transferring information between members of the Working Group. Given the present state of the micro-computer market, I feel that IBM micro-computers or IBM-compatibles are the dominant product on the market today and should be the system of choice. I must admit to being biased by the fact that I own an IBM-PC, but there are many reasons why I purchased the system. The IBM-PC and IBM-XT are very well-supported by both hardware and software. The IBM-XT is essentially an improved version of the IBM-PC whose only major difference is the inclusion of a 10-megabyte hard disk. Both of these systems are good, solid products that have proved themselves since the PC's introduction in 1980.

For those people who want more speed and capacity than the PC or XT offers, IBM has recently released their new AT computer. By using a more powerful microprocessor, the AT works at two-to-three times the speed of the XT and has a 20-megabyte hard disk. The basic AT system lists for about $5,600 which is about $1,500 more than the XT. Without going into details, the AT can use almost any software that the PC and XT can and at higher speeds. Also, the AT will be a much more powerful system once IBM comes out with their version of UNIX, called XENIX, which is due for release in January 1985. The only real limitation of which I am aware is that floppy disks written by the 1.2 mb floppy disk drive that comes with the AT may have problems being read by PCs and XTs. This problem can be avoided by purchasing a second floppy disk drive that is identical to the 360-kilobyte drives used in the PC and XT.

Numerous other companies have developed IBM-compatibles which are typically lower in price than the original IBM-PC. None of the IBM-compatibles are exact duplicates of the IBM products; thus there is a risk that a "compatible" system will not be able to use all software used by the IBM products. The buyer of an IBM-compatible system should be careful to get an independent opinion on the degree of compatibility between that system and the IBM-PC.

The second purpose of this article is to identify a database management system that could be commonly used by members of the Working Group. There are tens or perhaps hundreds of database programs on the market today, making it virtually impossible for me to evaluate and compare all the programs available. The three primary purposes of the data management system are library management, statistical analysis of building information and, finally, storage of experimental test data. In addition, it is important that the program be easy to use and that the data is stored in a compact form for transfer on floppy disks.

Two major software packages on the market are Dbase II or Dbase III by Ashton Tate and 1-2-3 or Symphony by Lotus Development Company. Dbase III is an improved version of the database management system Dbase II, and Symphony is an improved version of 1-2-3, a spreadsheet program, which also includes a word processor, communications and database manager in addition to the spreadsheet. These two packages have major limitations for the purposes stated above. Lotus 1-2-3 and Symphony both are very limited in terms of the size of the database on which they can operate. Generally, Symphony is complex and difficult to use but has great power for the tasks for which it was designed.

Dbase II and Dbase III are database managers that were created primarily for

the organization and calculation of numeric data. As a result, their use for library management is a difficult and tedious process. The internal editor is cumbersome and difficult to use for general text. Creating a report using the data from a given database requires learning the programming language supplied with Dbase. Although this language is very straight forward, it is an additional task which must be learned before Dbase II can be effectively used.

I examined several other major database systems each having their own limitations. A couple of these systems had no glaring deficiencies, except for a general level of complexity. The price of these systems ranges between $400 and $1,000.

In speaking to the head of a local IBM-PC Users' Group, I was introduced to a program called Notebook. This program is inexpensive -- $150 for the present version, versus approximately $600 for Symphony or Dbase III. Notebook is extremely easy to use and the manual is clearly written; I learned how to use the system in 2 or 3 hours as opposed to the 2 or 3 days which it took me to learn Dbase II. The other advantages to this program are: 1) the internal editor is very good and the commands are similar to those used in the popular word processor Wordstar; 2) the report output formatting is extremely easy to use; and 3) it can be used to receive input from or output to other database systems, e.g., Symphony or Dbase. Its primary limitation is that the program is set up for the organization of text information and thus has no ability to do internal mathematical calculations. It is easy to determine the number of records with one or more characteristics but you are unable to do calculations on these values for output. Nevertheless, numeric information could be output without much difficulty to a file for use by Dbase II, Lotus 1-2-3 or another program. For example, it is easy to output the information from the database which could then be read into a Fortran program for further analysis.

Another advantage to Notebook over many database systems including Dbase II is that the size of each record is allocated dynamically, which means that the size of each record is determined by the amount of data in each record. In Dbase II, the size of each record is determined when the database is initially defined, making the size of a record constant no matter how much data is in the record. A database created with Dbase II is filled with a tremendous number of blanks, which is especially critical when the space on floppy diskettes is so precious.

For large amounts of experimental data, it is probably more appropriate to store the information in the more compact binary format as opposed to the ASCII format used by these database systems. I would be very happy to supply a Fortran callable subroutine which can be used to store experimental data in binary format. When the amount of experimental data is smaller, it may well be easier to use the database management system through which the data can be easily examined.

In conclusion, Notebook is extremely easy to use, very inexpensive, and allows for the relatively easy transfer of data to other programs. It is not the most powerful database program on the market but does provide the flexibility to accomplish the three purposes stated above. The company which sells the program is listed below, although I do not recommend purchasing it until the new version is released about November 1st of this year. The present version is priced at $150; I have not been able to get an exact price for the new version except that the price will be the same or very close to it.

Digital Marketing
2363 Boulevard Circle
Walnut Creek, California 94595, USA.
Tel: (800) 826-2222.

Erratum

In the June 1984 issue, we published a review of Paul McHenry's Adobe and Rammed Earth Buildings: Design and Construction. However, there was a decimal error in some figures, shocking several readers. The sentence should read: "...(at 32-47 cents per brick, a typical adobe house in the Western US uses between $1,920 and $2,820 for brick alone)...". Many apologies.

Calendar of Meetings

September 10-14, 1984: 3rd Latin American Conference on Earthquake Engineering, Guayaquil, Ecuador; hosted by the Escuela Superior Politécnica del Litoral in collaboration with the Organization of American States. For information contact:

Prof. Ottón Lara, Coordinador
Apartado 5863
Escuela Superior Politécnica del Litoral
Guayaquil, Ecuador

September 27-30, 1984: International Seminar on Vulnerability to Earthquakes and Methods of Risk Reduction, Noto, Sicily, Italy. Sponsored by the Dept. of Processes & Methods for Building Protection/University of Florence, the Institute of Topography and Rural Buildings/University of Catania, the Institute of Architecture & Urban Planning and Institute of Science of Construction/University of Catania. Topics to be covered include: Study of the Seismic Hazard on Large and Small Territorial Scale; Methods for Assessment of Vulnerability to Earthquakes; Seismic Rehabilitation and Upgrading; Seismic Design Criteria, Codes and Standards; Civil Protection, Preparedness and Contingency Planning for Earthquake Disasters. For information contact:

Corrado Latina, ing.
Departimento di Processi e Metodi
della Produzione Edilizia
Università degli Studi di Firenze
Via Cavour 82
50129 Firenze, Italy

October 8-11, 1984: Natural Hazards Mitigation Research and Practice: Small Buildings and Community Development, CIB/W-73 international conference, New Delhi, India. For more information contact:

Chairman, CIB/W-73 International Conf.
Building Research Council, University of
Illinois at Urbana-Champaign
One East Saint Mary's Road
Champaign, Illinois 61820, USA.

November 5-10, 1984: International Conference on Low Cost Housing for Developing Countries, Roorkee, India, organized by the Central Building Research Institute (CBRI), Roorkee. For more information, contact:

T.N. Gupta
Secretary, Housing Conference
Central Building Research Institute
Roorkee, U.P., India
Telephone: 2608

November 12-16, 1984: International Conference on Disaster Mitigation Program Implementation, Ocho Rios, Jamaica, organized by the Center for Development Studies, Virginia Polytechnic Institute & State University, and hosted by the Office of Disaster Preparedness & Emergency Relief Coordination, Government of Jamaica. The objectives of the conference are to collect material, share experience and produce a document which will provide practical models for the development, promotion and implementation of disaster mitigation programs. For information, contact:

Dr. Frederick Krimgold
Associate Dean for Research & Extension
College of Architecture & Urban Studies
Virginia Polytechnic Inst. & State Univ.
Washington - Alexandria Center
101 North Columbus Street
Alexandria, Virginia 22314, USA
Telephone (703) 548-0099

November 19-23, 1984: 4th Venezuelan Congress on Seismology and Earthquake Engineering, Barquisimeto, Venezuela. For information contact:

Ing. Eduardo Chollet, Coordinator
COICA
Apartado 781
Barquisimeto 3001, Venezuela

December 10-12, 1984: International Colloquium on "Earth Construction Technologies Appropriate to Developing Countries", Palais d'Egmont-Egmontpalais, Brussels, Belgium. See article in this newsletter for further details on content.

February 7-9, 1985: EERI Annual Meeting and Seminar, Seattle, Washington. For information contact:

Bruce Olsen
1411 Fourth Avenue, Suite 1420
Seattle, Washington 98101, USA
Tel: (206) 624-7045

February 17-20, 1985: 7th International Brick Masonry Conference, Melbourne, Australia. For information contact:

7th International Brick Masonry
Conference Secretary
396 Clarendon Street, South Melbourne
Victoria 3205, Australia.

March 29-31, 1985: Earth Systems Expo '85, New Mexico State Fairgrounds, Albuquerque, NM. For information contact:

Earth Systems Development Institute
P.O. Box 1217
Corrales, New Mexico 87048, USA
Tel: (505) 897-2196

International Colloquium: Earth Construction Technologies

During the Habitat - U.N. Conference on Human Settlements, emphasis was placed on the necessity to develop and promote building materials and techniques suitable to local conditions through the production of audio-visual material, documentation and discussion with the aim of stimulating the creativity and self-development of inhabitants and local communities. Earth was among the materials highlighted by Habitat because of its extensive use both past and present.

In 1982, the Belgian Ministry of Development Cooperation provided financial support to the UNCHS, which commissioned the Post-Graduate Centre for Human Settlements in co-operation with the Centre de Recherches en Architecture to undertake a research project entitled "Earth Construction Technologies Appropriate to Developing Countries", with the main objective to clearly situate the potentialities of earth as a building material in a continuously evolving world and to promote its use wherever desirable. The project's main outputs are:

1. A series of case studies analyzing the use of earth as a building material in various countries.

2. A synthesis of all case studies resulting in a comprehensive analysis and evaluation.

3. Guidelines for policymakers including the scope, advantages and requirements of earth construction.

4. A "primer on earth construction" describing building material characteristics, production and construction methods, design aspects, etc.

5. A set of audio-visual materials.

The international colloquium will disseminate the results of the project and will focus on working sessions to identify the priorities for future actions related to the potentialities of earth as a building material within the framework of its obstacles and constraints.

Themes of the working sessions are: institutional aspects; economic and technical aspects; social and cultural aspects.

Participation (approximately 60 professionals) is restricted to those actively involved in the development and use of earth as a building material in developing countries, with a limited number of observers invited as well. There is no registration fee. Early brochures listed the tentative date as November 1984, so please note the change in final dates.

For information, contact:

AGCD - ABOS
Place du Champ de Mars, 5
Boite 57
c/o Mr. Liebaert, Bureau 1925
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Information Request

In recent months a number of housing specialists working with adobe housing in developing countries have requested information regarding capillary action in adobe walls. The literature regarding ways to prevent water from rising up from the ground through the walls is only minimal. Two methods that have been suggested are placing one or two layers of asphalt-stabilized adobe between the foundation and the normal adobes or placing a sheet of plastic between the adobes. While the first method appears to be satisfactory and some test information is available from Peru, the use of plastic at the base of the building may induce shear at that point.

Readers having information about water action in adobe walls and methods of preventing it are requested to send the information to the newsletter editors so that it can be abstracted for future editions.

CINVA-Ram Reassessment

In the 1950s, the CINVA Institute in Bogotá, Colombia, developed a block machine known as the CINVA-Ram to produce rammed soil-cement blocks for housing construction. Over the years, the CINVA-Ram has been promoted widely, not only in Latin America but throughout many earthquake-prone regions in other parts of the world. In some areas, earthquake reconstruction programs have organized teams to produce large numbers of CINVA-Ram blocks for housing reconstruction. (For example, a major use of the CINVA-Ram took place in the town of Sanarate in Guatemala in 1976 where 800 houses were produced using a battery of 22 CINVA-Rams which were in production around the clock for several months.)

The basic CINVA-Ram block is produced by adding cement to a natural soil mixture which is slightly moistened before being pressed into a block.

During the recent 8th World Conference on Earthquake Engineering, a number of housing specialists reported problems with the block occurring several years after houses have been erected. Most reports concerned the problem of rapid deterioration of the blocks from the inside out. Several observers reported that after five years the blocks appear to "be flaky on the outside". Another problem mentioned was deterioration due to uneven curing. There were no reported failures of CINVA-Ram walls under earthquake conditions; however, since several major institutions (including Habitat, USAID and many private organizations) have utilized CINVA-Ram machines extensively in housing in earthquake areas, further information on the performance of CINVA-Ram walls may be a concern that needs to be further investigated.

Readers are requested to send any information about the performance of CINVA-Ram blocks to the newsletter editors for abstracting and distribution in future issues of the newsletter.

NEW ADOBE INSTITUTE

We have been informed of the creation of the Adobe Institute in Puebla, Mexico. For information regarding the Institute and its projects, please contact the Universidad Popular Autonoma del Estado de Puebla, 21 Sur No. 1103, Codigo Postal 72000, Puebla, Pue., Mexico.

INTERNATIONAL NEWSLETTER: EARTHEN BUILDINGS IN SEISMIC AREAS

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"COMO REPARAR UNA CASA DE ADOBE"

Rather than publishing a paper in this issue, we have decided to attach a copy of a typical training aid, developed for use in a community housing repair and reconstruction program.

The Popayán project was described in the February 1984 newsletter, and mention has been made in this issue of the wire mesh repair technique tried during that project. This training booklet shows how to use the screening for repair of an adobe house. The booklet is used in conjunction with classes and "hands on" training conducted by SENA for building craftsmen and homeowners.

SERVICIO NACIONAL DE APRENDIZAJE "SENA"
PROGRAMA DE RECONSTRUCCION

MANUAL ELABORADO POR: "INTERTECT": ESPECIALISTAS INTERNACIONALES EN RECONSTRUCCION

JAMES VIETS: Dibujante

CON LA COLABORACION DE: "SERVICIO NACIONAL DE APRENDIZAJE "SENA" REGIONAL CAUCA

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Dr. LUIS ENRIQUE MARTINEZ - Asesor Técnico

Sr. GERARDO OVIDIO AGREDO - Dibujante

Sr. GERARDO PIANDA TASCON - Dibujante

Sta. ANA MARIA CHAVEZ CHAUX - Mecanógrafa

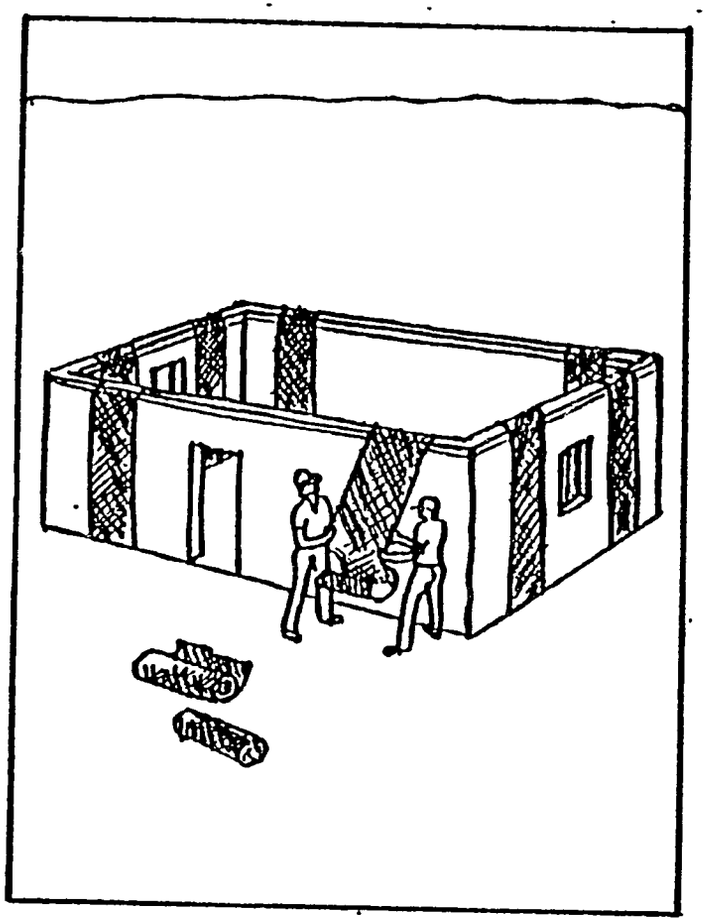
Sta. CIELO PATRICIA GARCES - Auxiliar

OTROS COLABORADORES: Instructores de Construcción y Participación Social

Popayán, septiembre 1983

Este Manual ha sido financiado en parte por la Agencia Internacional de Desarrollo E.E.U.U.

COMO REPARAR UNA CASA DE ADOBE

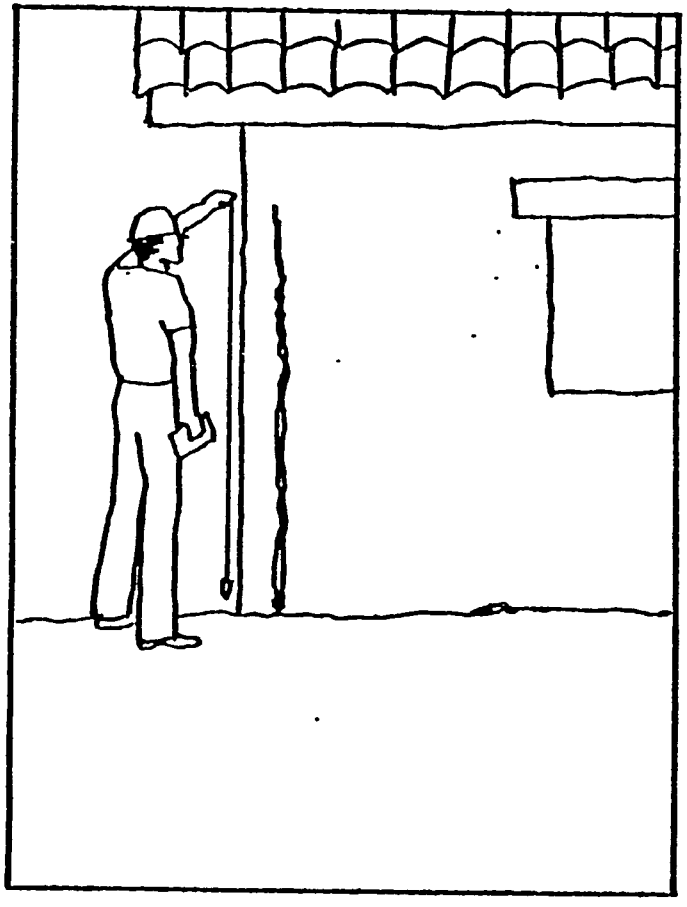


SENA

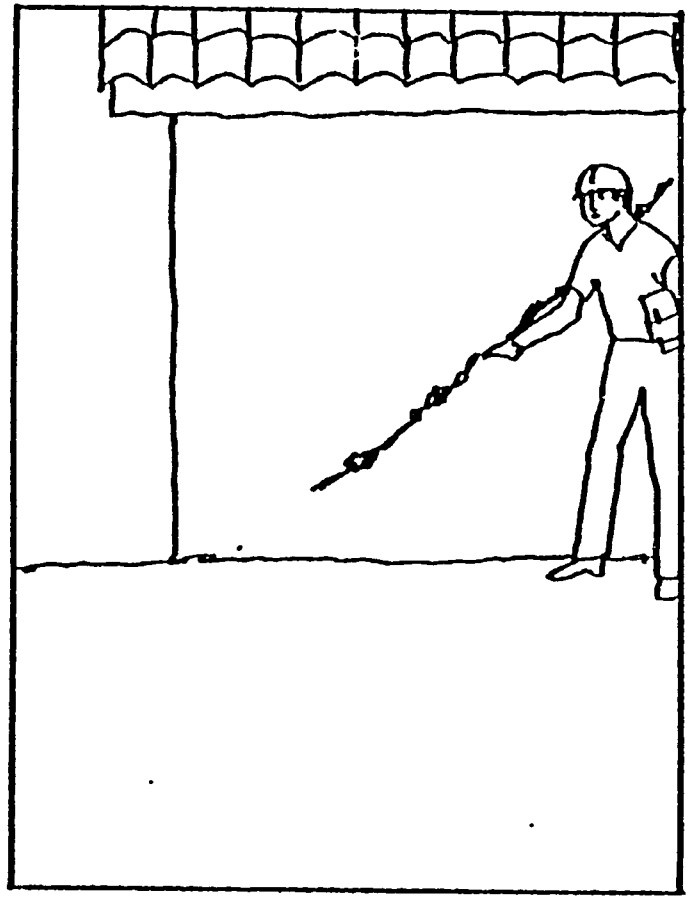
Programa de Reconstrucción

REGLAS PARA REPARAR UNA CASA

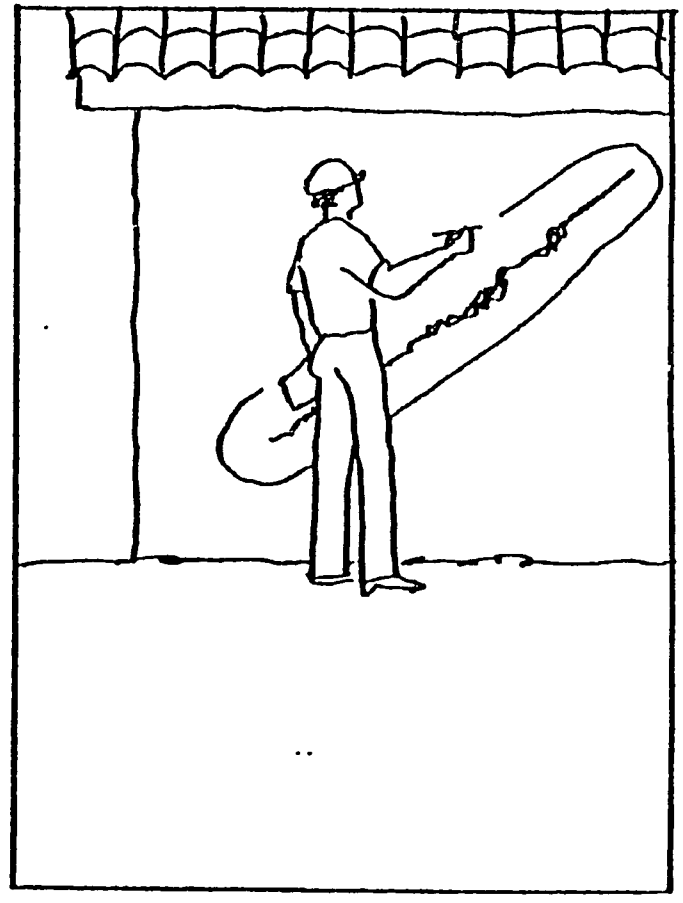
1. DESARME DE ARRIBA HACIA ABAJO
2. REPARE DE ABAJO HACIA ARRIBA
3. SIEMPRE QUITE EL TECHO SI NO HAY VIGA DE AMARRE
4. SIEMPRE AÑADA UNA VIGA DE AMARRE EN LA PARTE SUPERIOR
5. SI LA PARED ESTA DAÑADA MAS DE UN 25%, RECONSTRUYA LA PARED ENTERA.
6. GUARDE LOS MATERIALES QUE PUEDAN SER REUTILIZADOS



INSPECCIONE LA CASA

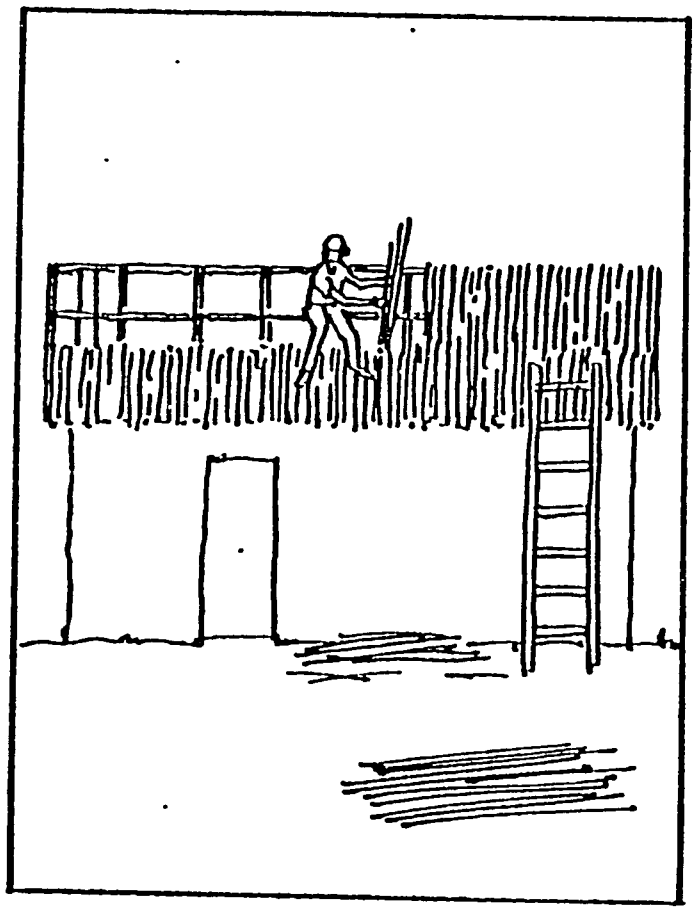


IDENTIFIQUE LA FALLA



MARQUE EL AREA A SER RECONSTRUIDA

BAJE LAS TEJAS



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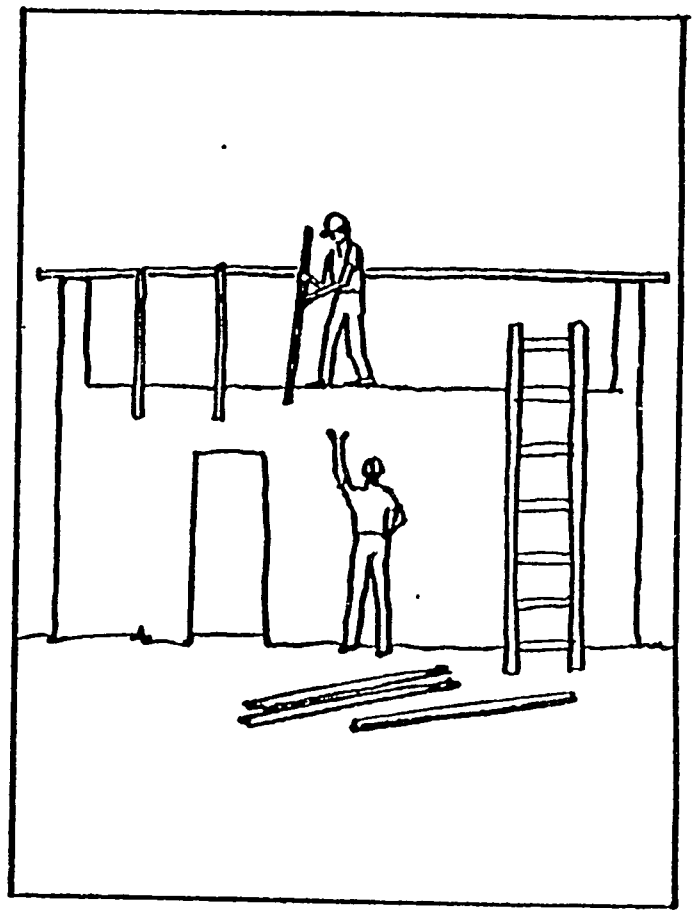
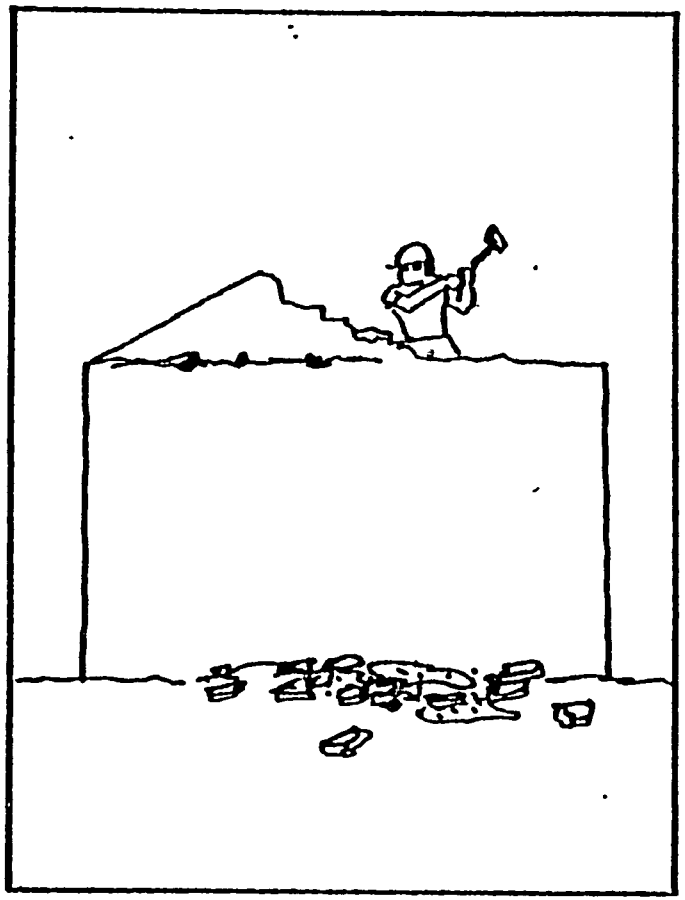
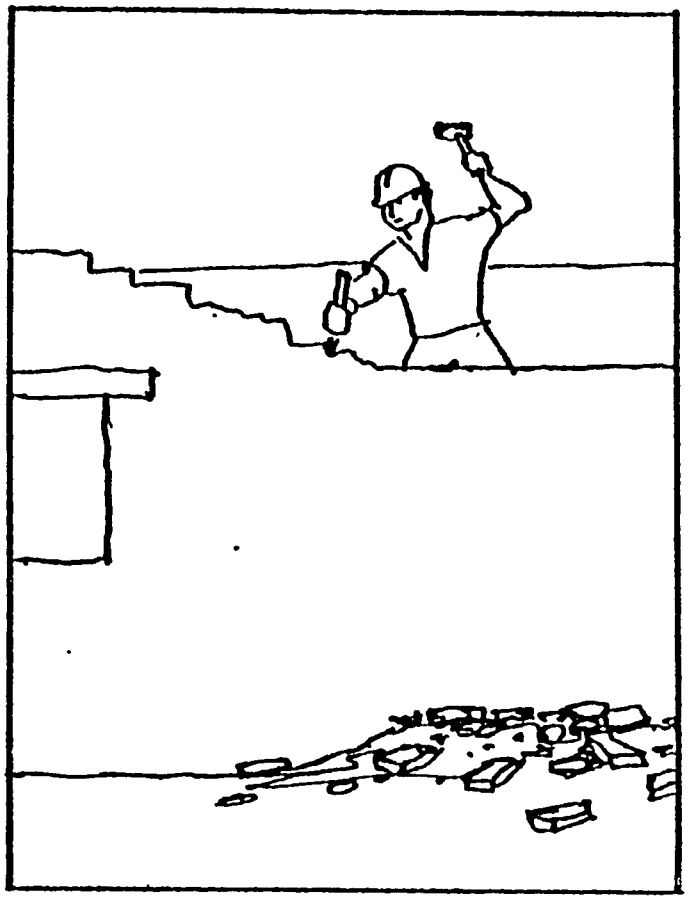


QUITE LAS MADERAS

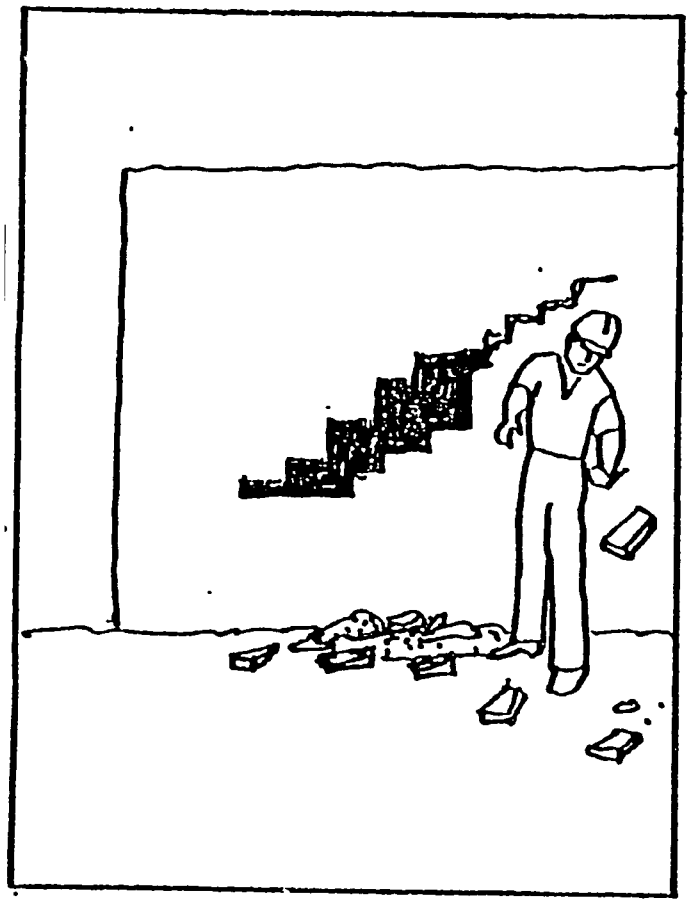
148



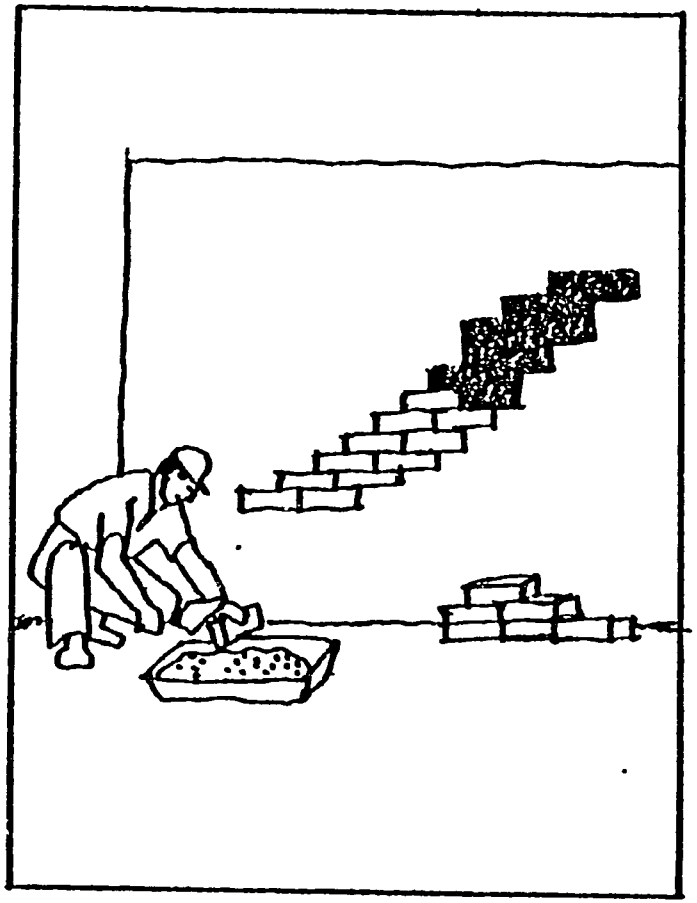
TUMBE LA CULATA



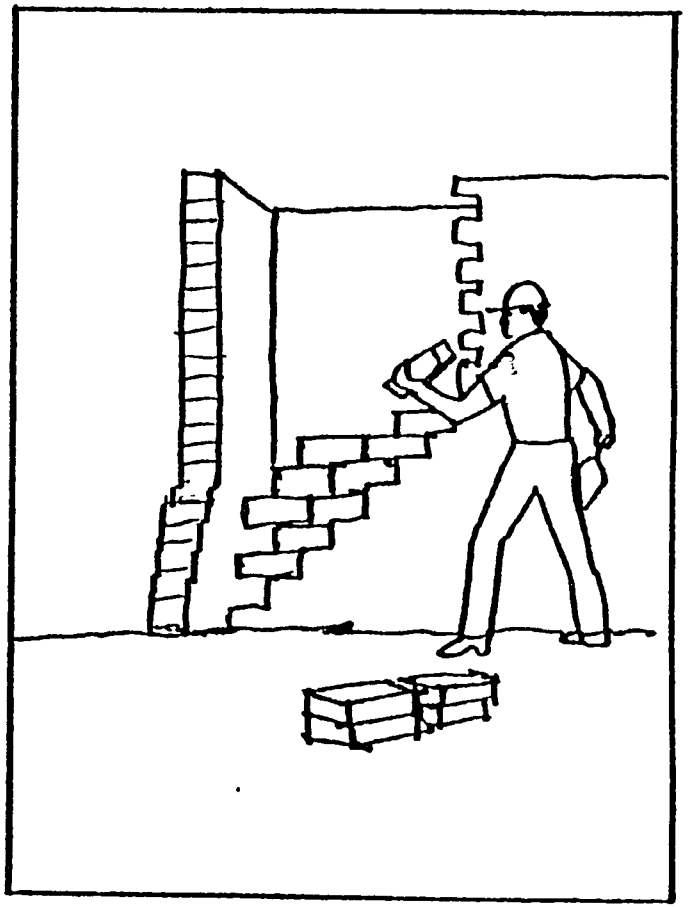
REDUZCA LA ALTURA DE LOS MUROS



RETIRE LOS ADOBES DEL AREA MARCADA

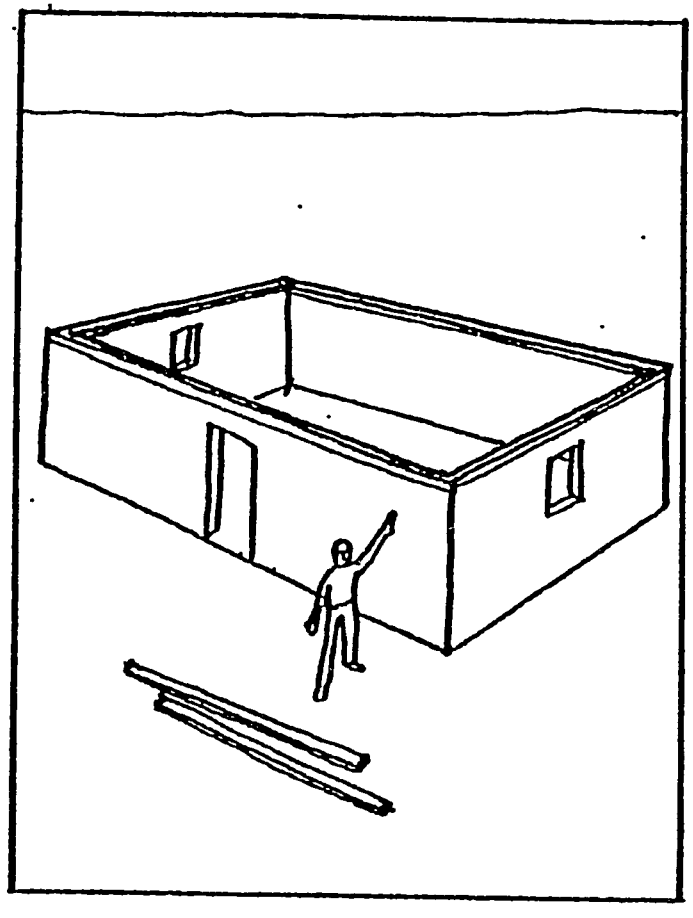


RECONSTRUYA LA PARED

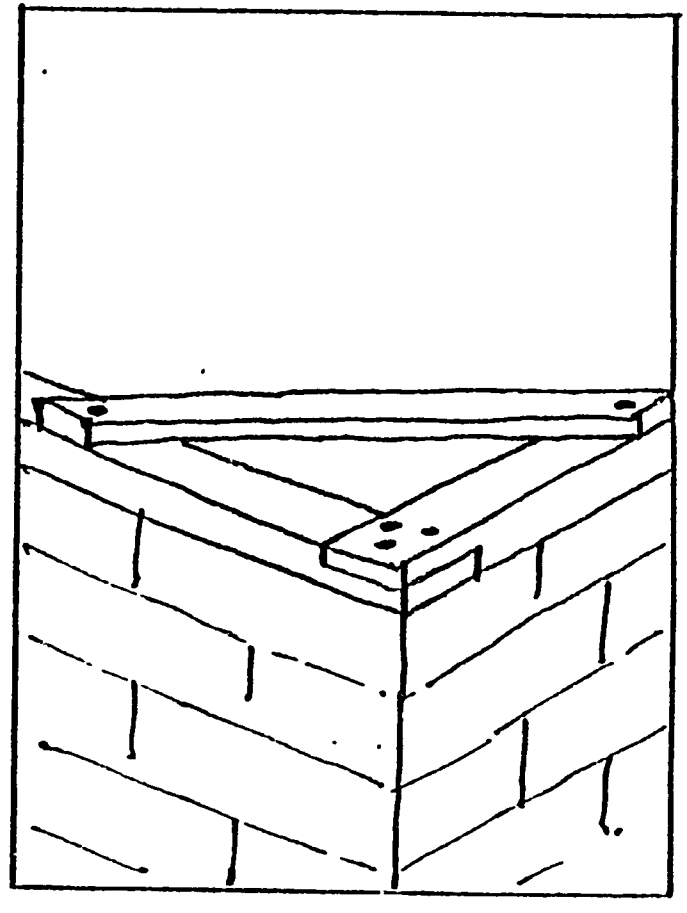


RECONSTRUYA LA PARED

PREPARE MADERA PARA SOLERA CON EMPALME A MEDIA MADERA

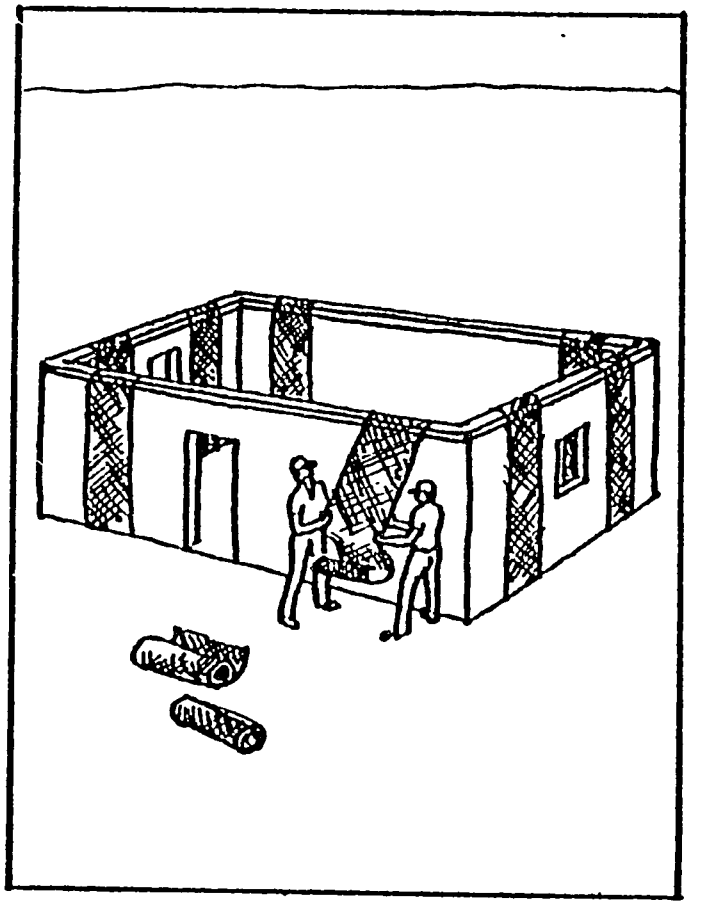


COLOQUE SOLERA SOBRE EL MURO



COLOQUE Y ASEGURE RIOSTRAS EN LAS ESQUINAS

ALISTE Y CORTE MALLA



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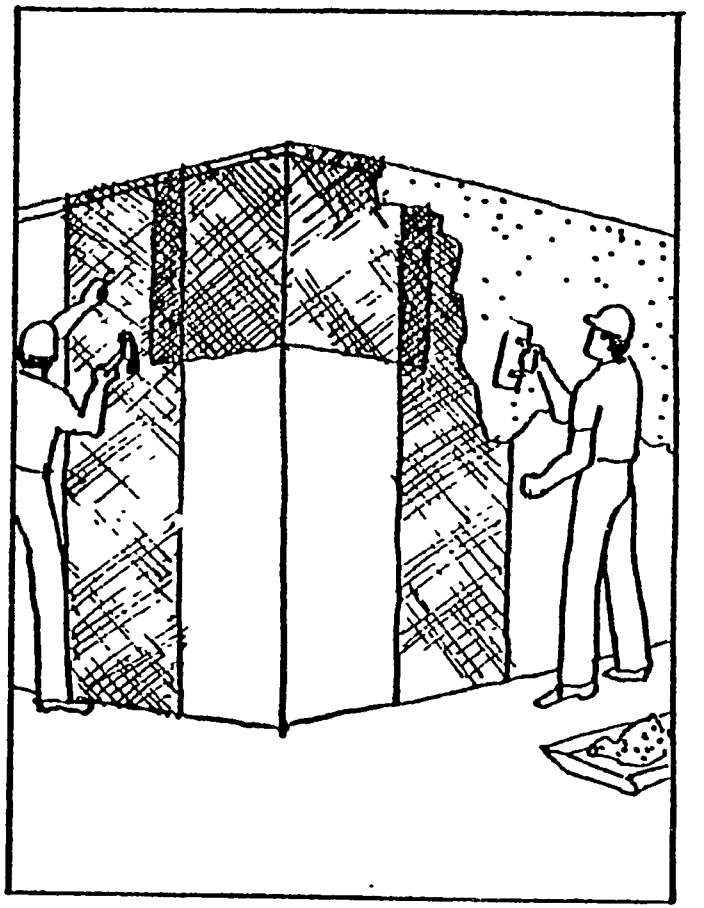
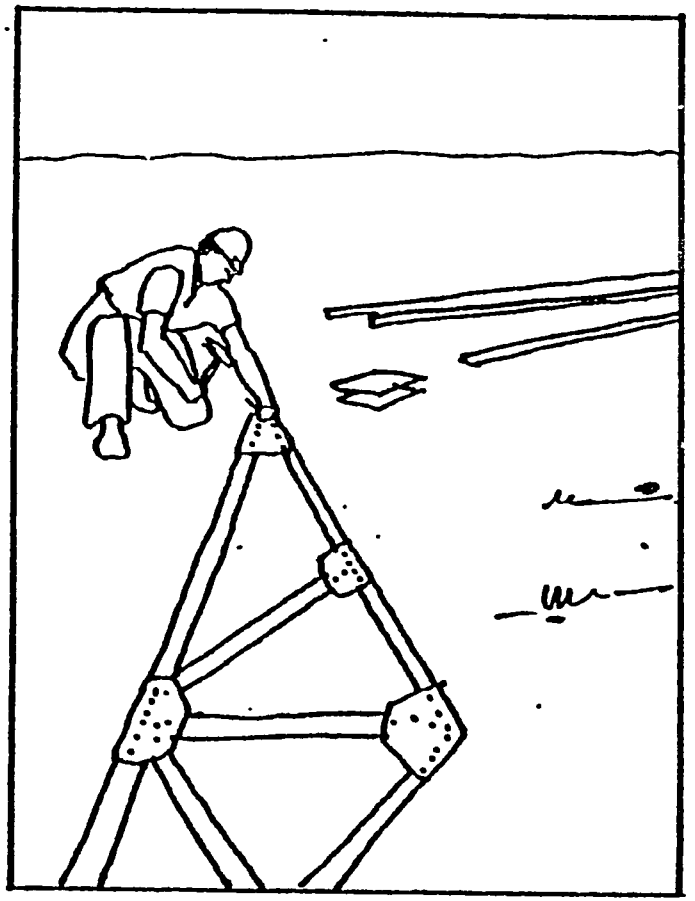
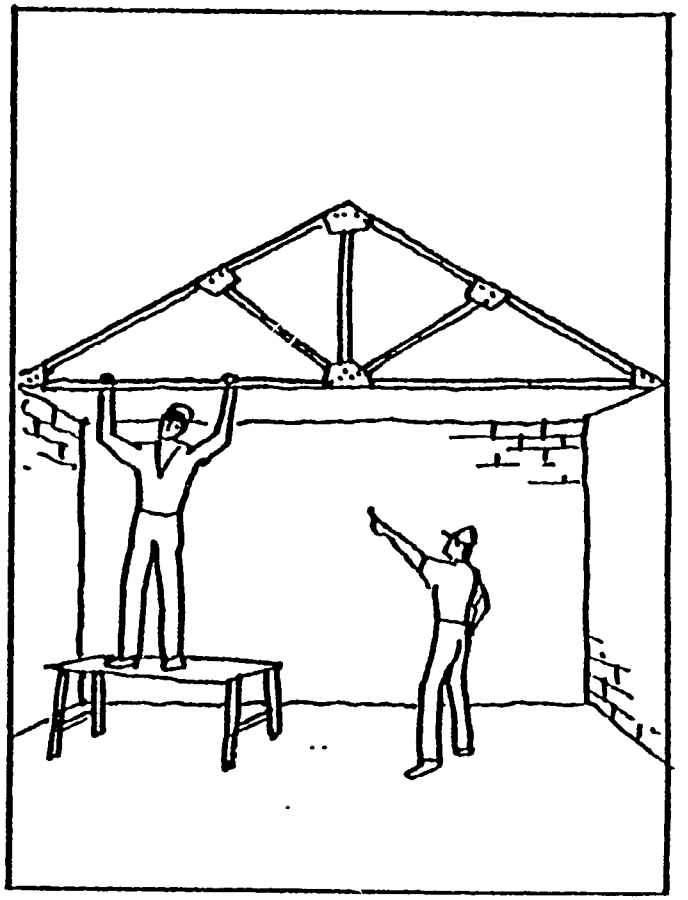


ASEGURE LA MALLA AL MURO CON GRAPAS O CLAVOS Y REPELLE.

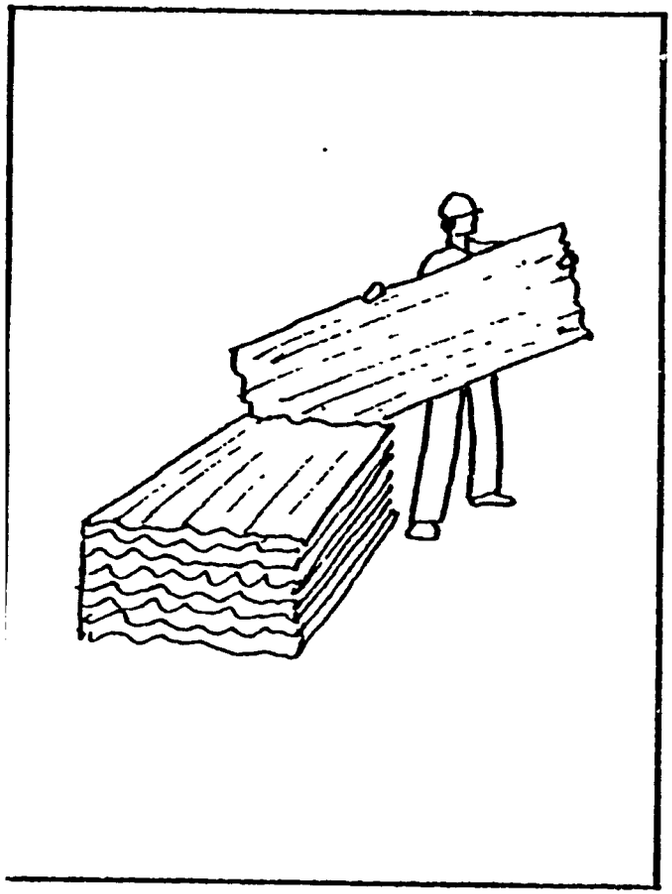
PREPARE MADERA



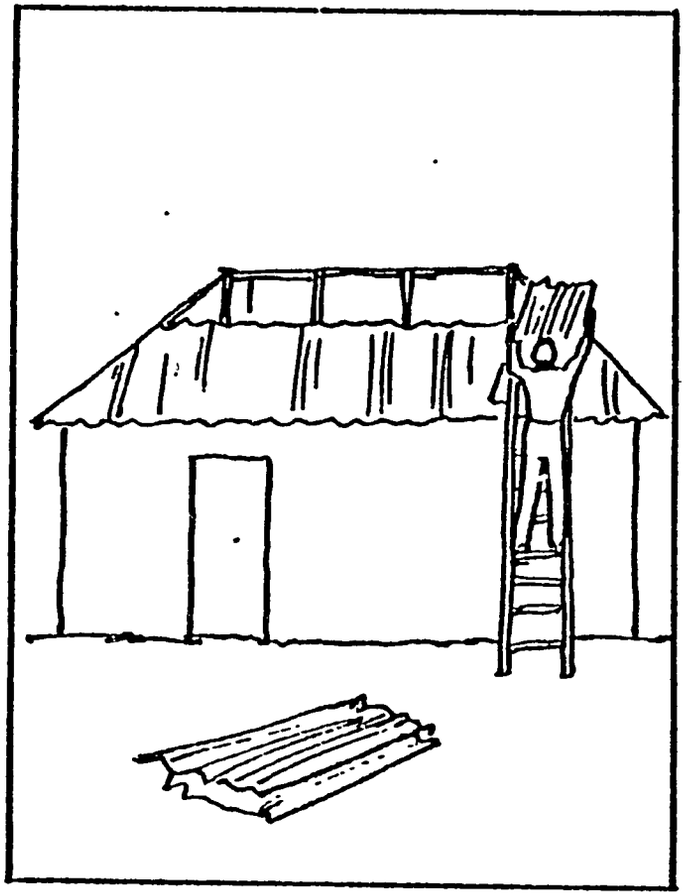
ARME CERCHA



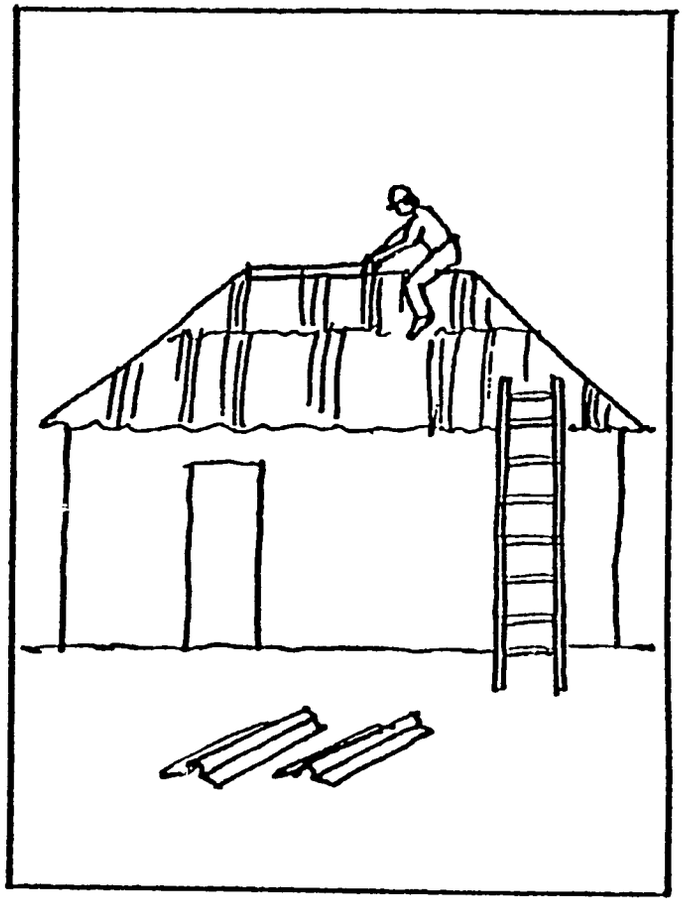
COLOQUE CERCHA



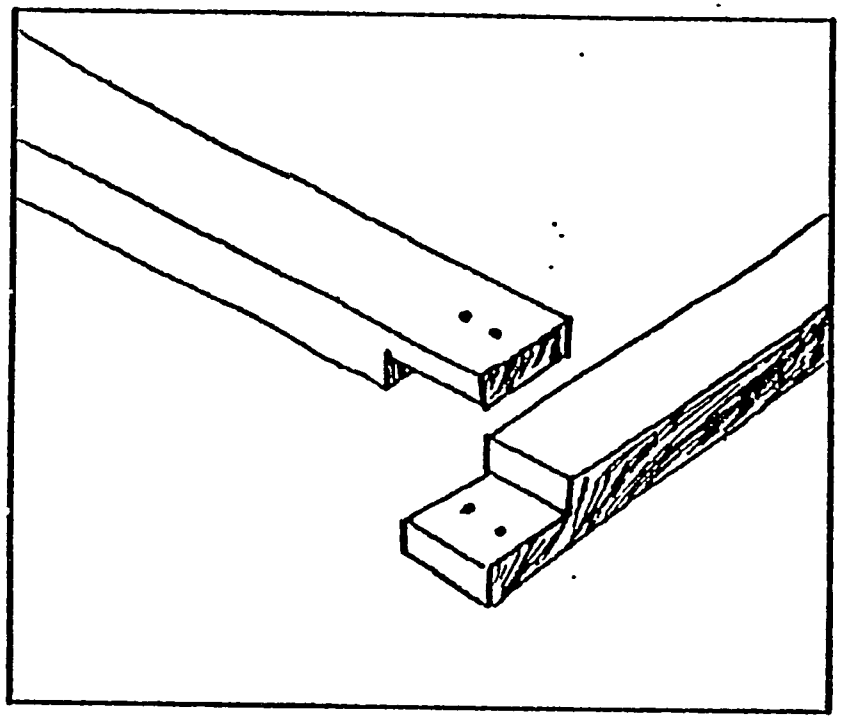
ALISTE TEJA LIVIANA



COLOQUE TEJA DE ABAJO HACIA ABAJO



COLOQUE CABALLETES



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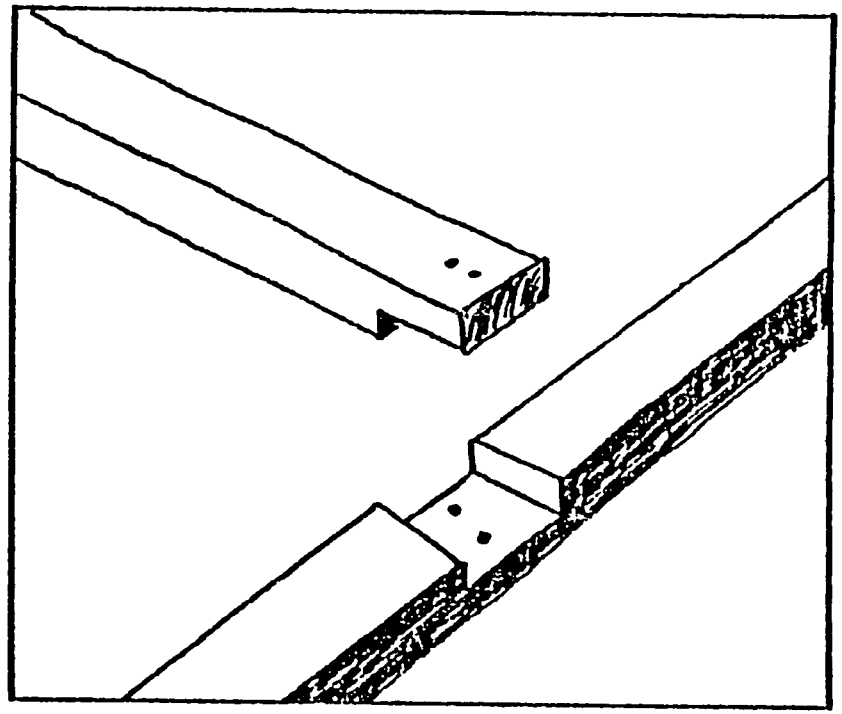

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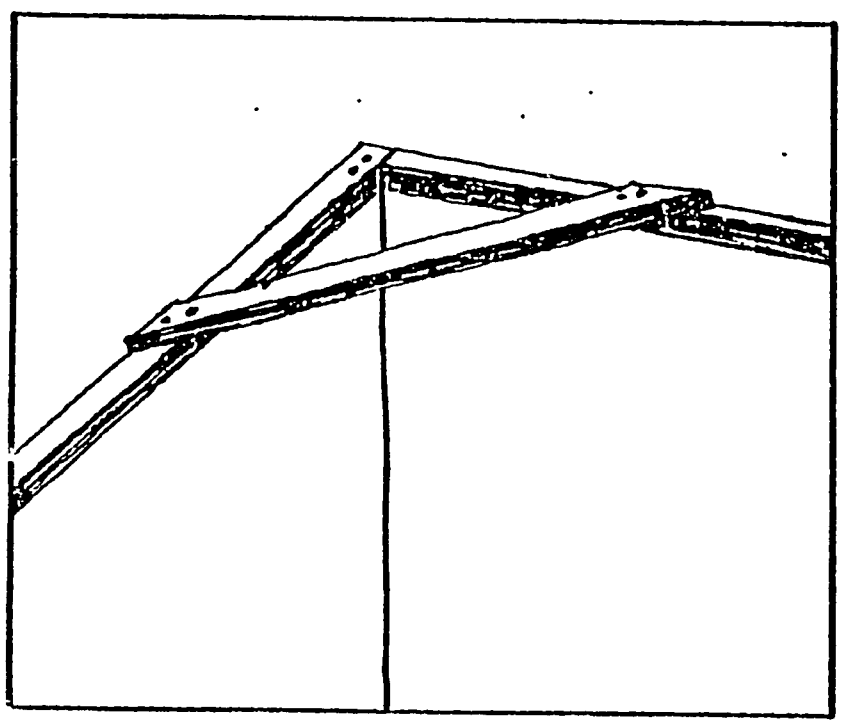
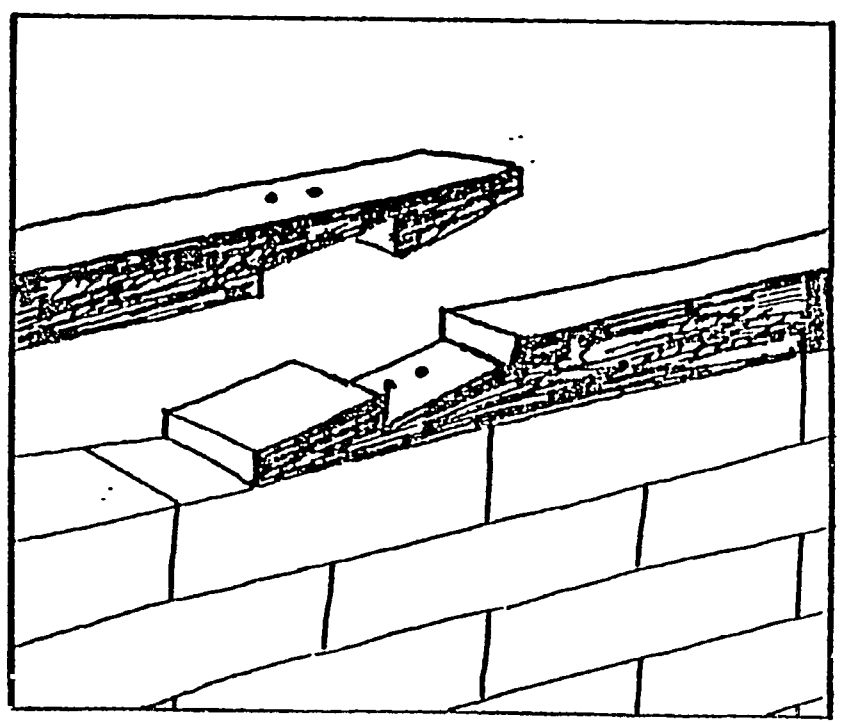


Riostra de soleras en esquina



Conexión de soleras

International Newsletter:

EARTHEN BUILDINGS IN SEISMIC AREAS

June 1985

Editorial

With this issue, we begin a second year of newsletter publication. We appreciate those of you who took the time to fill out the evaluation questionnaire concerning the newsletter and the Albuquerque and Lima conferences, and we now have an extensive list of suggestions, critiques, etc., to guide us regarding what you feel is most valuable about the information published in this format (see article in this issue).

However, we do have a very basic problem to which only you can respond. We need information: articles, reports, studies, publications, notices of meetings and conferences, etc. While a certain amount of information comes to us already, we can only print what we know, and there is a great deal going on in other countries about which we have no information, or we may receive it too late for it to be published. Please let us know about your research and field projects, about conferences/meetings you have attended, and any other information which would benefit other members. Also please let us know if you wish to use the newsletter for information requests.

The intention of this newsletter and Working Group is to provide information and contacts that are not available from any other single source, to benefit you and, through you, to expand and further the state-of-the-art in this field. This is an interactive and participative activity, and we rely on you to keep us up-to-date on what is going on in your region and profession. So please keep in touch and use your newsletter!

Standard Procedures for Analyzin Non-Engineered Buildings

In the last issue of this newsletter, we reported on the agreement of the Working Group members that standard procedures for analyzing damage to non-engineered buildings were needed. Dr. Andrew Coburn offered to begin the task of developing a model methodology. Modifications to his first draft have been made by his colleagues in England, Robin Spence and Richard Hughes, and the resulting second draft is attached to this issue for circulation and comment.

We now ask two things of our members. First, that you go through the draft carefully in light of your own experience, and make comments and suggestions for a final draft. Second, that those of you who have the opportunity field test the proposed procedures. Please send all comments to INTERTECT (P.O. Box 10502, Dallas, TX 75207, USA); we will collect and forward them to Dr. Coburn.

The final copy will be published and sent to the IAEE, EERI and others for wide circulation. Ing. Julio Vargas has offered to translate the document into Spanish, and we hope to receive offers of translation from other members.

Dr. Coburn has raised the question of how to make the collected data available to others and has suggested that we discuss the collection/dissemination issue at the next meeting of the Working Group. In the meantime, INTERTECT has offered to act as a repository for survey data and will use this newsletter and other contacts to ensure that the data is made available to people involved in this field.

Conferences/Meetings

June 10-21, 1985: Innovative Approaches to Improving Human Settlements Through Co-operative Systems, Washington, D.C.; Workshop sponsored by the Cooperative Housing Foundation to examine successful experiences, organizational techniques and methodologies used to improve human settlements, emphasizing cooperation between public and private sectors. For information contact:

Cooperative Housing Foundation
2501 M Street, N.W., Suite 450
Washington, D.C. 20037, USA
Telephone: (202) 887-0700

July 22 - August 2, 1985: Multi-protection Design Summer Institute, sponsored by FEMA (Federal Emergency Management Agency), National Science Foundation, and U.S. Geological Survey. Two-week institute for architecture and engineering professors with courses on wind engineering, earthquake-protective design, flood-protective design, fire safety and fallout shelter analysis. For further information, contact:

Shelter-Rad Technology, Inc.
2000 Century Plaza
Columbia, Maryland 21044, USA
Tel: (301) 596-6777

August 2-3, 1985 (Salt Lake City, Utah) and October 25-26, 1985 (Seattle, Washington), Reducing Earthquake Damage to the Built Environment; Workshops to be held by the American Institute of Architects Foundation, focusing on the role that architects and other building professionals can play in reducing the impact of earthquakes. For information and registration materials, contact:

Donald E. Geis
Program Director
Natural Hazards Protection Design
AIA Foundation
1755 New York Avenue, N.W.
Washington, D.C. 20006, USA
Tel: (202) 626-7409

Summer 1985: Second theoretical and practical seminar on earth construction, organized by the Centre de Recherche en Architecture/Catholic University of Louvain and the Post-Graduate Centre - Human Settlements/Catholic University of Leuven. For information contact:

Didier Dagelingx
Centre de Recherche en Architecture
Place du Levant, 1
1348 Louvain-la-Neuve, Belgium

February 1986: EERI Annual Meeting and Seminar in northern California.

August 24-28, 1986: Third U.S. National Conference on Earthquake Engineering on the occasion of the 100th anniversary of the 1886 Charleston, S.C., earthquake, sponsored by EERI. For information contact:

Jim Beavers
Martin-Marietta Energy Systems
Building 9733-4, M/S 2
P.O. Box Y
Oak Ridge, Tennessee 37830, USA

September 21-26, 1986: Advancing Building Technology (10th CIB Congress), Washington, D.C.; Conference organized by the International Council for Building Research, Studies and Documentation with two of its three sub-themes on "Shelter for the Homeless in Developing Countries" and "Translating Research into Practice". Abstracts are due no later than August 1, 1985. For information on preparation of papers, contact Dr. James R. Clifton, CIB 86 Program Committee Chairman, B348 Building Research, National Bureau of Standards, Gaithersburg, Maryland 20899, USA, Tel: (301) 921-3458. Limited fellowships will be available. For information about the Congress and possible participation, contact:

Dr. Noel J. Raufaste
Director, CIB 86
Center for Building Technology
National Bureau of Standards
Gaithersburg, Maryland 20899, USA
Tel: (301) 921-3106

Working Group Survey

The responses received on our evaluation questionnaire concerning the Working Group conferences and newsletter have given the Working Group Coordinating Committee a clearer focus on the interests of members, the information you are seeking via the newsletter, and the relevance/usefulness of the conferences.

The profession best represented is engineering, with architecture and planning a close second. The majority of respondents are involved in research, testing and assessment, although implementation and information-sharing are not far behind. (This category is somewhat misleading because of the overlapping of activities, e.g., some engineers are also practitioners, and many are involved in information-sharing as teachers or in implementation/training programs.) The largest segment of respondents have been involved in this field for 7-10 years; 2 have been involved for 30 years, and 1 for 48 years.

Many respondents attended the Albuquerque Workshop, but only 2 participated in the Lima Workshop. The mix of conference participants was generally deemed good, multi-disciplinary, well-balanced, although several noted that more practitioners would have been an asset. The conference format was described as useful and well-organized. However, one person noted that more time was needed for informal discussion, and another that it was unfortunate that choices had to be made between two work sessions conducted at the same time.

In terms of the impact of conference attendence, most respondents found it valuable for new ideas, contacts and stimulation. A number of people stated the value in terms of international collaboration; for example, "...a new awareness of the international nature of the research efforts being undertaken in many parts of the world"; "...put me in contact with international researchers and substantial body of work I was unaware of". The interaction with people in other allied fields was also noted as an important component. The proceedings were judged very useful, informative, and excellent reference material. Several people mentioned their usefulness in course instruction and as a library resource.

Suggestions for improving the conference format included: more audio-visual presentations; more emphasis on implementation of improvements; more time at end of each presentation for questions/comments; more involvement of those in decision-making capacity. There were approximately equal numbers of respondents who suggested there was too much social-cultural-historical emphasis and too little social-cultural-historical emphasis!

In regard to the newsletter, comments ranged from "excellent" to "adequate". Most agree that it is informative, a good blend of news and academic items, and useful as a means of keeping current in the field -- "a good pool of information drawn from sources otherwise not easily available; also good cross-discipline information". One respondent noted that it provides very relevant information, but is only accessible for those who speak/read English.

A number of suggestions for improvements/expansion were offered: more technical material/research reports; more local case studies; more damage statistics; more information on technology transfer at the local community level; information on reinforcement using local materials; more advanced warning on conferences/meetings.

Specific information requirements listed by respondents include:

Review of international funding agencies sympathetic to the subject;

Statistical data on strength, deformability, overall behavior;

Information on social & psychological aspects of non-engineered construction, e.g., patterns of design and relation of buildings within the cultural development of a community;

Annual summary of ongoing work;

Non-technical articles on new ideas, projects;

More information on implementation strategies;

Directory of members and their work/ fields of expertise.

In addition to the questions we asked concerning past activities of the Working Group, we also requested suggestions for future activities, to add to the list begun at our meeting in San Francisco in July 1984. The following are representative of the ideas expressed in this portion of the questionnaire:

1 Coordinate sub-groups to write definitive overviews, reference works, state-of-the-art papers, etc., for example on strength-testing techniques/methods, field evaluation methods for large building stocks, repair and strengthening manual, etc.

2 Hold more conferences, small regional meetings, in as varied locations as possible.

3 Continue publication of newsletter.

4 Develop regional short training courses, correspondence courses.

5 Focus more attention on vernacular design solutions for damage mitigation in earthquake-prone areas.

6 Prepare do-it-yourself booklets for rural areas stressing basic seismic safety.

7 Encourage quantitative research.

8 Prepare agenda for research and implementation, for identified potential funding organizations.

Your comments and suggestions have been passed on to our original funding agencies and to a U.S. committee looking into international training needs for the earthquake engineering community. Please continue to send us suggestions/ideas.

Notes on Brussels Colloquium

About 60 participants and a large number of observers gathered at the International Colloquium on Earth Construction Technologies Appropriate to Developing Countries, held in Brussels, December 10-12, 1984. A group of 15 Fellows of the Belgian Govt. and the U.N. Center for Human Settlements (UNCHS/Habitat) met from December 3-19 to prepare papers and assist in pre- and post-colloquium organization.

The focus of the Colloquium was on the presentation of a preliminary set of eight volumes including case studies, design guidelines and an earth construction primer, by the Post-Graduate Centre Human Settlements, Katholieke Universiteit Leuven, and the Centre de Recherches en Architecture, Université Catholique de Louvain-La-Neuve. A ninth volume will include the papers of the Fellows and other participants, and the entire set will be available from UNCHS.

The underlying concept was the need for adequate housing stocks for the growing populations of most countries, and the potential for filling this need with earthen construction. The study volumes and Colloquium were intended to narrow the existing institutional and technical gaps in this field, and to produce guidelines for promoting and transferring earth construction technology at the local and national level. While Ing. Julio Vargas did present a paper on "Seismic Strength of Adobe Masonry", the Colloquium dealt primarily with non-seismic regions and issues (many participants were from Europe and Africa). However, one of the major decisions reached was to develop a basis for codes for both seismic and non-seismic countries, with the collaboration of UNCHS.

[Ing. Vargas was one of the Colloquium Fellows. Both he and Prof. Volker Hartkopf (who also made a presentation) contributed information for this article, and Prof. Hartkopf distributed copies of our newsletter to participants.]

Publications

"Housing Crisis after Natural Disaster: The Aftermath of the November 1980 Southern Italian Earthquake", David Alexander, Geoforum 15 (1984), No. 4, pp. 489-516: Pergamon Press, Maxwell House, Fairview Park, Elmsford, New York 10523, USA.

Terra Non Firma, James M. Gere and Haresh C. Shah, 1984: W.H. Freeman and Company, 41 Madison Avenue, New York, New York 10010, USA. Relatively non-technical description of earthquakes, why they happen and their effects, as well as introductory information on mitigation and preparedness measures.

Mud, Mud: An Earthscan Photosheet (1983). 28 pages of black-and-white photos showing the uses of earth for houses and other structures in both rural and urban situations around the world. Illustrates various problems and technologies, decorative uses, self-help construction, and adaptations for climate. Wall charts also available. Request information and price from: Earthscan, 10 Percy Street, London W1P ODR, U.K.

Sistema Modular de Quincha, a detailed training aid for the construction of seismic-resistant "quincha" houses, produced by the Sistema Nacional de Defensa Civil and the Catholic University of Peru. Available in Spanish. For information, contact: Ing. Julio Vargas N., Laboratorio de Estructuras, Pontificia Universidad Católica del Perú, Apartado 12534, Lima 21, Perú.

1985 Uniform Building Code, International Conference of Building Officials, 5360 South Workman Mill Road, Whittier, California 90601, USA. Update of 1982 edition including complete rewrite of the masonry chapter. Related volumes include "Uniform Housing Code" and "Dwelling Construction under the Uniform Building Code". Complete list available from ICBO.

Seismic Performance of Low Rise Buildings: State of the Art & Research Needs (1981), Ajaya Kumar Gupta, Editor. Proceedings of a workshop held at the Illinois Institute of Technology, Chicago, 1980, sponsored by the National Science Foundation. Focuses on concrete and masonry, wood and light metal structures. Available from: American Society of Civil Engineers, 345 East 47th Street, New York, New York 10017, USA.

Down to Earth, beautiful book on "adobe architecture: an old idea, a new future", based on the exhibition Des Architectures de Terre, conceived and directed by Jean Dethier and produced by the Centre Georges Pompidou, Paris, in collaboration with the Deutsches Architektur Museum, Frankfurt, 1981-82. The 303 illustrations show earthen architecture, both historical and modern, throughout the world. The richness, variety, adaptability and continuity of the material and designs are presented with brief commentaries on earth construction. Published in the USA in 1983 by Facts on File, Inc., 460 Park Avenue South, New York, New York 10016.

"Social and Economic Constraints to Modification and Obstacles to Technology Transfer for Making Mud Houses Resistant to Seismic Forces", G. C. Mathur, National Buildings Organisation, "G" Wing, Nirman Bhawan, Maulana Azad Road, New Delhi 110011, India (No date). Good general information on constraints to implementation. The NBO has also produced excellent monographs on rural housing throughout the country, reports on demonstration projects, and research reports/studies.

Vernacular Housing in Seismic Zones of India, report under Phase I of the Joint Indo-U.S. Program to Improve Low-Strength Masonry Housing, by the University of New Mexico and INTERTECT. Includes analyses of the various building systems/processes, recommendations for improving seismic resistance, and discussion of the factors involved in setting up a housing improvement/training program. Available at cost of mailing only, from INTERTECT, P.O. Box 10502, Dallas, Texas 75207, USA.

Recommended Specifications for Adobe and Construction Details, Native Products Division, Eight Northern Indian Pueblos Council, P.O. Box 969, San Juan Pueblo, New Mexico 87566, USA. Includes detailed drawings and reprint of Section 2405 of the New Mexico State Building Code.

The Portalab Manual: Low-Cost Soil-Engineering Tests for Constructing Earthen Buildings, Howard Scoggins, Earth Lab Systems, Alamogordo, New Mexico, June 1981. Description of the Portalab equipment and instruments — why, when and how to use them — in easy-to-understand terms. Published by New Mexico Energy & Minerals Department, 525 Camino de los Marquez, Santa Fe, New Mexico 87501, USA.

Earth Systems, quarterly newsletter focusing on earthen construction, primarily in the Southwest USA. Good information on U.S. equipment, building and preservation techniques, etc. Subscription is $25.00 per year, available from Earth Systems Development Institute, P.O. Box 1217, Corrales, New Mexico 87048, USA.

Audio-Visuals

No Hay Mundo A Donde Fugarse (1984), produced by PREDES, TAREA and ANC. 27-minute slide show on the causes and effects of natural disasters (earthquakes, floods, and landslides) and methods of protection/mitigation, designed as a tool for those working with low-income populations living in vulnerable or disaster-affected areas. For price and availability, contact:

Andrew Maskrey
PREDES
Apartado 11832, Jesús María
Lima 11, Perú

Simulador de Terremotos (1984), produced by the Laboratorio de Estructuras and the Centro de Teleducación/Pontificia Universidad Católica del Perú. Twenty-minute videotape describing the research and testing activities at the Catholic University in Lima, including excellent footage of shake table tests performed to compare the behavior of unreinforced and reinforced adobe houses. Good description of construction techniques and reinforcing methods/materials used. For Spanish version, contact:

Ing. Julio Vargas N.
Laboratorio de Estructuras
Pontificia Universidad Católica del Perú
Apartado 12534
Lima 21, Perú

English version is available from INTERTECT, P.O. Box 10502, Dallas, Texas 75207, USA. Please indicate format desired (BETA, VHS, or 3/4" VHS). Price is cost of reproduction (approximately $22.00).

Earthquake Engineering, Prof. Vitelmo V. Bertero. 120 slides with descriptive manual showing causes of structural damage, principles of earthquake resistant design, testing, and examples of modern construction, based on Prof. Bertero's studies in Alaska, Argentina, Algeria, California, Guatemala, Japan, Nicaragua and Venezuela. Focus is on timber, masonry, concrete and steel structures. For price information and availability, contact:

International Structural Slides
P.O. Box 466
Berkeley, California 94701

Human Settlements and Disasters, five slide lectures and manual, coordinated by Ian Davis. Part 3 is "Simple Techniques for Making Adobe Houses More Earthquake Resistant" (Everett Ressler). For brochure and price list, contact:

CAA Projects Limited
The Building Centre
26 Store Street
London WC1E 7BT, U.K.

Available in USA from Richland Educational Media, Route 1, Box 490, Keller, Texas 76248, USA.

EARTHEN BUILDINGS IN SEISMIC AREA

Proposal for International Standardisation of Recording Earthquake Damage to Earthen Buildings

1. Introduction

At the Second International Meeting of Earthen Buildings in Seismic Areas in San Francisco, 28 July 1984, it was proposed that those involved in surveying earthquake damage to earthen buildings should collect data in a methodical way which would be useful to others and form the basis of a comparative and homogenous set of data. To do this a standard method of collecting, recording and processing data needs to be agreed. This is the second draft of a proposal for circulation and comment for a standard survey methodology for use by the Earthen Housing Network.

2. Philosophy

Because earthen buildings are not engineered buildings and are highly variable in form,construction, condition and subsequent earthquake damage, case studies of individual buildings on their own are insufficient to describe characteristics of what is usually a large population of buildings. Some form of statistical data collection is necessary to describe the damage condition and variations for any sized group of buildings. It is proposed that a standardised statistical description of damage should be used to form the framework within which the case studies of individual buildings would have increased meaning and relevance.

The nature of earthquake damage surveying is that it is often undertaken during or shortly after the emergency period, in a limited timescale and with limited resources. A standard minimum survey of damage data collection that will yield meaningful and comparable information should be agreed. Larger survey teams with a lot of skilled manpower and plenty of time can collect more detailed and widespread data, but essentially the basic survey should be able to be performed by a four man team working in the field for two weeks. (It is recommended that in addition to the men carrying out the building survey, someone with geological expertise is included to define ground condition zones for the building survey.)

The survey should be designed assuming it is to be carried out by people from the country affected, and whose experience of surveying previous earthquakes may be limited. It is hoped that by keeping the standard survey as simple as possible, a larger number of earthquakes

will be surveyed and a data base built up which is of more application than that of a small number of very detailed earthquake damage investigations.

3. Objectives

The objective of recording earthquake damage to earthen buildings is to understand and define their vulnerability in ways that contribute to the overall objective of improving the resistance of such buildings to future earthquakes.

The understanding of vulnerability is achieved by investigating the way that buildings behave structurally under earthquake loads and the factors affecting their damage. Descriptions of the predominant types and patterns of damage to different building types can lead to deductions about their behaviour during the earthquake. Analysis of the variations in damage between buildings with different characteristics can yield general understanding of the effect of different characteristics of a building on its damage. The vulnerability of a building type can be quantified by collecting statistical data on the damage caused to buildings of this type by earthquakes of different severity.

Where information can be gathered which relates building damage to known parameters of ground motion, for example, if a strong motion instrument has been triggered by the earthquake, then a high priority should be given to studying the damage to buildings in the immediate vicinity of the instrument. Prediction of damage levels and characteristics in relation to measured parameters of ground motion must be the long term aim of vulnerability assessment. However, few areas of the world at present have networks of strong motion instruments dense enough to provide the necessary data. After an earthquake is over, usually the only indication of earthquake severity is building damage. The spatial distribution of earthquake damage, its attenuation and variation at distances away from the earthquake epicentre is at present the best way to define the vulnerability of the structures affected and the macro effects of the individual earthquake. It is important that the overall distribution of damage is recorded in a systematic, objective and accurate way.

The total record of earthquake damage to buildings should include:

A) An inventory of total earthquake damage and its spatial distribution.

B) A significant sample of damaged buildings documented by observational survey.

C) Detailed investigations of individual buildings.

This proposal for the standardisation of earthquake damage data collection is concerned with setting out guidelines for the inventory and the survey, parts A and B, which will establish the framework for the investigation of individual buildings, part C.

4. Guidelines for Part A, the recording of total earthquake damage

4.1. Inventory of total building damage

A damage inventory is usually carried out by the disaster authorities concerned with administration of relief operations and estimating total housing need for reconstruction. Such figures, if reliable and available, are an important part of the overall description of earthquake damage. They are, however, usually not so concerned with scientific investigation an may be crudely assessed and approximate.

An accurate damage inventory takes a lot of time and manpower. In a large earthquake many hundreds of settlements may be affected and the counting of every house in every settlement is a large operation. It may be out of the scope of most research teams visiting an earthquake area and it is not proposed that such an inventory be carried out independently of th disaster authorities. If the research team is assisting the disaster authorities in the preparation of a damage inventory, it should be structured to quantify the loss to the building stock in each settlement or urban district. Buildings should be classified into very general usage types, e.g. dwellings, storage buildings, animal barns, etc., although for obvious reasons disaster authorities will be most concerned with dwellings and may be unwilling to spend time and effort counting other types of buildings. If at all possible buildings should also be further classified into general structural types and based on their structural form and materials of construction, but this level of detail may not be required by the authorities and again, they may be unwilling to allow extra time assessing this kind of information.

Building damage should be classified from exterior damage as:

Collapse :	Buildings with more than one entire wall collapsed or more than half of a roof, or more than half of one storey height collapsed.
Partial Destruction : (MSK damage level 4)	Buildings with less than an entire wall collapsed, less than half of a roof or less than half of a storey height collapsed.
Heavy Damage : (MSK damage level 3)	Wall or roof material dislodged or single cracks greater than 20mm wide or multiple cracks 5-20mm. wide (more than one crack per 5 metres in any direction).
Moderate Damage : (MSK damage level 2)	Buildings with external render dislodged, single cracks 5-20mm wide or multiple cracks up to 5mm wide (more than one crack per 5 metres in any direction)
Slight Damage : (MSK damage level 1)	Buildings with hairline cracks, up to 5mm wide, on exterior of the building, bulges or leaning walls.
Undamaged : (MSK damage level 0)	Building with no visible damage on exterior of building

The inventory should be carried out by walking through the settlement systematically and counting numbers of each type of building in each damage class. Estimates of damage given by inhabitants should not be used in place of a systematic count.

Where possible buildings should be classified as individual and complete structural units and a damage level assigned for the whole building. For complete damage inventories many authorities will require damage assessed related to ownership and it must be recognised that ownership is often not confined to individual and complete structural units. In this case the structural units should be assessed with notes on the ownership subdivision of a single unit or differences in damage between the number of units belonging to a single owner.

The complete inventory should be a list, settlement by settlement of the number of buildings of each type damaged to which degree. It should include settlements which have been visited and have no external damage.

4.2. Mapping the damage and describing its spatial distribution

Each settlement on the total damage inventory should be located on an accurate map. An indicator of the extent of its damage, the % of its total buildings destroyed, can be used to plot the spatial distribution of the earthquake effects. It may be convenient to classify settlements into 3 or 4 groups of similar overall damage levels (e.g. Group I villages 75%-100% destruction, Group II 50%-75%, Group III 10%-50%, Group IV 0%-10%). Settlements not included on the damage inventory should also be marked. An example is shown in figure 1.

Other geographical features of the earthquake area such as mountains, rivers, main roads should be marked and areas where different building types or construction techniques predominate should be indicated.

Attenuation of damage can be shown by average % destruction contours. These can be drawn by taking arbitrary grid squares across the earthquake area of a size such that approximately 10 settlements fall within it. By adding up and averaging the % destruction for all the settlements in each square, the centres of the squares can be marked with an average % destruction value and contours of, for example 75%, 50%, 25%, 5%, can be drawn around them. See figure 2 a and b.

If the damage inventory information is available classified by building type, then the spatial distribution and attenuation of damage of each individual building type will give extremely valuable information on their comparable earthquake performance.

5. Guidelines for Part B, the documentation of a sample of damaged buildings by observational survey

5.1. Selecting the sample

The observational survey should, if possible, build on and cross-check the total damage inventory.

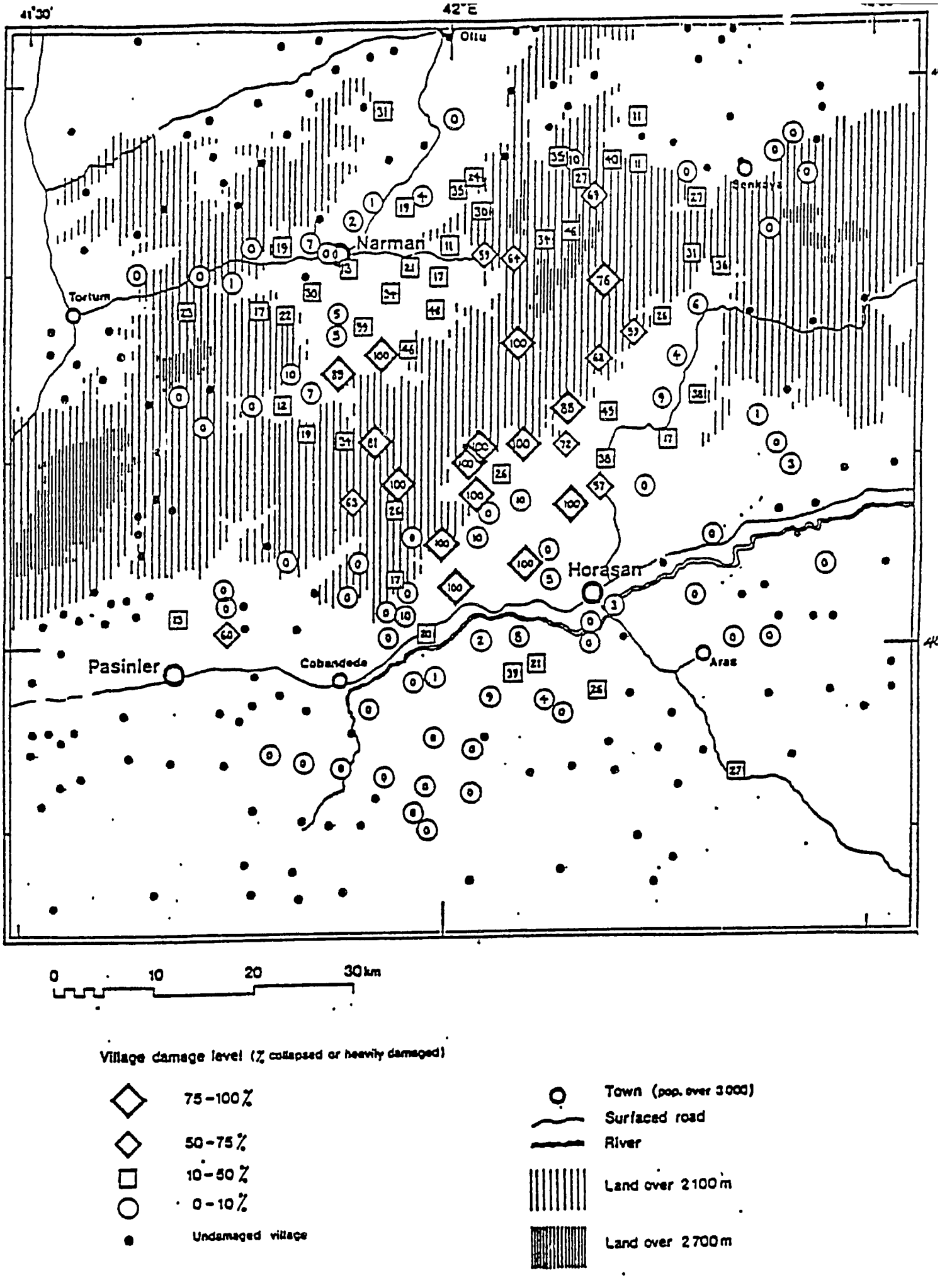


Figure 1. Spacial distribution of earthquake damage showing % destruction of dwellings for each village. (From

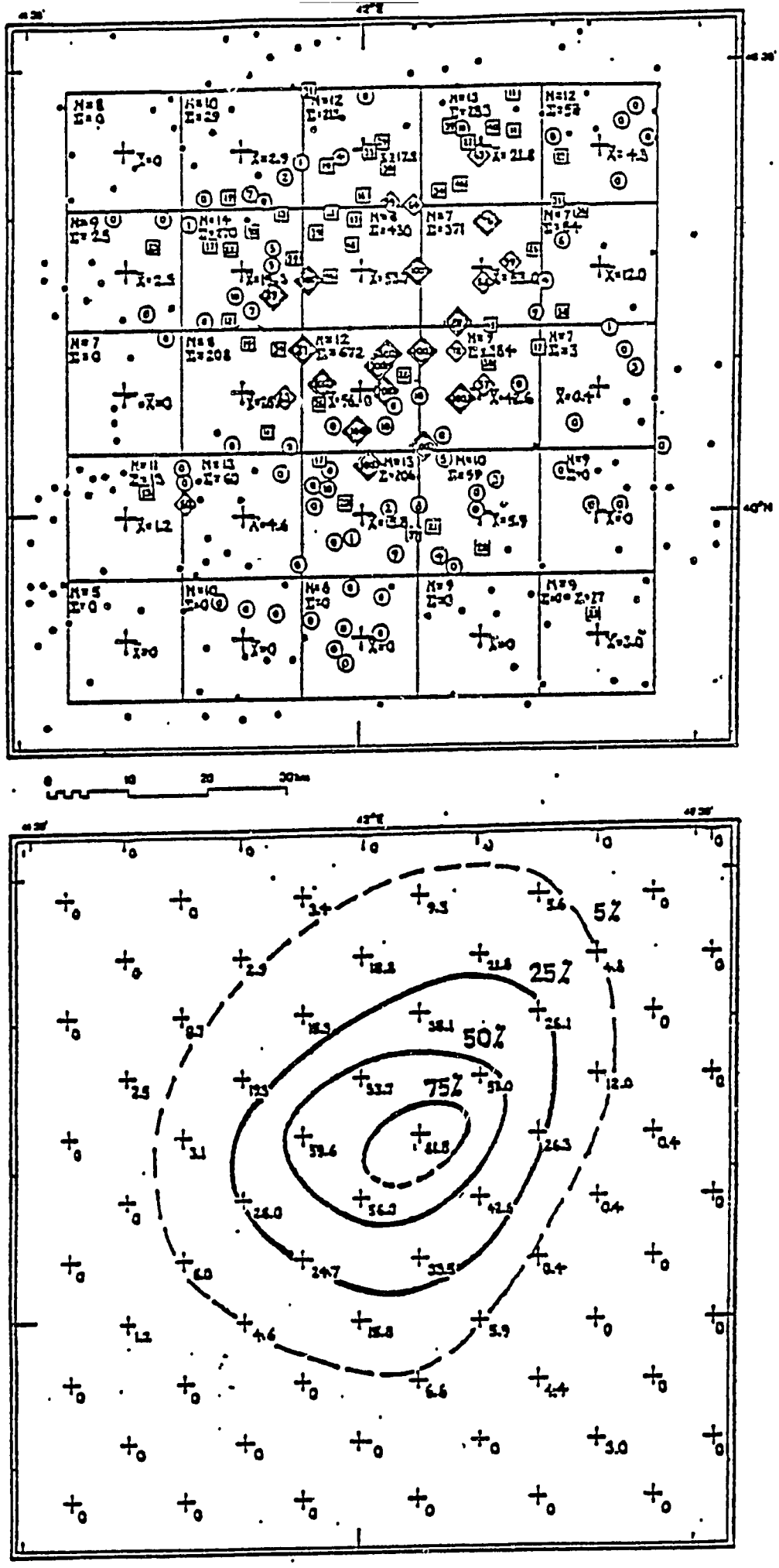


Figure 2. Calculation of Average % Destruction Contour. (for rural stone masonry buildings)
a) An arbitrary grid divides the earthquake area into groups of approx. 10 villages. Their average damage is marked at the centre of each box.
b) The operation is repeated with a shifted grid. The centre points from both.

The sample should be chosen as a number of settlements from the inventory and all the buildings of those settlements or urban districts should be surveyed rather than choosing samples of buildings within settlements. Before selecting settlements to survey, enquiries should be made to find out whether any strong motion instruments were in the affected area and recorded the ground motion. If so, part of the time available should be concentrated on surveying all the buildings in the area around the location of the instrument that might reasonably be expected to have experienced the same ground motion as that recorded by the instrument.

The size of the rest of the survey sample taken will largely depend on the manpower and time available. The total number of buildings affected will depend on the size of the earthquake and the density of population of the area. (An earthquake of magnitude 6.5 in an area of 30 persons/km^2, for example, could affect around 20,000 houses. 2,000 houses surveyed, 10% of the total, would be a significant sample.) The absolute size of the sample surveyed, however, is more important than the percentage of the total houses affected. If it is possible to survey 5,000 buildings, then the results of analysis of the data are more signficant than if 500 buildings have been surveyed. Analysis is carried out by subdividing and cross-tabulating the data. A simple analysis subdividing the data only three times, for example comparing the damage (6 categories) of different building types (say only 4 types) in 4 different zones of the earthquake would result in 96 separate categories in all. Conclusions drawn from the distribution of a small sample over 96 categories could be influenced by the performance of relatively few buildings. More analysis can be carried out and with more signficance if there is more data.

It is also important that the sample taken is representative; that is, that the buildings surveyed are a reflection of all the buildings affected. The larger the sample is, the more likely it is to be representative. The sample should be as broad as possible and include both large and small settlements, badly damaged and less damaged, easily accessible and, if possible, less accessible ones. Avoiding surveying some of the settlements for any particular reason may bias the findings of the survey. A random selection of settlements should be made, according to how many can be surveyed, perhaps with an equal number from each damage level group, and all of them completed. A good way of selecting settlements randomly is to draw a complete section through the affected area, from the furthest extent of damage across the epicentral area and out to the other extreme of damage, and survey all the settlements within it.

5.2. Describing the settlement

Each settlement chosen to be surveyed should be fully described. It is highly recommended that an additional member of the survey team, preferably with geotechnical expertise, is included to study the settlement as a whole. His first job, before the survey team begins its house-by-house survey, is to define approximate ground condition zones and to agree with the team on boundary landmarks. While the survey team are surveying buildings within the zones, he can make a number of notes and a rudimentary sketch map of the disposition of the village or urban district. It is a good idea, if possible, to find a high vantage point on a hillside or tall building overlooking as much of the settlement

as possible. A panorama of overlapping photographs should be taken. (Preferably other panoramas should also be taken from other vantage points if they exist.) The sketch map and notes should include:

1. The zoning of the settlement into areas of similar ground condition and geological substructure. At its simplest level this consists of defining approximate areas where houses generally have their foundations on rock (i.e. where rock is outcropping and close to the surface) and areas of deeper soil, together with areas of steep slopes, like hillsides and flat lands, like valley floors. Many settlements will be sited across more than one type of ground and damage to buildings may be different on the different types of ground.

   Once the ground condition zones are defined, approximate landmarks, such as roads, streams, trees and particular buildings can be agreed by the survey team as boundaries to each zone and buildings surveyed in each zone.

2. Physical features of the village including roads, streams, identifiable landmarks, and recognisable areas of different land use (cultivated land, animal grazing, orchards, meeting places, etc.).

3. Positions of important or public buildings.

4. General description of the situation of the settlement in the landscape, its stream system and, if possible, a detailed description of its geological and geotechnical characteristics.

5. Position and orientation of any photographs and panoramas taken.

In addition to the sketch mapping of the settlement, other information on the settlement as a whole should be gathered, from village officials and other documentation, including :

1. Its present population and past population figures (the rate of recent growth will give some indication of the age profile of houses in the settlement).;

2. Significant history of the settlement, especially history of past earthquakes;

3. Any other general information about the settlement, including its accessibility, apparent level of affluence, local industries, etc.

5.3. Surveying buildings

The survey of an individual building should be a one-line survey and not take longer than 1 or 2 minutes to complete. In this way a settlement of 100 buildings can be surveyed in 3 man-hours. A two-man team could visit 2 such settlements a day and complete a 1000 house study in 5 days. A four-man team might be expected to survey around 3000 buildings in two weeks.

The number of facts recorded about an individual building should therefore be limited, and as many as possible should be of a yes/no format or a choice from a simple 'menu' carried separately. All facts recorded should be observational. Survey teams should not be expected to find and question occupants or work deductively.

Safety is an important consideration for the surveying of damaged and unstable buildings and all data collected must be observable from the outside and at a safe distance from all damaged structures.

The detailed survey form and 'menu' should be drawn up for each earthquake, preferably with some knowledge of the building types. A reconnaissance trip to the earthquake area before drawing up the survey menu is highly recommended. Where this is not possible the survey form should be left as flexible as possible. The menu of structural form, construction type etc., can be added to when new building types are encountered and may actually be compiled during the survey, describing each building type as it is found.

A suggested survey form would include information on

(1*) Location. The identification of each building within the settlement by address and house numbers, if such a system exists. In addition or in places without individual house addresses, the ground condition zone that each building is located in (see 'Describing the settlement' above).

(2*) Structural form. Buildings in the earthquake area should be grouped into classes of similar structural forms, based principally on plan types and loadbearing characteristics. The primary classification of structural form differentiates between loadbearing walls and systems of loadbearing columns or frame structures. Secondary classification is of configuration of walls, number of storeys, opening sizes and span dimensions.

In some areas house forms are very similar and easily classified into representative types but in others, buildings may vary considerably and only a general classification is possible. Some of the important variables such as number of storeys, configuration with other buildings and overall plan size should be included as observations in the survey.

If possible, structural form should be assessed independently of the materials of construction. Obviously some forms are only built in one particular material, for example timber framed structures, but many masonry forms may be built in different types and qualities of masonry which should be assessed separately (see (6)).

(3*) Usage. Structural form is linked closely with use of a building and the two together record the building type. Classification of a building's use is important to relate damage to human needs.

(4*) Number of storeys. The total height of the building should be recorded as storey height. Storeys built into sloping ground should also be recorded. Any stepping back or changes in profile of the building at different storeys should be recorded as a different class of structural form.

(5*) Adjacency of other buildings, ground floor configuration. Adjoining buildings affect the earthquake behaviour of a structure. When surveying blocks of houses grouped together it is important to record each vertical structural unit as an individual building with other buildings adjacent.

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* Numbers refer to note on sample survey form and menu, figures 3 and 4.

(6*) Construction type of vertical loadbearing members. For loadbearing masonry the type of wall construction is critical to earthquake performance. Construction type should be classified:

- primarily according to the material used, e.g. adobe block, fired brick, cut stone, random rubble.
- secondly, according to mortar material.
- thirdly, according to different block shapes, sizes, bonding patterns, wall thicknesses and
- fourthly, according to any reinforcement, horizontal timber courses, tension tie bars, squared corner stones or buttresses.

(7*) Differentiation between 'long' and 'short' walls. It may be useful for the analysis of structural behaviour to survey the building as two sets of walls. Most loadbearing masonry buildings can be assumed to have two sets of structural walls, nominally at right angles to one another. Where the floor plan is rectangular there are two external 'long' walls and two external 'short' walls and this terminology is continued even for square and L-shaped plans. The surveyor should assign one set of parallel walls as the 'long' walls and the other as the 'short' walls, even if this assignment is arbitrary.

(8*) Loadbearing and non-loadbearing walls. It is also important for structural analysis to determine whether a set of walls is loadbearing or not. Usually this can only be observed from outside in partially collapsed buildings. In less damaged buildings it often cannot be surveyed without either entering the building or making deductions from outside. Unless the surveyor can observe evidence from the outside (for example, beam ends projecting through walls, or the direction of ceiling joists visible through open doorways) this column should be left blank. Any assumptions made about whether wallsare loadbearing or not should be left until the analysis stage, when explicit assumptions can be made, based on the evidence of span direction observed in partially collapsed buildings and from detailed records of building types (see 5.4.1.), rather than rely on different assumptions made by different surveyors in the field. For pitched roofed buildings the loadbearing walls may be directly related to the form of the roof, where trusses bear onto eaves walls. Both 'long' and 'short' sets of walls may be loadbearing, especially in buildings with slab floors or roof, or in buildings where the floor span changes direction, but many earthen buildings have a predominant direction of span making one set of walls loadbearing and the other non-loadbearing. This should particularly be investigated in the detailed records of individual examples of different building types.

(9*) Orientation of the building.This is a relatively time-consuming fact to survey, involving checking a compass for each building, and in compiling a survey form, its inclusion should be weighed against the value of the information gained. The orientation of buildings may have an effect on their damage if there was a predominant direction to the earthquake ground motions. For masonry buildings, with some failure modes that depend on the out-of-plane strength of the walls, the direction of the ground motion and the orientation of the building may be of more signficance in determining damage level than many other factors being surveyed. Directionality will be different at each location, depending on the relationship between the site and the epicentre, and local ground effects. The orientation of the building surveyed should be assigned from the direction of the 'long' set of walls. This should be done from a compass (or can be deduced, with some reservation, from shadow angles from the wall) An approximate orientation into four categories of North/South, East/West, North-East/South-

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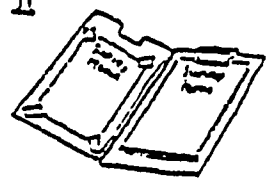
* Numbers refer to note on sample survey form and menu, figures 3 and 4

ERZURUM Earthquake

Survey Menu

Turkish National Committee for Earthquake Engineering

The Martin Centre for Architectural and Urban Studies

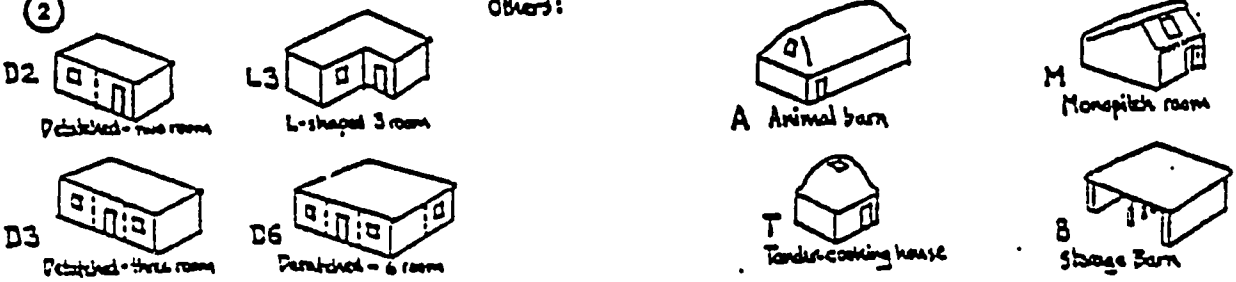


Tape Menu to inside of clipboard cover

STRUCTURAL FORM (2)

Load-bearing Masonry — Post-and-beam — Composite

Others:

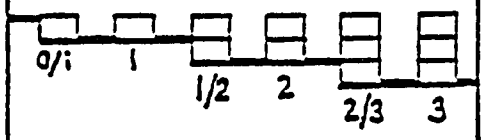


USE (3)

Others:

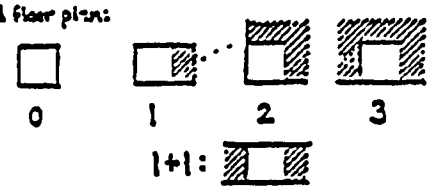
- D: Dwelling
- A: Animals
- S: Storage
- R: Retail shop
- W: Workshop

NUMBER OF STOREYS (4)



ADJACENT BUILDINGS (5)

Ground floor plan:



WALLS - CONSTRUCTION TYPE (8)

- S Stone, random rubble in mud mortar
- D Dressed stone, Squared blocks in mud mortar
- A Adobe, Mud brick in mud mortar
- B Concrete Block in cement mortar
- F Fired clay bricks in cement mortar
- U completely Rendered - Unable to tell Construction

Unusual Mortars

If a different mortar is used, add:

- M Mud (brown)
- C Cement (grey)
- L Lime (white)
- CP Cement pointing

Strengthening

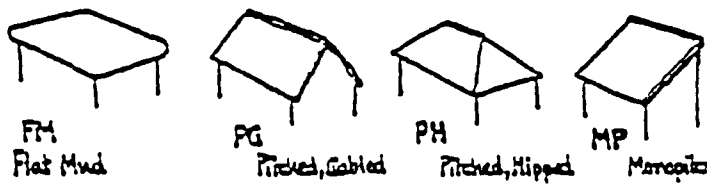
If wall has additional strengthening; add:

- Q Squared corner Quoins
- H Horizontal timber Helifs
- R Reinforced concrete Ringbeam
- B Buttresses
- T Metal Tension rods

OTHER CONSTRUCTION TYPES:

ROOF - CONSTRUCTION TYPE (13)

OTHERS:



Roofing Materials:

- M Mud
- G Galvanised metal roofing sheet
- T Fired clay tiles
- RC Reinforced concrete slab

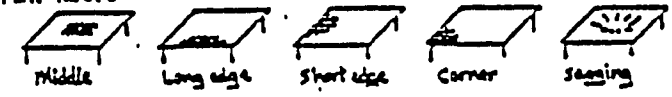
Others:

ROOF - DAMAGE LEVEL (14)

NV	FLAT ROOF Roof Not Visible	PITCHED ROOF Roof Not Visible
0	No exterior damage	No exterior damage
1	Single cracks 0-5mm Sagging	Single tiles dislodged Roofing sheets untied
2	Single cracks 5-20mm Multiple cracks 0-5mm	Many tiles dislodged Roofing sheets dislodged
3	Collapse of chimneys Roof material dislodged Single cracks > 20mm Multiple cracks 5-10mm	Collapse of chimneys Many roofing sheets dislodged Battens/purlins dislodged
4	Roof beams dislodged or Partial collapse of a slab	Trusses/primary supports dislodged.
5	More than half of the roof beams dislodged or more than half a slab.	More than half of trusses or primary supports dislodged.

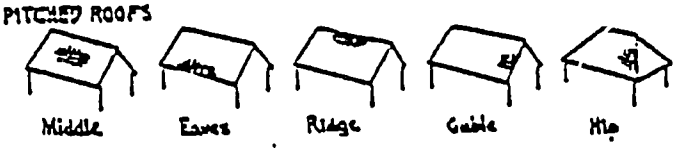
ROOF - DAMAGE POSITION (15)

FLAT ROOFS



Others:

PITCHED ROOFS



Others:

Figure 3. Sample survey form. Numbers in circles refer to notes in text.

Turkish Research Committee for Earthquake Engineering

The Martin Centre for Architectural and Urban Studies

ERZURUM Earthquake

Damage Survey

SURVEYOR : PAGE :

VILLAGE : DATE :

	BUILDING TYPE					WALLS (7)											ROOF			
							LONG WALL					SHORT WALL								
	LOCATION	STRUCTURE FORM	USE	Nº OF STOREYS	Adjacent buildings	CONSTRUCT^N TYPE	Approx. Length (m)	Orientation (Y/N/NE)	Load-bearing? ✓-X	DAMAGE LEVEL	DAMAGE TYPE	Approx. Length (m)	Load-bearing? ✓-X	DAMAGE LEVEL	DAMAGE TYPE	CONSTRUCT^N TYPE	DAMAGE LEVEL	DAMAGE POSIT^N	NOTES
1	(1)	(2)	(3)	(4)	(5)	(6)	(10)	(9)	(8)	(11)	(12)	(10)	(8)	(11)	(12)	(13)	(14)	(15)	(16)
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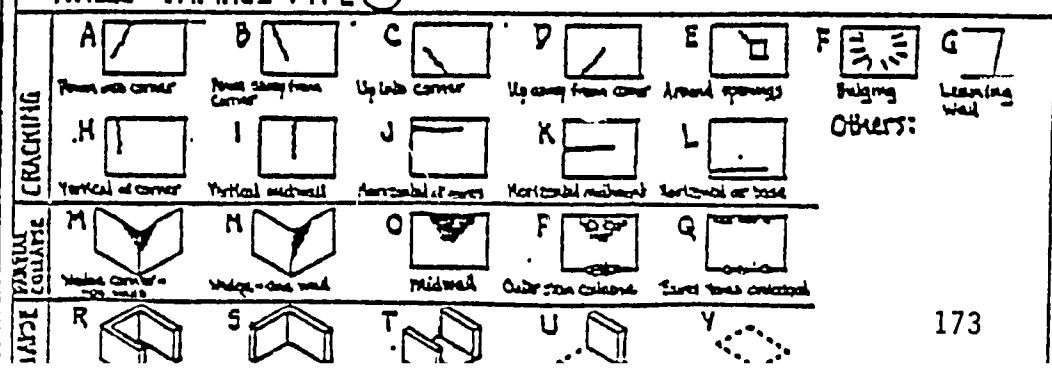
WALLS - DAMAGE LEVEL (11)

0	No visible damage
1	Single cracks 0-5mm Bulges, leaning.
2	Single cracks 5-20mm Render dislodged Multiple cracks 0-5mm in 5 metres
3	Wall material dislodged Single cracks greater than 20mm Multiple cracks 5-10mm in 5 metres
4	More than half a wall collapsed or more than half a storey height
5	More than one wall collapsed

WALLS - DAMAGE TYPE (12)



West and North-West/South-East is probably sufficient to determine differences in damage with orientation at a settlement.

(10*) Length and width of the building. These should be approximate maximum overall dimensions of the structural unit being surveyed, noted as length of 'long' walls and length of 'short' walls. Dimensions should be to the nearest metre and measured, paced or estimated according to the experience of the surveyor.

(11*) Damage level. The level of damage should be assessed as the maximum level observed in each set of external walls, both 'long' and'short'. The scale of damage proposed is that prescribed in the MSK Scale of Intensity and more precisely defined for masonry walls as follows:

Damage scale for masonry walls

0	Undamaged	No visible damage to exterior walls
1	Slight damage	Single hairline cracks (cracks up to 5mm. maximum width) or wall bulging or leaning out of vertical.
2	Moderate damage	Render dislodged or single major cracks (cracks 5mm-20mm wide) or multiple hairline cracks (more than 1 crack less than 5mm wide per 5 metres in any direction).
3	Heavy damage	Wall material (bricks, blocks, stones) dislodged or single severe cracks (cracks over 20mm. wide) or multiple major cracks (more than one crack between 5mm and 20mm wide per 5 metres in any direction).
4.	Partial destruction	More than half a wall collapsed or half a storey height of wall.
5.	Collapse	More than one wall collapsed.

(12*) Damage type. In addition to assessing the level of damage, the principal types of damage visible should be noted. A catalogue of damage types would include different positions and directions of diagonal cracks, vertical cracks and horizontal cracks, different positions and shapes of collapsed portions and different combinations of wall collapse. Any particular wall or set of walls may exhibit more than one type of damage and the types of damage should be listed in order of severity, with worst first.

(13*) Construction type of horizontal structure: roof/internal floors. The horizontal structure is almost as important as vertical structure in earthquake behaviour. The horizontal structure is, however, more obscure and difficult to assess in many less-damaged buildings. Construction type of roof should be based on its external appearance, for example, flat, pitched, hipped, and its roofing material. Examination of individual examples

* Numbers refer to

should give sample roof construction, truss and support design to inform the analysis of survey data. The major structural item to look for is evidence of a ring beam, slab or tied horizontal members at the top of a wall or at storey heights tying walls together.

Buildings suffering some collapse are the best opportunities to survey internal floor construction types and these should be especially noted.

(14*) Damage to roofs and floors. A similar scale of damage as used for walls is proposed for roofs (and internal floors where exposed) but the definitions of the scale need adapting to different types of construction, for example:

Damage scale for roofs and internal floors

NV		Roof not visible.	
0	Undamaged	No exterior damage.	
		Flat roofs/internal floors	Pitched roofs
1	Slight damage	Single hairline cracks, sagging.	Single unpegged tiles/ small amounts of thatch dislodged.
2	Moderate damage	Single major cracks, multiple hairline cracks. Chimneys cracked or chimney pots dislodged.	Many unpegged tiles dislodged or single pegged tiles/single roofing sheets dislodged. Chimneys cracked or chimney pots dislodged.
3	Heavy damage	Collapse of chimneys or roofing/flooring material dislodged or multiple major cracks.	Collapse of chimneys or many pegged tiles/many roofing sheets dislodged or battens, purlins or other secondary members dislodged.
4	Partial destruction	Primary bearing members dislodged or partial collapse of a monolithic slab.	Individual trusses or primary support members dislodged.
5	Collapse	More than half of primary bearing members dislodged or collapse of more than half of a monolithic slab.	More than half of the trusses or primary support members dislodged.

(15*) Damage position in roof and floors. The mechanisms and types of damage are far less critical in the horizontal structure than in the vertical, but noting the position of damage and deterioration is useful Where there is more than one position, they should be listed in order, worst first.

* Numbers refer to note on sample survey form and menu, figures 3 and 4.

(16*) Notes. Any unusual characteristics or other information should be noted. If a photograph is taken of the building or a characteristic of its construction or condition, it should be noted on the form with the number of the photograph and a brief explanation. Longer notes should be kept in a separate notebook and referenced on the form.

5.4. Detailed record of survey 'menu'

For every item on the survey 'menu' there should be a detailed record of at least one example encountered. It is easiest to make a record of each item when it is first recognised during the survey itself, although intially this slows up the time taken for the survey. If the detailed record is left until the survey is finished it may mean travelling back to the settlements where it was found and an unnecessary duplication of effort.

Photographs and notes are probably the best method of recording detailed observations of most items. A complete record of photographs taken should be kept in a notebook noting film number and exposure and the subject taken. The 'menu' sheet itself can be used to record items photographed and serves as a checklist that all items on the checklist have one example recorded.

5.4.1. Building types

The different building types encountered are so central to the survey and to the description of the effects of the earthquake that it is essential to record one or more examples thoroughly. Individual buildings should be chosen, as representative as possible of the building type and preferably an example which is lightly damaged or undamaged. It is proposed that measured drawings should be made in addition to the photographs.

Drawings of an example of each building type should include:

a) Floor plans at a suggested scale of 1:100, indicating the complete interior layout, loadbearing and non-loadbearing walls, thickness of walls, position of doors and windows, direction of floor/roof spans in each room, north point.
b) Elevation of two facades showing position and sizes of openings, damage.
c) Section, scale 1:100 indicating roof and floor construction, wall materials and heights, interior elevations.
d) Studies of construction details at a suggested scale of 1:10 showing typical roof: wall junction, window lintol, wall foundation, etc. (sometimes better observed in more damaged buildings).

Photographs should be taken of the invididual buildings measured and of other examples of the same structural form, especially variations of it, for example of different storey heights and configurations with other buildings.

5.4.2. Construction type

Close up photographs of each different type of construction to distinguish brick bonding and coursing types, corner construction, wall defects, etc. Examples of partially collapsed construction may reveal more detail. Photographs should include something to give scale, for example a short measuring rod.

5.4.3. Damage

Taking the most common building type or types, a photographic record should be made of an example of the classification of each level of damage, 1 to 5, and an example of each type of damage encountered. The menu card should be used to tick off each damage level and type photographed, marking the film and exposure number alongside.

5.5. Processing of survey data

The processing of survey data can be done fairly straightforwardly by hand, using a pocket calculator, although for large samples and many detailed analyses this can prove rather tedious. Where the survey team has access to a computer with standard statistical package software, the processing can be done quicker. It should be emphasised, however, that access to a computer is not essential to process survey data.

The data should be used as coarse information and treated as likely to contain many errors. Cross tabulation should be used to find signficant differences between large sub-groups of the data and any sub-group which contains less than, for example, 20 buildings should be disregarded. This restricts the number of subgroups into which the data can be divided, depending on the size of the total sample. The total number of subgroups depends on the number of times the data is divided and the number of categories it is divided into each time. The best analysis results are from fewer amalgamated categories and the minimum number of subdivisions.

The first stage of processing is a complete description of the whole survey sample, broken down by each individual variable (univariate analysis) that is

Total number of buildings in villages A, B, C ...

Total number of buildings of structural form x, y, z ...

Total number of buildings of 1, 2 and 3 storeys ...

Total number of buildings with wall construction type ab, cd, ef ...

Total number of buildings maximum damage 0, 1, 2, 3, 4, 5

etc.

The second stage is to decide which cross tabulations are of most interest and proceed through the analysis first choosing two variables, e.g.

% of buildings in each village A, B, C, of structural form x, y, z ...

% of buildings of structural form x, y, z of 1, 2 or 3 storeys

% of buildings of structural form x, y, z with wall constructions type ab, cd, ef ...

then subdividing each of those by a third variable, e.g.

% of buildings of structural form x, y, z, of 1, 2 or 3 storeys with wall construction type ab, cd, ef, and so on.

As cross tabulation becomes more complex, more selection is necessary to choose analyses which are of most interest and are most meaningful. Care should be taken to compare similar sets of buildings. For example, the comparison of damage levels between two building types across the whole sample will give a distorted picture if there is a higher population of one building type in settlements nearer the epicentre than the other. This sort of comparison is best made by taking data from villages in the same damage level groups. Separate comparisons for each damage level group will give the difference in earthquake performance of the two building types at different general levels of earthquake severity and the data can be used as approximate vulnerability functions.

If the distributions of damage are not significantly different between two similar building types then it may be desirable to consider them as a single building type for the purposes of analysis to obtain larger and more meaningful subgroups in cross-tabulation.

Suggested investigations of the data which involve only four or less subdivisions of the total might include:

for any particular building type:

- variations in damage for different storey heights
- variations in damage level and type for different types of wall construction
- changes of predominant types of damage with increase in damage level
- differences in damage between loadbearing and non-loadbearing walls
- relationship between length of wall and its damage
- relationship between damage to walls and damage to roof.

for any particular settlement:

- differences in damage distribution between different building types
- difference in damage between buildings of different orientation
- multiple variable analysis, for example the relationship between damage to long, non-loadbearing walls orientated in one direction compared to short, loadbearing walls orientated another.

When conclusions have been reached which appear to show a significant difference in performance between one subset of the data and another, the confidence limit o this conclusion should be tested. This is done by assessing the maximum possible error on the surveying of each variable (for example, if a surveyor has assigned a wall to be damage level 3, what is the maximum and minimum damage level that someone else could reasonably assign to it, or how far could he reasonably be mistaken and how many times in the survey is this mistake reasonably likely to have occurred?) The conclusion should be tested by assuming that the maximum error works against the conclusion and seeing if the same conclusion could still be reached. The degree to which the errors being considered would reduce the conclusion is a mark of the confidence that can be placed in it.

6. Part C, the investigation of individual cases

This proposal for a statistical description of damage provides the framework for the detailed analysis of causes and particular parameters affecting earthquake

damage gives an insight into the general performance of a population of buildings. It should identify general characteristics of structures which make them more prone to damage and detail the more common mechanisms of damage propagation and collapse. But the major demonstration of statistical data is the large variation of damage to groups of very similar buildings, even those which can be assumed to have suffered the same ground motion. Two apparently very similar structures next door to each other often suffer from remarkably different types and levels of damage. The investigation of individual buildings is needed to determine the detailed causes of the damage mechanisms identified in the statistical survey, and why one building should be damaged one way and other buildings damaged another.

The deterministic analysis of the earthquake's exploitation of weaknesses within the structure of a building involves a complex diagnosis of defects arising from techniques of construction, considerations of siting, performance of materials, processes of weathering and decay, natural movement of structures and usage of the building. This type of diagnosis is the subject of a manual to be published shortly: "A Manual of Survey Techniques for Earthquake-damaged Buildings", by Richard Hughes, which should be adopted as the guidelines for part C, as an integral part of the surveying of earthquake damage to earthen buildings.

7. Equipment checklist

The equipment needed for the observational building survey as outlined above is as follows:

Printed or photocopied survey forms (100 forms to survey 3,000 buildings).
Printed or photocopied 'menu' cards (1 for each surveyor).
Clipboard (with folding cover) (1 for each surveyor).
Additional bulldog clips.
Pencils and waterproof pens
Eraser
Notebook
35mm. camera
3 x 36 exp. films minimum.
measuring rod (scale for photographs).
5 metre measuring tape.
directional compass.

Proposal prepared September 1984 Andrew Coburn

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6 Chaucer Road
Cambridge
England.

INTERNATIONAL NEWSLETTER ON EARTHEN BUILDINGS IN SEISMIC AREAS

In 1981, the International Workshop on Earthen Buildings in Seismic Areas was held in Albuquerque, New Mexico, to begin the process of bringing together researchers, practitioners, funding organizations, governmental agencies, etc., to focus on ways in which these vulnerable buildings can be improved and strengthened. One result of this Workshop was to initiate a worldwide network of people and organizations involved in this field. In order to provide a forum for the exchange of information, an informal newsletter has been published periodically to provide notice of meetings, information about new publications in the field, and articles about project activities. Each newsletter also includes an original paper or project training manual used in the implementation of housing modification or repair programs.

The grant which funded the establishment of these networking activities has ended and the newsletter now must become self-supporting. The following rates for yearly subscriptions (a minimum of three issues) will apply for 1985:

1 year subscription, developing countries	$5.00
1 year subscription, industrialized countries	$25.00
1 year subscription, institutional rate	$40.00

Please fill in and return the attached subscription request if you wish to continue to receive this newsletter. No further issues will be mailed to non-subscribers.

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EARTHEN BUILDINGS IN SEISMIC AREAS

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Published three times per year under the auspices of the International Working Group on Improvement of Earthen and Low-Strength Masonry Buildings in Seismic Areas.

APPENDIX VIII

INTERTECT

International Disaster Specialists

P. O. Box 10502

Dallas, Texas 75207 U.S.A.

Tel.: (214) 521-8921

August 21, 1984

Mr. John Guy Smith
Manager, Latin America & the Caribbean
Appropriate Technology International
1331 H Street, N.W.
Washington, D.C. 20005

Dear Mr. Smith:

Fred Cuny and I returned recently from San Francisco, and I wanted to give you a brief informal report on the activities of the International Working Group on Improvement of Earthen Housing in Seismic Areas during the recent 8th World Conference on Earthquake Engineering and subsequent meeting of the Working Group.

The 8WCEE granted me press credentials on the basis of my editorship of the earthen housing network newsletter, which allowed me to attend all sessions plus press conferences/briefings and some special functions. Fred Cuny and I tried to cover all the sessions where Working Group members were giving presentations, and of course we have copious notes from the very enthusiastic Working Group meeting on July 28th. All of this will be covered in the third and last newsletter funded under tne ATI contract with the University of New Mexico, which we plan to complete in September.

As you may know, AID/OFDA funded travel, registration and expenses for a number of international members of the Working Group to attend both the Conference and the network meeting. I have sent brief informal reports to them and expressed our appreciation for this assistance which enabled us to schedule a meeting of the network members. A copy of my letter to Denise Decker is attached.

During the 8WCEE sessions, several Working Group members took the Conference to task for appearing to focus so strongly on reinforced concrete and steel construction when the majority of lives lost in earthquakes worldwide result from failure of earthen and low-strength masonry buildings. There were several sessions wherein architects, engineers and sociologists drew participants' attention to the small amount of time and money devoted to resolution of the problems faced by low-income residents of earthquake-prone regions and to ways of using existing knowledge to help these most vulnerable people protect themselves and their property.

On Saturday, July 28th, we convened a meeting of Working Group members which continued several hours past our original schedule due to the numerous exchanges and ideas that were expressed. Several of these will be of particular interest to ATI. First, the primary focus of the network has been even more emphatically placed on implementation (repair, retrofit, low-cost improvements, socio-economic considerations, etc.).

Second, the members reiterated their concern that existing information be translated into an easily-understandable format for local community dissemination. We looked at projects where this is underway, e.g. various INTERTECT projects in Popayán, Solomon Islands, India, etc.; the PUC project in N. Peru to develop and teach earthquake resistant and rain/flood resistant construction techniques to builders and homeowners; post-earthquake reconstruction projects in Yemen and Turkey, etc. Many of the participants were not aware of the extent of these activities in other areas of the world and were most anxious to trade information on their respective research and implementation projects.

Third, the group suggested that they compile a document of all the ways that people in different parts of the world have modified their houses for earthquake resistance -- a compendium of popular knowledge, so to speak -- so that these methods could be tested and evaluated. A member from Nepal has assumed responsibility for coordinating this effort.

A great many more suggestions were made and accepted by the members on various ways to continue this excellent information exchange. Approximately 23 new members were added to our mailing list, and many attended the Saturday meeting. Extra copies of the newsletter were taken to San Francisco specifically for the purpose of advertising the Working Group and its sponsors, and all were given out to interested participants. A great deal of interest in repair/retrofit and low-cost improvements in rural construction has been shown in China, and we have been invited to hold another major international meeting (similar to Albuquerque, but for about 200 participants) there in 1987.

All the participants expressed their appreciation to NSF, AID and ATI for the funding which has made development of this Working Group possible. They unanimously agreed that the network, regional workshops and newsletter were extremely valuable and must be continued and expanded. We are evaluating proposals made at the meeting for methods of funding the newsletter on a permanent basis, including subscription memberships, corporate financial grants, etc. Although all the participants were willing to pay to continue publication of the newsletter, there are foreign exchange problems in some countries which will require some special considerations.

In light of such a positive response by network members, I want to thank ATI for granting us the extension necessary to cover the 8WCEE and hold this special meeting of the Working Group to discuss what has been achieved and future directions. The enthusiasm for the exchanges and joint projects initiated since Albuquerque was perhaps more than even I had expected, and the direction of research toward meeting expressed implementation needs is very exciting. The role ATI has played in this process is very sincerely appreciated by all of us and we hope that there may be opportunities for your support again in the future.

Sincerely,

Jean W. Parker

JWP:me

cc: Carlos Lola/ATI
Ed Smith/AID
Gudrun Huden/AID
Jerry May/UNM

APPENDIX IX

INTERNATIONAL WORKING GROUP ON IMPROVEMENT OF
EARTHEN AND LOW-STRENGTH MASONRY BUILDINGS
IN SEISMIC AREAS

Dear Fellow Members of the Working Group:

In order to assess the needs of the Working Group membership, how they are being met, and the usefulness of the Albuquerque and Lima Workshops, and our newsletter, we are requesting that all members fill out the attached questionnaire and return it to us for evaluation. As funding for our networking activities and newsletter has ceased, we must reevaluate our function and activities toward the goal of continuing to exchange information and translating it into techniques for implementation.

The Coordinating Committee of this Working Group is willing to continue the networking activities and to assume a portion of the cost. However, the production of a newsletter is very time-consuming, and postage costs for international mailing are high. Thus we are proposing that the newsletter become partially self-supporting at this time. At an informal Working Group meeting held in San Francisco, in July 1984, a sliding scale of subscription rates was set to enable us to publish a minimum of three issues per year. If we receive enough subscriptions and sufficient information to warrant a fourth issue during the year, we will publish it. A subscription form is attached to this letter, and we hope that all of you will continue to support and be part of this Working Group.

We hope that the questionnaire will help us to assess the effectiveness of our conferences and the newsletter, and help determine the future of the Working Group. We wish to continue to be responsive in the most effective manner, but can only do so with your help. We would appreciate your taking the time to respond to these questions. If there is not sufficient room for your answers on the printed questionnaire, please include extra sheets.

Thank you in advance for your prompt response.

Sincerely,

The Coordinating Team

Attachment

INTERNATIONAL WORKING GROUP ON IMPROVEMENT OF EARTHEN AND LOW-STRENGTH MASONRY BUILDING IN SEISMIC AREAS

Questionnaire for Evaluation of Information Needs

NAME: _____

TITLE OR POSITION: _____

ORGANIZATION: _____

MAILING ADDRESS: _____

TELEPHONE NUMBER: _____

PROFESSIONAL BACKGROUND: (Engineering, Planning, etc.) _____

NATURE OF PRESENT INVOLVEMENT IN EARTHEN BUILDING FIELD: _____

LENGTH OF TIME ACTIVE IN THIS FIELD: _____

CONFERENCES:
DID YOU ATTEND ALBUQUERQUE (USA) CONFERENCE, MAY 1981?: _____
DID YOU ATTEND LIMA, PERU (SA) CONFERENCE, MAY 1983?: _____

PLEASE COMMENT ON:
THE MIX OF PARTICIPANTS: _____

THE FORMAT OF THE CONFERENCES: _____

THE IMPACT OF THE CONFERENCE ON YOUR WORK: _____

THE PROCEEDINGS AND PUBLICATIONS: _____

WHAT WAS MOST USEFUL TO YOU: _____

_____

_____

_____

WHAT IMPROVEMENT COULD BE MADE: _____

_____

_____

_____

NEWSLETTER:

HOW DID YOU HEAR OF THE NEWSLETTER OR THE WORKING GROUP?: _____

_____

_____

HOW MANY ISSUES DID YOU RECEIVE? _____

HOW MANY INDIVIDUALS READ YOUR COPY OF THE NEWSLETTER?: _____

PLEASE COMMENT ON:
THE CONTENT OF THE NEWSLETTER:

_____

_____

_____

THE FORMAT AND READABILITY OF THE NEWSLETTER: _____

_____

_____

_____

THE RELEVANCE OF THE INFORMATION TO YOUR WORK: _____

_____

_____

_____

THE UNIQUENESS OF THE INFORMATION IN THE NEWSLETTER: _____

_____

_____

_____

WHAT SHOULD BE INCLUDED IN FUTURE NEWSLETTERS: _____

_____

_____

_____

WHAT COULD BE IMPROVED IN FUTURE NEWSLETTERS?: _____

_____

_____

_____

WHAT OTHER INFORMATION REQUIREMENTS DO YOU HAVE FOR YOUR WORK?:

_____

_____

_____

_____

WHAT DO YOU SUGGEST FOR FUTURE ACTIVITIES OF THE WORKING GROUP?:

ANY OTHER COMMENTS?:

PLEASE RETURN TO:
INTERNATIONAL WORKING GROUP
C/O INTERTECT
P.O. BOX 10502
DALLAS, TEXAS 75207, USA

INTERNATIONAL NEWSLETTER ON EARTHEN BUILDINGS IN SEISMIC AREAS

In 1981, the International Workshop on Earthen Buildings in Seismic Areas was held in Albuquerque, New Mexico, to begin the process of bringing together researchers, practitioners, funding organizations, governmental agencies, etc., to focus on ways in which these vulnerable buildings can be improved and strengthened. One result of this Workshop was to initiate a worldwide network of people and organizations involved in this field. In order to provide a forum for the exchange of information, an informal newsletter has been published periodically to provide notice of meetings, information about new publications in the field, and articles about project activities. Each newsletter also includes an original paper or project training manual used in the implementation of housing modification or repair programs.

The grant which funded the establishment of these networking activities has ended and the newsletter now must become self-supporting. The following rates for yearly subscriptions (a minimum of three issues) will apply for 1985:

1 year subscription, developing countries	$5.00
1 year subscription, industrialized countries	$25.00
1 year subscription, institutional rate	$40.00

Please fill in and return the attached subscription request if you wish to continue to receive this newsletter.

SUBSCRIPTION FORM:

INTERNATIONAL NEWSLETTER ON EARTHEN BUILDINGS IN SEISMIC AREAS

Name: _____

Organization: _____

Mailing Address: _____

_____

_____

1-Year Subscription:	Member from Developing Country	$5.00	/ /
	Member from Industrialized Country	$25.00	/ /
	Institutional Subscription	$40.00	/ /

(Price includes first class postage to Canada, U.S. and Mexico; surface postage to other countries)

Checks, money orders or UNESCO coupons should be made payable to International Working Group and mailed to:

International Working Group
c/o INTERTECT
P.O. Box 10502
Dallas, Texas 75207, USA