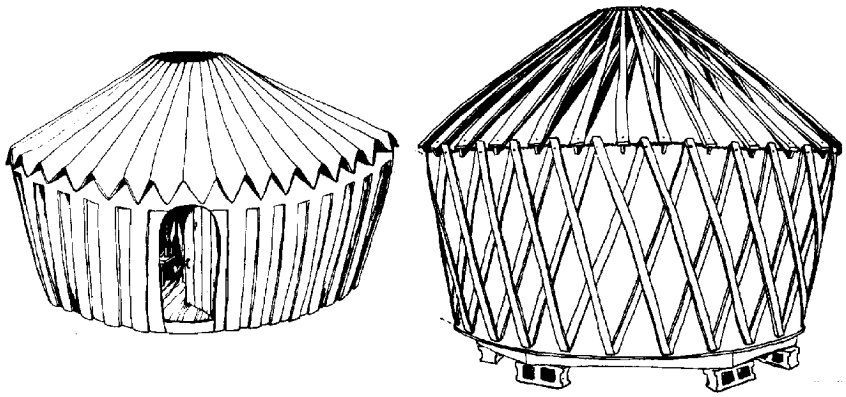

Housing and Construction

"It is not so much 'how to build' as 'how to choose techniques and materials appropriate to a given situation.' "

—letter from a volunteer in Papua New Guinea

There are housing problems everywhere, in industrialized as well as developing countries. In Jakarta, Manila, Mexico City, and Calcutta millions of squatters camp indefinitely in structures made of cardboard, sheet plastic and flattened cans, on strips of land beside canals and railways, sometimes even in the shadows of high-rise "low-cost" housing. In the urban United States, the great majority of homeowners could not afford to purchase the homes they live in today if they had to do so at today's prices. In these and countless other urbanizing areas, the cost of a place to live is rapidly outstripping the ability of ordinary people to pay. Inflation of land values triggered by the growth of gigantic urban centers is one factor. The cost of energy intensive manufactured building materials, which inevitably rises faster than the other costs of living, is another.

In developing countries, the amount of attention and resources that public works administrations and development assistance agencies devote to housing is probably second only to that devoted to water supply. And the history of housing projects, like that of water supply projects, is largely a history of disappointments worldwide. In **Housing by People** *(this section), John Turner notes that,*

" ... it is common for public agencies to build houses or flats to standards which the majority cannot afford, nor can the country possibly subsidize them on a large scale. On top of this, it is not unusual for governments to prohibit private building of the type of housing the vast majority can afford and are satisfied with."

Turner argues that governments should not provide houses built to arbitrary specifications, but should instead make building codes more flexible and provide opportunities for secure access to land. An appropriate housing strategy would rely on a community's initiative, thrift, and ability to organize and turn local resources

to advantage to meet the basic human need of shelter. Many of the entries in this section provide illustrations and documentation of the power and validity of this approach.

*Egyptian architect Hassan Fathy (***Architecture for the Poor***) helped to inspire a re-examination of traditional architecture and materials. Fathy and others emphasize the ingenuity contained in indigenous building systems, which have tended to evolve to fit local conditions. "Far from being backward or illogical as is often supposed, many traditions do in fact have an underlying rationale or system" which has developed in response to local climatic conditions and availability of materials, states Iran's Development Workshop. Appropriate technologies for housing should begin with and extend these indigenous systems. Self-help, owner built housing, says John Turner, "is very much a process, intimately related to the user's needs and finances, and very much in the user's control. The idea of housing being the production and distribution of a number of units by the government or a private institution to a passive, recipient population is one of the misleading models set up by Western countries." The Development Workshop adds: "Control, participation and culture emerge more easily in an operation that uses local resources, is labor-intensive, is small-scale, and has continuity with local traditions"*

Most of the entries in this chapter cover construction materials and techniques for building houses, other buildings, and bridges. The emphasis is on simple methods, whose principal advantages are twofold: they are inexpensive and they can be used by people to build their own homes. Wood-framed and stone structures are relatively low-cost in many areas. Earth is the most important building material, providing housing for the majority of the world 's population. The thermal properties of earth also make it well-matched to passive solar design requirements in many climates. Several books in this section discuss construction of houses made with monolithic earth walls, soil-cement bricks, and adobe bricks. There are two sets of plans for the construction of hand-operated presses that can be used to make soil-cement blocks. Improved techniques for small-scale brickmaking is the topic of several books. Two more entries cover the principles of design of underground buildings; one of these presents an owner-builder approach.

Bamboo has a long history as a flexible, safe, low-cost building material, and is plentiful today in many parts of the tropics and subtropics. Three entries cover some recent innovations and results of research in structural uses for bamboo, as well as reinforcing applications in plaster, cement, and stucco roofs and walls.

Ferrocement—a strong, thin sheet of cement reinforced with mesh—is a more recent technology with potential applications wherever durable waterproof walls, roofs, or hulls are required. It is widely used in water tank and boat construction. The techniques are described in three entries in this chapter, and in books on water tank construction (WATER SUPPLY chapter) and boat building (TRANSPORTATION chapter).

Housing by People: Towards Autonomy in Building Environments, MF 25-604, paperback book, 169 pages, by John Turner, 1977, Pantheon, Random House, out of print in 1988.

With many years of experience working in low-cost housing projects in developing as well as developed countries, Turner has written a penetrating analysis of the housing "problem," with broad implications for other kinds of appropriate technology work.

Turner proposes "a radical change of relations between people and

government in which government ceases to persist in doing what it does badly or uneconomically— building and managing houses—and concentrates on what it has the authority to do: to ensure equitable access to resources which local communities and people cannot provide for themselves." Throughout the world, so-called "low-cost housing" projects have repeated the same mistakes by setting a material standard (including building codes) ill-suited and far too expensive for the poor majority. Backed by many case studies, Turner argues that within the constraints of poverty, the poor succeed rather well in providing for their housing needs when they have land tenure and access to materials. "The economy of housing is a matter of personal and local resourcefulness rather than centrally controlled, industrial productivity."

"Personal and local resources are imagination, initiative, commitment and responsibility, skill and muscle power, the capability for using specific and often irregular areas of land or locally available materials and tools; the ability to organize enterprises and local institutions; constructive competitiveness and the capacity to cooperate." The existence and vitality of "dense local communication and supply networks open to local residents" appears to be a key factor in the "material savings and human benefits of owner-building, rehabilitation, and improvement in the United States."

Government activities in housing often prevent or hamper the use of these resources and networks. Improved income opportunities, guaranteed land tenure and building codes based on broad function rather than specific requirements would have more effect on housing for the poor than most direct housing projects.

In developing countries subsidized housing has proved a failure, for it usually is occupied by the relatively well-off and the ultimate costs of subsidized housing for all those who need it are far beyond the capability of governments to provide. Whereas, "By far the greatest financial resources are the actual savings of the population from their own earnings, and these are under their direct control. This probably represents between 10 and 15 percent of all personal incomes. It is roughly equivalent to all taxes obtained from incomes and retail sales in an economy such as that of Mexico."

Two non-monetary factors that play a very important role in housing for the urban poor are accessibility (to jobs) and security (of ownership, including the ability to sell so as to recoup the costs of improvements made). By concentrating solely on physical standards for dwellings, without reference to such factors, authorities cannot understand the decision-making context faced by the poor.

The author concludes with "an argument for the redefinition of housing problems as functions of mismatches between people's socioeconomic and cultural situations and their housing processes and products; and as functions of the waste, misuse, or non-use of resources available for housing."

Architecture for the Poor, paperback book, 234 pages, by Hassan Fathy, 1973, $14.95 from The University of Chicago Press, 5801 Ellis Avenue, Chicago, Illinois 60637-1496, USA.

Hassan Fathy, an Egyptian architect, argues that housing should be based on traditional forms of architecture, not those forms imported from the West. The people themselves should be intimately involved with the design, building and ownership of their own housing. When the government or private contractors step in and build for the people, the result is often housing and planning which is vastly out of touch with local social, cultural, economic and environmental conditions.

"This book describes in detail Fathy's plan (during the 1940s) for building the village of New Gourna, Egypt, from mud bricks, employing almost exclusively such traditional Egyptian architectural designs as enclosed courtyards and domes and vaulted roofing. Fathy worked closely with the people to tailor his designs to their needs; he taught them how to work with the mud bricks, supervised the erection of the buildings, and encouraged the revival of such ancient crafts as claustra (lattice designs in the mudwork) to decorate the buildings .... In addition, Fathy worked out an economic and organizational base, so that the production in the village derived from local crafts and organizational patterns."

Although bureaucratic and other problems prevented the completion of New Gourna, today Fathy's ideas are becoming more accepted as rural development becomes more of a priority throughout the world.

Self-Help Practices in Housing: Selected Case Studies, MF 25633, book, 129 pages, 1973, U.N. Department of Economic and Social Affairs, out of print in 1985.

Adequate housing for the growing poor communities in urban areas of developing countries is the subject of this report. Case studies of self-help housing projects are included from cities in Colombia, El Salvador, Senegal, Ethiopia, and the Sudan. These projects were undertaken by local and national government agencies, sometimes in cooperation with private organizations. Timetables and size of project varied considerably. The Senegal project involved 90 white-collar and other middle-class family heads in training and construction over a period of four years. The dismantling and rebuilding of houses for 1000 families on new land in Port Sudan was accomplished within one month.

The studies show how certain key factors affect the outcome of any self-help housing scheme An accurate assessment of loan repayment capability is one important consideration. Continued access to jobs, distribution of manual skills in construction work groups, kind of supervision, and timing of construction work periods are equally important factors that affect the success or failure of a project. The studies also show that communal activities essential to the success of the new neighborhoods, such as maintenance of waste disposal systems, depend on involvement of local leaders and groups from the earliest planning stages. An important reason for the success of the Port Sudan project, for example, was the fact that many people "had already organized themselves into teams which worked in the docks according to the arrival and departure of ships. In this way, the whole team would be free from work two or three times a week" and available to dismantle shacks and rebuild houses together. Other projects, which strictly screened participants according to need and eventual ability to repay, sacrificed these reservoirs of self-help potential by breaking them up in the selection process.

The sometimes difficult language used in this report may present problems for readers with limited English ability.

Chawama Self-Help Housing Project, Kafue, Zambia, MF 25-589, book, 80 pages, American Friends Service Committee, 1975, out of print in 1985.

"Between 1968 and 1973, a project to improve the conditions of life of squatters in Kafue was conducted jointly by the Government of Zambia, the Kafue Township Council and the American Friends Service Committee. The objective of the project was not only to provide acceptable housing with suitable amenities but also to develop patterns of cooperation among the residents which would create the

conditions of a viable and harmonious community."

This well-illustrated report covers all aspects of the project design, planning, and construction. The successful effort in community building at Chawama was the result of thorough surveys of the origins, nature and needs of the squatter settlement. Included is a good review of CINVA-Ram block construction, the building method the Chawama community finally chose.

"The project may be seen as an instance of productive collaboration between a foreign voluntary agency and an African government as they joined together to meet a pressing social need. The AFSC found that it could respond to the government's explicit request for assistance with a flexible and informed approach, as well as with a philosophical outlook in respect to self-reliance which was in harmony with the governments. Zambian participation in all aspects of the project, from planning to actual construction, was central to the philosophy underlying the program's development. Thus the AFSC played a catalytic and facilitating role, not a controlling one."

Recommended.

House Form and Culture, MF 25-603, book ,135 pages, by Amos Rapoport, 1969, $27.75 from Prentice Hall, Englewood Cliffs, New Jersey 07632, USA.

A thoughtful look at the way that cultural factors have influenced the form of houses. Although this is not intended to be a book on the practical side of building design, it is full of interesting examples of the ways different peoples have solved a wide variety of problems. Includes about 100 drawings.

"Construction and materials are best regarded as modifying factors ... they do not determine form. They merely make possible forms which have been selected on other grounds .... Given a certain climate, the availability of certain materials, and the constraints and capabilities of a given level of technology, what finally decides the form of a dwelling, and moulds the spaces and their relationships, is the vision that people have of the ideal life."

Recommended reading for those involved in low-cost housing. This book will hopefully dispel any lingering ideas that standardized box-shaped houses built of industrial materials should be imposed upon any people.

Farm Structures in Tropical Climates: A Textbook for Structural Engineering and Design, MF 25-667, book, 410 pages, edited by Lennart Bengtsson and James Whitaker, 1988, from FAO/SIDA Cooperative Programme, P.O. Box 30470, Nairobi, Kenya.

This is a broad compendium of construction information, some of it particularly useful to engineers or readers interested in learning some engineering, but most of it accessible to the general reader as well. This book is probably of greatest value to a reader with some prior construction experience who wishes to try some unfamiliar construction techniques and materials.

Major topics include presentation (drawing and model building), surveying, building materials (including traditional ones), structural design, loads on building components, the process of building production, climate and environmental control, planning, crop storage, animal housing, small farm buildings, farm dwellings, roads and fences, and water supply. None of the topics are covered in great depth, but the light treatment given to each is often sufficient to provide the reader with a good basic understanding. This material has been assembled from a

great many other references, some of them also reviewed in the **A.T. Sourcebook**. Readers looking for in-depth coverage of any of these topics should look at the narrower references reviewed here.

Shelter, MF 25-635, paperback book, 176 pages, edited by Lloyd Kahn, 1973, $16.95 from Home Book Service, P.O. Box 650, Bolinas, California 94924, USA.

"This book is about simple homes, natural materials, and human resourcefulness. It is about discovery, hard work, the joys of self-sufficiency, and freedom. It is about shelter, which is more than a roof overhead."

Filled with photographs and drawings, **Shelter** is a tribute to native, traditional, rational, and recent innovative building styles. Included are articles on a variety of structures from animal dwellings to a survey of human habitats; from the so called "primitive" to the futuristic

The authors note that there is much to learn "from wisdom of the past: from structures shaped by imagination, not mathematics, and built of materials appearing naturally on the earth."

A highly recommended and stimulating book, **Shelter** has some precise working drawings on basic designs, such as hipped, gabled, or shed roofs, concrete floors, wooden framing, windows and doors. At the back of the book, there happen to be some brief but very good drawings, photos, and text on sail windmills.

For those seeking design inspiration, **Shelter** is required reading.

Shelter II, MF 25-637, large paperback book, 224 pages, by Lloyd Kahn, 1978, $8.95 from Home Book Service, P.O. Box 650, Bolinas, California 94924, USA.

Hundreds of photographs and drawings in **Shelter II** give an inspirational view of indigenous building styles and techniques, from Nebraskan sod houses to the thatched stick dwellings of nomadic Kenyan shepherds. The author discusses the ways structure has related to culture, physical environment, and basic shelter requirements. The book emphasizes innovation and diversity among human dwellings, but the appropriateness of traditional building technologies is also a unifying theme. "Practical builders, wherever they live, work with simple techniques and what is most readily at hand: earth, thatch, stone milled lumber or abandoned city buildings. Weather, purpose, materials govern design. Tradition, experience, practice determine building technique."

Some of the most practical shelter alternatives for North America—stud-frame and adobe construction—are explored. An introduction to design of small single family houses is followed by a guide for pouring the foundations, framing, and roofing a stud-construction house. Also included are sections on interiors, bungalows, yurts, cabins, and dismantling buildings for scrap. The book concludes with pictorial case studies of homeowner rehabilitation in Massachusetts and cooperative homesteading in gutted buildings in New York.

A fascinating book with a broad range of design ideas and useful information. Certain to fire the imagination of all kinds of owner-builders.

Appropriate Building Materials, MF 25-584, book, 324 pages, by R. Stultz and K. Mukerji, 1981, revised 1988, Swiss Francs 30.00 from SKAT; also from ITDG and TOOL; also available in Spanish.

A useful reference book for people who wish to research Various traditional

and promising new materials for use in construction of one-story buildings. The book begins with "Fundamental Information on Building Materials," which discusses soils and soil testing, binders, concrete fibrocement, natural fibers, bamboo and timber. Next, "Fundamental Information on Building Elements" covers components of buildings such as foundations, bricks, and roofing. Finally, examples of each building element are given.

Recommended.

A Manual of Building Construction, MF 25-616, book, 360 pages, by the Rev. H. Dancy, 1948, revised 1975, £8.95 from ITDG; also available from TOOL.

Originally published by the Sudan Interior Mission in 1948, this book was reprinted by ITDG because it has "exceptional value as a practical field building manual." Written for missionaries as amateur builders/supervisors, the text occasionally reflects the paternalistic thinking of the time.

A comprehensive manual, it deals with the essential elements of permanent dwelling construction, relying on block, brick, adobe, or stone walls. The author makes effective use of illustrations. The book does, however, reflect only Western ideas of proper house construction and design. It does not draw on the building methods, designs and experience of other cultures, nor does it touch on the innovative new building techniques such as ferrocement and the various methods for making stabilized earth blocks.

The Owner-Built Home, MF 25-624, book, 367 pages, by Ken Kern, 1975, out of print, spiral-bound photocopy available for $23.00 postpaid (airmail extra) from Owner Builder Publications, P.O. Box 817, North Fork, California 93643, USA.

"The Owner Built Home is intended to be a how-to-think-it book. Alternatives to the professionally executed, contractor built home are presented in text and through non-detailed sketches." It is mostly concerned with design considerations for all facets of home building.

The areas covered include heating and natural ventilation, living space design, floor, wall, and roof design. One-third of the book covers how to work with different kinds of building materials—adobe blocks, rammed earth, concrete, wood frames, pole frames, stone masonry. This is perhaps the most useful, practical information contained in the book; it gives a good view of the principles and techniques of building with rammed earth, for example.

The rest of the sections on general design are somewhat directed towards Americans building their own homes. However, the materials sections provide a very good practical overview.

This book does not tell you how to build a house—it tells you all the things to consider in designing a house.

The Owner-Built Homestead, MF 25-625, book, 400 pages, by Ken Kern, 1975, $13.00 postpaid (airmail extra; two or more copies $8.00 postpaid each to readers in developing countries) from Owner Builder Publications, P.O. Box 817, North Fork, California 93643, USA.

This book is a supplement to **The Owner Built Home** (see review above). It covers how to develop the land around a home—a garden, orchard, pasture, wood lot, water supply, wells, fish-culture ponds, fencing, barn, shop and outbuildings.

Also included are an oil drum stove design, an adobe barn and silo (for grain storage) design, animal shelter and feed management, waste disposal methods such as composting privies, and nutrition.

Like **The Owner Built Home**, this book is an overview of the great many topics included, and a broad compilation of skills and techniques. There is again a slant towards North American applications. For their value as very complete skills, ideas and methods guides, we feel Ken Kern's books are extremely useful and lend themselves very well to use in other countries.

Construction Reference Manual, MF 25-652, book, 113 pages, by Donald Batchelder et. al., Experiment of International Living, Brattleboro, Vermont, out of print.

This training manual, based on experiences in Uganda, covers a variety of Western and local construction techniques. These include, for example, poured perimeter foundations using concrete or a clay/ash/cowdung mixture, rough framing for doors and roofs, and anthill kilns for brick production.

How to Build a House Using Self-Help Housing Techniques (Como Fabricar una Casa Usando Tecnica Ayuda Propia), MF 25-605, illustrated book, 50 pages, 1974, stock number O23-000-00276-1, U.S. Government Printing Office, Washington, D.C., out of print.

"This manual is designed as a graphic means of demonstrating the basic methods and techniques used in building a home, whether it be a one room cabin or a more complicated dwelling. It has been conceived as a basic technology handbook for use by either individuals or groups who have the goal of building, or adding to, a home of their own, and for those involved in self-help home building projects."

Each of the many drawings presents a complete idea, so a knowledge of English or Spanish is not essential. The drawings are clear and simple.

This manual is intended to be an idea book, to show the reader different methods of constructing each part of a house. For example, there is a section which illustrates methods of making floors using either wood, concrete or stone. There are also sections on walls, roofs, windows and doors, water supply systems, sewage disposal systems, how to measure and lay a foundation, and a comparison of house designs appropriate to different climates: rainy, hot, hot and humid, and temperate areas. The designs are distinctly Western.

Rural Building: Reference Book, MF 25-672, 244 pages, by John van Winden, 1986, Dfl. 18.00 from TOOL.

This is the first in a four-volume set written for use by both teachers and students in technical training courses on simple building techniques for rural areas. It was developed based on many years of teaching experience in Ghana.

This volume introduces basic hand tools used in construction, along with commonly used rural building materials (wood, sand, aggregates, lime, cement, concrete). Steel mesh and reinforcing bars, pressed blocks, concrete blocks, plywood, fasteners, and door and window fittings are all briefly covered.

Rural Building: Basic Knowledge, MF 25-669, book, 184 pages, by John van Winden, 1986, Dfl. 16.25 from TOOL.

This second volume in a four-volume set introduces basic construction techniques. It begins with masonry wall construction (including corner bonds, cross junction bonds, and attached piers and their footings). Site preparation and foundations, and concrete floors are also briefly covered.

Basic carpentry techniques are the other major topic of this book, but this is limited to light carpentry used in small items, not wood framing for buildings. (Readers seeking details on how to make doors, windows and lightweight roofs should refer to another volume in this series entitled **Rural Building: Construction**.)

Rural Building: Construction, MF 25-671, book, 301 pages, by John van Winden, 1986, Dfl. 21.50 from TOOL.

Of the books in this series, this is the most complete on construction techniques. Major topics include site preparation and foundations, masonry walls, doors and windows and their frames, scaffolding, arches, reinforced concrete lintels over doorways, timber roof construction including trusses, plastering, reinforced concrete slabs, concrete floors, and locks and fittings.

Rural Building: Drawing Book, MF 25-670,126 pages, by John van Winden, 1986, Dfl. 14.25 from TOOL.

This is another introductory drawing book, but the emphasis is on drawings used in building construction plans. Topics include scale drawings, foundation plans, floor plans, elevations, cross sections, and site plans. This is part of a four-volume set of books used in a vocational training course for rural builders.

Self-Help Construction of 1-Story Buildings, Peace Corps Appropriate Technology for Development Series Manual M-6, MF 25-632, book, 235 pages, by Peter Gallant, 1980, available to Peace Corps volunteers and development workers from Peace Corps; also available from ERIC (order no. ED241769) and NTIS (accession no. PB85 245066/AS).

The author stresses the importance of involving the people who will use a building in the process of planning and design. The text balances basic concepts and techniques for planning with a more technical presentation of basic construction principles using low-cost materials available in most parts of the world. In particular, concrete, bamboo, and adobe are discussed, with separate chapters to deal specifically with latrines and construction in earthquake areas. Examples of cut-out "human measuring pieces" will help in arriving at room size and laying out of floor plans. Clearly illustrated.

Construire en Terre, MF 25-592,265 pages, by Doat, Havs, Houben, Natuk and Vitoux (CRATERRE), 1979, Groupe de Recherche sur les Techniques Rurales (GRET), out of print.

Produced by a group of architects, this French language manual is one of the best books available on earth building construction. Rammed earth (pise), adobe,

compressed blocks, soil analysis, soil stabilization, and earth roofs are the major topics.

This exceptional book contains hundreds of drawings and photos documenting a wide range of indigenous earth construction techniques from Sub-Saharan Africa the Middle East, China, Latin America, North Africa and elsewhere. Use of local materials and owner or community labor in house construction has obvious advantages in developing countries; in fact, more than half the world's population is estimated to live in earth buildings. This volume may contribute to a cross-fertilization of ideas and thus better exploitation of the possibilities offered by earth construction in the South.

Handbook for Building Homes of Earth, MF 25-602, book, 158 pages, by L. Wolfskill, AID, 1962, accession no. PB-179 327, paper copies $23 domestic, $46 foreign; microfiche $8 domestic, $16 foreign; from NTIS; also available in French (title: Batir en Terre, accession no. PB80-149024, same prices).

This is a very complete, all-purpose manual covering all types of earthen housing construction including adobe, rammed earth, and pressed blocks. The author also discusses different types of soils, testing soil, soil stabilizers, building site preparation, foundations, roofs, and preparing soil. There are detailed chapters on how to make different kinds of blocks, and how to build structures with them.

The contents will be useful in many different climates and regions—for example, there is information on soil cements applicable to humid, tropical climates where protecting earth structures from rain is important. Photographs and illustrative drawings are included.

Earth for Homes, HUD Ideas and Methods Exchange #22, MF 25-593, book, 70 pages, Housing and Urban Development, publication no. PB-188-918/ 7, domestic prices $19.00 plus $3.00 handling, overseas prices $38.00 surface mail plus $4.00 handling (airmail extra), from NTIS.

This book is very similar to **Handbook for Building Homes of Earth** (see review); it covers almost all of the same material but is not as detailed. For example, all the different methods of earth wall construction are covered in one chapter here. Soil stabilizers, earth floors and roofs, and general wall design considerations are discussed. There are only a few drawings and photographs. A good secondary reference book

Mud, Mud: The Potential of Earth-Based Materials for Third World Housing, MF 25-620, book, 100 pages, by Anil Agarwal, 1981, Earthscan, Dfl. 15.50 from TOOL.

The author argues that mud-based housing (such as adobe, earth bricks, soil cement, etc.) may provide the only answer to the need for low-cost housing throughout the developing world. Written primarily to influence people making planning and policy level decisions, the book also presents useful information for the designer/builder in its survey of mud-based housing in 25 countries.

Building with Earth: A Handbook, MF 25-673, book, 72 pages, by John Norton, 1986, £6.50 from ITDG.

A practical guide aimed at helping the reader decide when it is appropriate to

build with earth, and how to do so effectively, with an overview of the major techniques and considerations. Look here in particular for the section on testing soils with simple equipment and protecting walls from water damage (rendering). Other books more thoroughly cover specific techniques, such as rammed earth and vaulted roof construction.

Mud Brick and Earth Building the Chinese Way, book, 158 pages, by Ron Edwards and Lin Wei-Hao, 1984, $18.00 from Rams Skull Press, Box 274, Kuranda, Queensland 4872, Australia.

A magnificent, profusely illustrated treatment of traditional techniques of earth construction that are still practiced in China today. This book was intended for use by people wishing to apply these techniques themselves in Australia. Topics include mud brick production, rammed earth, pole mold walls (a much faster variation on rammed earth), rammed bricks (a cousin of compressed earth blocks), wattle and daub, fired bricks, plaster, and tile and thatched roofs. Special attention is given to foundations and piers. Cave and pit dwellings are also examined, along with an interesting assortment of fittings for doors, windows, and so forth.

A chapter on timber framing provides a nice look at a more economical version of post and beam construction that tends to utilize modest poles and posts, rather than the massive beams typically seen in references published in the United States.

"The pole mould system is ideal when there is a lot of wall to be built and the final finish is not of major importance. Some workers that I spoke to claimed that it was four to five times faster than building a rammed earth wall using conventional moulds. However, I think that part of this speed can be attributed to the fact that more workers can join in." A group of ten family members produced 12.5 meters of 2.6 meter high wall in a single day. The key disadvantage of this system is that it leaves weak points between each section of wall, which are subject to erosion.

Manual for Building a Rammed Earth Wall, MF 25-614, large illustrated booklet, 28 pages plus appendices, by L.A. and D.J. Miller, 1982, $8.00 postpaid from Rammed Earth Institute Intl., 2319 21st Avenue, Greeley, Colorado 80631, USA.

A concise book providing complete instructions for laying foundations, building and assembling form panels, and the earth tamping (ramming) process itself. Although the authors describe walls built for large homes in the U.S., the method has applications in many areas. Soil testing and stabilizing, making test blocks, and tamping tools are also covered.

"It is our experience that no concrete cap is needed on the wall. We recommend that you insert an eye bolt 12 inches long with a 12-inch piece of reinforcing rod through the eye of the bolt .... We have not provided the specifications and plans (for a house). That is beyond our abilities. We urge you to consult one of the many good books on house construction."

Adobe as a Socially Appropriate Technology for the Southwest: Solar Adobe Sundwellings, MF 25-582, report, 45 pages, by John Timothy Mackey, 1980, $20.00 from Center for Village Community Development, 1370 Townview Avenue, Suite 207, Santa Rosa, California 95405, USA

Adobe construction (using sun-dried earthen bricks) has been an ecologically

sound, low-cost building technique in many parts of the world for thousands of years. This paper examines the historical and current use of adobe in the southwestern U.S. Economic, social, and environmental considerations indicate that in this region, adobe is a truly "appropriate" technology: it is long-lasting conserves energy, uses local building materials, creates jobs, requires little capital, and "fits" culturally.

Adobe brickmaking and basic construction techniques are discussed, along with the thermal properties of adobe which have made it ideally adapted to passive solar construction in the southwestern U.S. Mesa Verde, Colorado is an ancient Native American city where " 'massive stone buildings are clustered under a cliff which protects them from the heat of the summer sun ... at Chaco Canyon (another ancient community in New Mexico) ... the buildings were terraced and the roofs of each succeeding unit provided a space outdoors to live and work in contact with nature. All day the sun's heat was buried in these massive walls, and in the great cliff to the north, which also protected them from winter winds.' "

Making the Adobe Brick, MF 25-613, book, 88 pages, by Eugene Boudreau, 1972, Bookworks, Random House, Inc., out of print in 1985.

Like several other books in this section, this one covers the basic operations in making adobe (mud) bricks. These include testing and choosing the proper soil, mixing the soil with a stabilizing agent (emulsified asphalt), and molding and drying the bricks using wood molds. Wall construction with the finished adobes is also discussed, as are Uniform Building Code requirements for construction with adobe in the United States.

Adobe Craft, MF 25-583, book, 72 pages, by Karl Schultz, 1974, out of print in 1985.

In addition to detailed information on brickmaking, this book describes the production of reinforced poured adobe, a process that eliminates the need for bricks. The appendix contains a very good explanation of adobe construction methods, as well as how to use oil drums to make both a soil sifter and a mixer.

Soil Cement: Its Use in Building, MF 25-640, book, 126 pages, by Augusto A. Enteiche G., 1964, 1980 edition $7.00 from UNIPUB, publication #E.64.IV.6; also available in Spanish and French.

"The compound of soil, cement and water, mixed in the proper proportions and compacted to the proper degree, constitutes "soil-cement." This paper shows how soil-cement may be used at various stages in the construction of a house, together with a number of examples which may be helpful to anyone wishing to use this material for building purposes.

"**Soil Cement** is divided into chapters, dealing with basic facts and practical application on: knowing soils, soil as a construction material, the preparation of soil-cement, the use of soil-cement for housing, and accomplishments in soil-cement. The order of presentation, the terminology used, and the large number of illustrations, are all designed to make the instructions more readily understandable with a view to the greatest possible circulation and impact."

The author was a staff member of CINVA (Inter-American Housing and Planning Center) in Colombia, South America, where the CINVA-Ram was developed (see **Making Building Blocks with the CINVA-Ram**). **Soil Cement** also

covers the use of the CINVA-Ram for making building blocks.

This book covers the subject of soils and soil-cement very completely; it is comparable to **Handbook for Building Homes of Earth** (see review) in the amount of useful information it has; the difference is that it concentrates on the use of cement as a soil stabilizer, rather than including all forms of stabilized soil construction.

Soil Block Presses, MF 25-660, book, 128 pages, by Kiran Mukerji, 1986, available from German Appropriate Technology Exchange, Dag Hammarskjold Weg 1, 6236 Eschborn, Federal Republic of Germany.

Around the world there are quite a variety of hand-operated presses for the production of building blocks from compressed soil. This book is the only place to find a summary of the design options for such presses.

The manufacturer's address and the rate of block production are provided for each design. Rates of production are mostly 40-60 blocks per hour with 3 workers with the hand operated equipment, although one design claims as much as 200 blocks/hour with 4 workers. The automated and semi-automated equipment generally produces from several hundred to as much as 1500-2500 blocks per hour with 3-4 workers. Much of the book consists of data sheets from the manufacturers.

Making Building Blocks with the ClNVA-Ram Block Press, MF 25-612, instruction manual, 21 pages, 1966, $6.25 (overseas orders add $3.00 for surface mail, $5.00 for airmail), from VITA.

"The CINVA-Ram is a simple, low-cost, portable machine for making building blocks and tiles from common soil. The press, made entirely of steel, has a mold box in which a hand operated piston compresses a slightly moistened mixture of soil and cement or lime" Blocks made with the CINVA-Ram are easier to make than concrete blocks, are low-cost, and can be made on a building site and so avoid transportation costs.

"This manual combines the experience of four people who used the CINVA Ram and figured answers to the inevitable problems of detail as they came up day after day." It is intended as a manual for fieldworkers and supervisors, giving instructions on how to use the Ram, including: testing and mixing the soil, operating the Ram to make blocks, curing the blocks, and construction using pressed blocks.

Subtitled "A Supervisor's Manual,' this book is intended as an instruction manual on how to use the CINVA-Ram. The Ram can be purchased for about US $250.00 (1976) from METALIBEC Ltda, Apartado Aereo 11798, Bogota, Colombia.

Two sets of plans for similar earth-block ramming machines are reviewed elsewhere (**Assembly Manual for the Tek-Block Press**, from Ghana, and **La CETA-Ram**, from Guatemala). See also review of **Soil Cement: Its Use in Building** and the accompanying drawing of the CINVA-Ram, in this section.

La CETA-Ram, MF 25-608, booklet, 14 pages, by Roberto E . Lou Ma, 1977, Centro de Experimentation en Tecnologia Apropiada (CETA), Guatemala City, Guatemala, out of print.

This Spanish language booklet (with English summary) provides drawings and photos of a machine for making pressed soil-cement blocks. This machine is unusual in that it makes two holes in each block so that reinforcing rods for

earthquake protection can be used.

Only one of the drawings, showing only the block itself, includes dimensions. All other dimensions of the machine will have to be calculated from this. The thickness of steel to be used, and the precise positioning of the pivot points are not provided, which is likely to cause the reader some difficulty.

The construction details provided for the Tek-block press (see review) are much more complete. Readers may wish to combine the two designs, for use in earthquake areas.

Manual para la Construccion de la CETA-Ram, MF 25-617, booklet, 29 pages plus plans, by Roberto E. Lou Ma, CETA/USAC, 1981, $12.00 postpaid (includes set of plans for the machine) from Centro de Experimentation en Tecnologia Apropiada, 15 Avenida 14-61, zona 10, Guatemala City, Guatemala; available in Spanish only.

This manual, in Spanish, contains more detail and better diagrams (with dimensions) than La CETA-Ram. However, it lacks the English summary of the earlier version.

Assembly Manual for the Tek-Block Press, booklet of plans, 26 pages, by John Dye, $5.00 from Department of Housing and Planning Research, Faculty of Architecture, University of Science and Technology, Kumasi, Ghana.

This is a complete set of drawings for the production and assembly of a hand operated press for making soil-cement building blocks. The blocks are about 4% cement and 96% soil. "These soil-cement blocks are nearly as strong and water resistant as sandcrete blocks, while containing about one-third as much cement." The blocks are made at the building site, greatly reducing the amount of materials that must be transported. The press can also be used to make sun-dried blocks (no cement added) for very low-cost construction.

These plans are for a simplified, strengthened version of the machine, which has been widely used in Ghana for more than 5 years. The basic concept is similar to the CINVA-Ram.

"Although a shaping machine, milling machine, and planing machine are all specified, it is possible to fabricate the machine if only one of these is available." The parts are all welded together.

The press can be operated by one person. Up to 10 people can be employed, at which point the machine is being operated continuously while digging and mixing of soil, and stacking of new blocks is going on. Output is 200 to 400 blocks per day with a 3 person crew.

Brickmaking in Developing Countries, MF 25-651, book, 88 pages by John Parry, Building Research Establishment United Kingdom, 1979, Dfl. 33.50 from TOOL.

A very well-presented discussion of the technologies and economics of brickmaking, this book especially examines the advantages of traditional producers over modern mechanized brick plants. Some of these apply to other labor-intensive vs. capital-intensive technologies as well. The traditional producers have low fixed costs and low total costs, and are able to vary output with market demand without affecting their economic viability. The major disadvantage of the traditional producer has tended to be variable brick quality— the author explores simple tools and techniques that can overcome this problem.

Current practices in a range of developing countries are reviewed, and the scope for improvement is identified in each case. Well-illustrated and well-written. Recommended.

Selection of Materials for Burnt Clay Brick Manufacture, Technical Bulletin #7, MF 25-630, leaflet, 5 pages, by Papua New Guinea's Building Research Station, 1970, out of print in 1985.

"The purpose of this bulletin is to provide instruction in the preliminary identification of suitable materials for burnt clay products." Burnt clay bricks are made from clay, and then fired in a special oven (kiln). Simple tests to determine whether a material is suitable for use in burnt bricks are described.

Small Scale Brickmaking, MF 25-659, book, 210 pages, ILO, 1984, $24.50 from VITA; also from ITDG, TOOL, and ILO.

This volume consists primarily of technical details on the various steps in brick production, and some possible improved technologies. There is more technical information here than in **Brickmaking in Developing Countries**, but the latter should be read first for its perspective on needed improvements in traditional production systems and its general observations on the economics of brickmaking.

The smallest production units of 1000 bricks per day capacity are the main concern of this book, but larger units are also described.

Small-Scale Manufacture of Burned Building Brick, MF 25-639, booklet, 14 pages, by D. Thomas, $6.25 (overseas orders add $3.00 for surface mail, $5.00 for airmail), from VITA; also available in French and Portuguese.

"The purpose of this manual is to outline, in as simple a manner as possible, the details of making and burning clay brick suitable for domestic building. The scope of the manual is confined to 'cottage industries' .... The author has had personal contact with such brickmaking plants in both Central Mexico and Honduras."

The booklet "explores the establishment and operation of a building-brick plant wherein nothing but 'on-hand' materials and labor will be utilized."

This is a step-by-step guide that also covers important considerations such as the location of suitable clay deposits and the firing and cooling of the finished bricks. Includes illustrations of the kiln and the brick loading patterns.

1000 to 3000 Capacity Brick Kiln, Technical Bulletin #12, MF 25622, leaflet, 18 pages, by PWG Dept. of Works and Supply, 1973, limited supply, free to serious groups from DWS.

"A 1000 to 3000 capacity brick kiln has been devised by the Building Research Station, to meet the needs of small scale intermittent production of a durable material at the village level. The kiln is a rectangular construction with an internal dimension sufficient to stack to a predetermined pattern of a maximum of 3000 bricks within its walls."

According to the authors, "the design has been made as simple as possible eliminating the need for skilled labor in its construction." Their design appears to be an efficient one capable of creating uniformly durable bricks; significant if this

characteristic is an important one in the reader's area. This kiln is more complex than the one described in VITA's Small Scale Manufacture of Burned Building Brick (see review). Also, this design doesn't employ a flue system, and the fire box construction seems less flexible than in the VITA design (which could be easily enlarged to whatever capacity is desired).

A well-illustrated leaflet with a glossary of terms and detailed drawings.

The Owner-Builder's Guide to Stone Masonry, MF 25-623, book, 192 pages, by Ken Kern, Steve Magers, and Lou Penfield, 1976, out of print, spiral-bound photocopy available for $23.00 postpaid (airmail extra; two or more copies $8.00 postpaid each to readers in developing countries) from Owner Builder Publications, P.O. Box 817, North Fork, California 93643, USA.

"The purpose of this book is threefold: 1) We show the inexperienced builder how to 'lay up' stone for various walls, how to 'face' building framework and how to 'cast' stone in a wall with a movable form; 2) ... (we) acquaint readers with the native properties and the availability of usable building stone. Next to earth, there is no more universal nor less appreciated building resource than stone; 3) ... (we) express the aesthetic satisfaction we three authors have experienced building with stone."

The authors carry out their purposes well: teaching the basics of building with stone. The only significant lack of information is on the coverage of earthquake problems. The book covers building with or without concrete, and there is a glossary of masonry technical terms.

"When you trowel mortar use only as much as necessary to provide the bed with sufficient covering. Too much mortar will only squish out and cover the stone face. Do not trowel smooth the mortar; let the stone mash it down. In this way gaps will more certainly be filled. Once a stone is in place try not to move it. Any movement will weaken the bond between stone and mortar."

Fireplaces, MF 25-600, book, 192 pages, by Ken Kern and Steve Magers, 1978, $10.00 (two or more copies $5.00 each to readers in developing countries) plus $3.00 per book postage and handling (airmail is extra), from Owner-Builder Publications, P.O. Box 817, North Fork, California 93643, USA.

"The traditional fireplace not only sends some 80 percent of the fire's heat up the chimney but a goodly portion of the room's heat as well." This is a practical book on good fireplace design to overcome this basic disadvantage of fireplaces in home heating. Step-by-step construction techniques are presented. The authors discuss the qualities of different building materials: "Most stone cannot withstand intense heat; in a fire box it soon fragments ... due to rapid surface expansion"

These specific skills and materials will be of most interest to readers in rich countries with cold climates. However, the general theory and principles presented are relevant in any setting. Another high quality Owner-Builder book.

The Timber Framing Book, MF 25-643, paperback, 178 pages, by Stewart Elliott and Eugenie Wallas, 1977, $19.95 from Housesmith's Press, P.O. Box 157, Kittery Point, Maine 03905, USA.

Timber-framing is a method of housing construction using interlocking notches and grooves combined with wooden pegs to connect the major wooden

beams. The method is labor-intensive and requires tools not common to modern Western carpentry but still common and inexpensive in many developing countries: the adze, auger, draw knife, chisel, and axe.

"Timber-frame houses built in Europe as early as the fourteenth century stand proud and sturdy to this day. Compared to conventional construction, timber-frame structures can be 20 to 30 percent less expensive to build. Less energy is expended in both the milling and the construction of the frame .... If you have some basic carpentry skills, you and some helpers can frame a house using the information in this book. If you do not, and have a carpenter in mind who has not previously used timber framing, he can use this book to teach himself how."

Where wood is plentiful the timber-framing methods of housing construction can be used to build houses of great durability (but you will have to look elsewhere for preservation information). Where wood is scarce, soil-cement, adobe and other wood-conserving construction materials would be more appropriate.

There are illustrations and pictures on almost every page, and a thorough glossary.

Wood Handbook: Wood as an Engineering Material, Agriculture Handbook No. 72, MF 25-662, book, 432 pages, by Forest Products Laboratory, USDA, 1974, out of print.

An in-depth reference book on the physical properties and characteristics of wood, this covers North American and some other hardwood and softwood species. Shrinkage, working qualities, decay resistance and mechanical properties (e.g., shear strength, modulus of elasticity) are discussed. Other topics include fasteners, beams and columns, glued-laminated timbers, plywood, and paint protection of wood. While the species listed here will not usually lee the same as those encountered in the South, the reader can get an idea of the range of values within which local species can probably be placed (e.g., in the selection of timber beam sizes for short bridges). A good place to look when you need a few important, hard-to-find numbers.

Pole Buildings in Papua New Guinea, MF 25-627, booklet with design drawings, 41 pages, by Peter Lattey, Forest Products Research Centre, 1974, US $5.00 from the Forest Research Institute, P.O. Box 314, Lae, Papua New Guinea.

This book describes work with traditional designs from PNG using wooden poles to build houses, schools, and meeting centers. Twelve designs are presented, with drawings and photos. Also covered are details of how to connect poles at joints, and how to join the poles to walls using galvanized iron strips.

The designs are based on the author's actual experience in building in PNG. He used traditional building techniques, updating and improving them. The methods and the designs should be applicable to many places where wood poles are available for housing, if an effort is being made to use low-cost local materials, local labor, and simple construction techniques.

Wood-Frame House Construction, MF 25-663, book, 223 pages, by L.O. Anderson, Forest Products Laboratory, USDA, 1975, revised edition 1989, $13.00 from Superintendent of Documents, USGPO.

Most houses in the United States are built using wood frame construction.

This involves using wood 2" by 4" to build the structural portions that provide the strength, carry the weight of the roof, and hold the house together. Interior and exterior walls and the roof are then covered with other materials.

The technique requires an abundant supply of low-cost milled lumber, a condition not met in most developing countries. However, some elements common to wood frame construction can be usefully incorporated into other building systems. For this purpose, this is a useful reference.

Popular Manual for Wooden House Construction, MF 25-656, book, 95 pages, by Instituto de Pesquisas Tecnologicas, Brazil, 1985, $12.00 (order no. E.90.III.E.6) from United Nations Publications, Sales Section, Room DC2-853, New York, New York 10017, USA; or $6.00 from UNIDO; also available from TOOL.

Hundreds of cartoons and drawings illustrate the construction of low-cost wood frame houses in this manual based on designs originally used in Brazil. The construction system presented is an interesting simplification of Western platform frame construction, and may offer ideas to readers seeking the advantages of this technique for special structures. It does require a good supply of milled lumber of consistent dimensions. The cost (US$50-60 per square meter, $4.635.56 per square foot), while very low by industrial country standards, averaged $2000 (40 square meters) for the 40 houses built in 1982. The author does not consider the severe space constraints faced by urban slum dwellers, the piecemeal construction strategy they commonly use, the extreme difficulty they have in raising such sums of money, or the likelihood that "low income" families able to raise $2000 would probably choose to invest it in a small business rather than a house.

The manual is intended for people without construction experience. Local language translations can be substituted for the English text. Wood species appropriate for the different components are identified for different parts of the world.

Low-Cost Country Home Building, MF 25-610, book, 119 pages, by the Department of Environment and Planning, Australia, 1981, Aust. $19.95 for paperback from Hale and Iremonger Ltd., G.P.O. Box 2552, Sydney, N.S.W. 2001, Australia.

A thorough and innovative guide for low-cost rural home builders in Australia, this text should be very useful in many other regions and applications as well. Of particular interest is the information on siting and landscaping to affect the climate of the area immediately surrounding the home. Also contains useful construction information for non-conventional, non-manufactured building materials.

Recommended.

Low-Cost Housing: Prefabricated Panel System, Technical Bulletin No. 14, MF 25-611, booklet, 39 pages, by D. Brett of Papua New Guinea's Dept. of Works and Supply, 1974, K3.50 from Dept. of Works.

"To assist in providing accommodations for low income earners in PNG this bulletin outlines economies possible by using a prefabricated panel construction technique. Prefabricated building can maximize returns in material, labor and money. This bulletin explains a simple technique through which reductions in materials and construction time can significantly reduce other building costs."

Contains construction techniques using these prefabricated walls (made from wood), assembly drawings for making the panels themselves, and photographs. The panels can be made locally using only hand woodworking tools.

Painting Inside and Out, USDA Home and Garden Bulletin #222, MF 25-654, booklet, 26 pages, 1978, publication 203N, Consumer Information Center, Pueblo, Colorado, out of print.

Wood and other construction materials need paint for protection against the sun and weather, to ensure a long life of service. General advice on painting is contained in this booklet written for a U.S. audience. The recommendations regarding such topics as surface preparation, use of primers, effects of temperature extremes, etc., also apply to other parts of the world, although the paints available will vary.

Manual of Rural Wood Preservation, MF 25-615, booklet, 27 pages, Forest Products Research Centre, 1975, US $5.00 from Forest Research Institute, P.O. Box 314, Lae, Papua New Guinea.

This is a practical manual for wood preservation techniques, useful in any tropical area where wood rots quickly or is eaten by termites. The areas covered include sections on wood destroying insects and fungi, building practice materials (including poles and woven bamboo), and treatment methods for rural areas (including sap replacement, use of C.C.A. and Octabor chemical preservatives). This last section outlines the various treatment methods in detail. The building techniques described will help in designing wooden structures to last longer.

Bambu—Su Cultivo y Aplicaciones, MF 25-586, book, 318 pages, by Oscar Hidalgo Lopez, Bambutec, P.O. Box 54118, Bogota, Colombia, 1974, in Spanish, out of print.

Available in Spanish only, this book contains a wealth of information about the cultivation and applications of bamboo in construction, engineering, paper processing, and handicrafts. Extensive illustrations and detailed graphs help present the biology and technology of this "wonderful weed" from throughout the world. Some of the more unusual examples include a 225-meter bamboo bridge (with five supports) spanning the Min River in Szechuan Province, China; an experimental single engine airplane from the Philippines with wings and fuselage of bamboo; and a bamboo geodesic dome seating 2000 people built in Honolulu Hawaii.

Many variations of bamboo construction joinery, appropriate hand tools, low-cost housing, bridge building, preservation techniques, and bamboo-reinforced concrete forms and formulas are described in this fascinating book. Even those unable to read Spanish will find many ideas and much inspiration through the illustrations alone

Highly recommended.

Nuevas Tecnicas de Construccion con Bambu, MF 25-621, book, 137 pages by Oscar Hidalgo Lopez, 1978, in Spanish, Estudios Tecnicos Colombianos Ltda., out of print.

A companion to Oscar Hidalgo Lopez's epic **Bambu—Su Cultivo y Aplicaciones**, this volume provides information on cultivation of a valuable Colombian bamboo species, and several specific applications of bamboo in

construction. Featured are A-frame structures for coffee processing and low-cost housing and a soil-cement plaster on a split bamboo base as an innovative roofing material. Another application with a lot of potential is bamboo reinforcing of cement and concrete; here it is used in water containers, flat panels, and concrete beams (with technical information on strength).

The Book of Bamboo, MF 25-650, book, 332 pages, by David Farrelly, Sierra Club Books, out of print.

An astonishing variety of bamboo uses for tools and structures are described in this book, along with a lengthy treatment of bamboo species and biology. The text knitting all of this together flows from fact to whimsy, from historical detail to philosophical wandering. English language readers now have something as voluminous and comprehensive as Oscar Hidalgo Lopez's Spanish language books on bamboo.

Bamboo as a Building Material, MF 25-585, booklet, 52 pages, by F.A. McClure, 1972 (revision of reports dated May 1953 and June 1967), accession no. PB-188 921, paper edition $17.00 in U.S., $34.00 overseas; microfiche $8.00 in U.S., $16.00 overseas; from NTIS.

The how-to material and many of the photos in this booklet have been reprinted in the VITA Village Technology Handbook. Shows techniques of fastening bamboo without the use of nails, and various uses of bamboo in building construction around the world.

One section is given to bamboo reinforcement of concrete; this is a reprint of a technical summary of conclusions from tests on concrete beams. Problems included bond between bamboo and concrete, and swelling that occurs when seasoned bamboo absorbs moisture from wet concrete.

While many houses have been built with only a machete, more refined or elaborate structures might require some of the handtools briefly described (no illustrations). The booklet also includes a lengthy list of bamboo types used around the world, and a 60-entry list of selected references up to 1953.

The Use of Bamboo and Reeds in Building Construction, MF 25645, book, 95 pages, U.N. Dept. of Economic and Social Affairs, 1972, out of print in 1985.

"Bamboos and reeds are the oldest and chief building materials in rural areas and villages throughout the world's tropical and subtropical regions .... More people live in bamboo and reed buildings than in houses of any other material. Bamboo and reed construction is popular for good reasons: the material is plentiful and cheap, the villager can build his own house with simple tools, and there is a living tradition of skills and methods required for construction. This tradition has been augmented in recent years by experiments carried out principally in India, Indonesia, the Philippines and Colombia. The bamboo and reed housing is easily built, easily repaired, well-ventilated, sturdy and earthquake resistant."

"Deterioration by insects, rot fungi and fire is the chief drawback of bamboo and reeds as building materials."

This study was produced to inform government planners, extension officers, contractors and villagers of new or less well-known techniques of construction, and to stimulate additional research to improve the material properties and techniques

of building construction with bamboo and reeds.

Included are descriptions with photos of common uses of bamboos and reeds drawings of a wide variety of joints used in building with bamboo, a summary of research (now 25 years old) on concrete with bamboo and reed reinforcing, strength data on selected bamboo species used in construction, tools and species lists, and preservatives for different bamboo end uses. Some of the material was taken from **Bamboo as a Building Material** (see review).

A Series of Articles on the Use of Bamboo in Building Construction, MF 25-658, 177 pages, collected by Dr. Jules J.A. Janssen, 1982, ITDG, out of print.

This welcome collection assembles a variety of practical bamboo articles in one place. Preservation techniques are followed by sections on the use of bamboo in housing, bridges, water supply, and concrete reinforcement. One article explains how to calculate the strength of bamboos for construction purposes.

Plastic Sheeting: Its Use for Emergency and Other Purposes, MF 25-655,18 pages, by Jim Howard and Ron Spice, 1973, 1989 edition £1.95 from Oxfam Publications, 274 Banbury Road, Oxford OX2 7DZ, United Kingdom.

A basic introduction to polyethylene sheeting, its performance, and various means of fastening it on structures.

The Yurt, MF 25-649, one large sheet of plans, by W. Copperthwaite, specify 10 to 12 or 17-foot ($15.00), 32-foot ($25.00), or 54-foot diameter yurt ($50.00), 30% discount for developing countries, from the Yurt Foundation, Bucks Harbor, Maine 04618, USA.

The Yurt is a circular dwelling that originates in Mongolia "where the prototype has for thousands of years been found to withstand the severe cold and violent winds of the steppes .... The purpose of this design is to reduce the skills needed in building to a minimum and still have a beautiful, inexpensive permanent shelter. The design of the contemporary Yurt is the result of 10 years' effort to develop techniques that make it possible for children and unskilled adults to participate in a major way in the creation of their own shelter."

Bill Coperthwaite created this particular design for North Americans. It remains simple in both materials and tools required, although some of the materials may be expensive in other parts of the world. It can be built by several people in just a couple of days.

The Yurt has a ten-sided plywood floor. The overlapping boards forming the exterior wall slope outward as they go up. They are held together at the top through the principle of the tension band (such as is often used in wooden buckets) with a 3/8-inch cable The roof slopes gently to the center of the structure, where a steel band forming a skylight keeps the roof from collapsing inward. This structure is evidently strong, and requires no complicated, expensive supporting beams.

Build a Yurt, MF 25-587, book, 134 pages, by Len Charney, 1974, MacMillan Publishing Co., out of print in 1981.

Charney began with the Yurt Foundation's design, and incorporated many of the original elements from the Mongolian Yurt back into it. The walls and roof are made from 1 x 2 inch strips arranged in a lattice network, rather than the solid

boards used by the Yurt Foundation. The positioning of the wood strips in combination with a 3/16-inch steel cable provides for an extremely stable strong structure.

The book has both text and drawings/photographs. The author describes in detail the construction steps, including building a wooden floor, using canvas, burlap, tar paper and/or wood shingles to cover the framework. The explanations are clear and easy to follow. Another good design.

The $50 and Up Underground House Book: How to Design and Build Underground, MF 25-599, large paperback book, 112 pages, by Mike Oehler, 1978, $9.95 plus $1.00 postage from Mole Publishing Company, Route 4, Box 618, Bonners Ferry, Idaho 83805, USA.

Low-cost underground dwellings are characteristically damp and somewhat dark. The houses described in this manual are designed such that the pitch of the roof coincides with the slope of a hillside so that rainwater drains off and away. The author's Post/Shoring/Polyethylene (PSP) construction method should result in a sealed, durable living space. "In the PSP system treated posts are set into the ground after excavation has been made. Beams for the roof are notched into these. Then a sheet of polyethylene is stretched around the outside of the wall. Shoring is placed between the posts and the polyethylene, one board at a time. The polyethylene is stretched snug, and earth is backfilled behind, pressing the polyethylene against the shoring and the shoring against the posts."

The author has lived in his PSP home for several years and made some adaptations—an uphill patio, a foyer, side-facing windows—which enhance its appeal. Photos and clear sketches show these and other possible modifications.

Underground housing has been used in many parts of the world for thousands of years. It offers, in particular, protection from extreme weather conditions. This book may calm some of those who accuse appropriate technologists of returning to the age of the caveman, with a nice look at the owner-built technology end of the underground housing spectrum.

Earth Sheltered Housing Design: Guidelines, Examples, and References, MF 25-594, book, 318 pages, by The Underground Space Center, University of Minnesota, 1979, $24.95 from Van Nostrand Reinhold Co., 115 5th Avenue, New York, New York 10003, USA.

"The intent of this study is to present information which will be useful in the architectural design of earth sheltered houses. Part A discusses design guidelines and includes pertinent factors to be considered. Part B gives plans, details and photographs of existing examples of earth sheltered houses from around the country. These serve to show a number of different ways in which the design constraints discussed in Part A have been dealt with in individual designs. Part C is intended to ease access to further detailed information and includes an annotated bibliography." This summary of design considerations for l underground housing, compiled by North American building professionals, emphasizes conventional materials and approaches (e.g., reinforced concrete and planning for mass production).

The authors plainly are not advocating independent design by owner-builders: "The provision of this design information should not be construed to mean that no outside assistance with design is necessary. In particular, the structural

design for earth sheltered houses should not be treated lightly and professional assistance in this aspect should normally be sought." In fact, the kinds of earth-sheltered homes presented involve so much special architectural and construction expertise that they would be far too expensive for most families in rich countries.

Nevertheless, this book presents the best summary we've seen of factors influencing earth-sheltered housing design and siting. Sections discussing configuration and thickness of earth "blankets" covering wall and roof surfaces, and the cost vs. energy savings implied by these blankets are especially good. Also covered are basic strategies for heating, cooling, ventilation, drainage and waterproofing, and the fundamentals of passive solar design. Appendices discuss building codes and compare energy use in earth-sheltered vs. above ground houses.

Recommended.

Roof Constructions for Housing in Developing Countries, MF 25-668, book, 165 pages, by Kiran Mukerji, Justin Whipple, and Rodolfo Escobar, 1982, available from GATE.

This is a thorough survey of low-cost roofing around the world conducted in 1979. Special attention is given to technologies that might fit the special needs of Central America, which include protection from earthquake hazards. Some preliminary tests were conducted to explore the potential of using various combinations of local materials as "do-it-yourself" roofing materials for low income home builders. "To be successful, a new roofing system of this type should be simpler to install than thatch, lower cost than galvanized steel, free from insect or rodent infestation, significantly lighter weight than clay tile and should present no earthquake hazard." These experiments did not immediately produce a successful new roofing system, but they did serve to identify some materials that seemed worthy of additional research.

The book is profusely illustrated with color photos and many line drawings. In English and German.

Roofing in Developing Countries: Research for New Technologies, MF 25-628, National Academy of Sciences report, 74 pages, 1974, paper copies $17.00 in U.S., $34.00 overseas; microfiche $8.00 in U.S., $16.00 overseas; from NTIS.

"The most serious obstacle to low-cost housing in the developing countries, regardless of setting or sophistication, is the lack of a low-cost roofing material that will provide satisfactory performance for a reasonable time under many adverse conditions .... In many developing countries roofing alone represents more than 50% of the total construction cost of a low-cost house."

An attempt is made here to identify materials that would last longer than thatch/fired clay and yet be cheaper than imported corrugated iron. The use of plastics, foam composites, sulfur, carbonized plant materials, asphalt, hydraulic cement binders, agricultural and wood wastes, and ferrocement is discussed. The qualities and research needs for each of these are pointed out. The work of the Central Building Research Institute of India is briefly described. This is an overview only of promising new technologies—useful primarily to research institutions and universities. No illustrations.

Mud Brick Roofs, HUD Ideas and Exchange Series #42, MF 25-619, booklet, 16 pages, 1957 (reprinted 1978), Department of Housing and Urban Development, out of print.

This short booklet describes the use of mud bricks for vaulted roof and dome construction, as used in traditional Egyptian architectural styles. It uses as a specific example Hassan Fathy's design for New Gourna (see review of Architecture for the Poor). The design of buildings using traditional vaulted arch construction is summarized; photographs of the process of building the arches are included. An appendix summarizes the technique for making mud bricks as done in Egypt.

The purpose of this booklet is to illustrate what can be done in housing using locally available materials and traditional construction techniques that are updated and improved.

Building to Resist the Effect of Wind, Volume 3: A Guide for Improved Masonry and Timber Connections in Buildings, MF 25588, booklet, 48 pages, by S. Fattal, G. Sherwood, and T. Wilkinson, U.S. National Bureau of Standards, 1977, stock no. 003-003-01719-1, out of print.

This report discusses the use of connectors in houses and other low-rise buildings to improve their strength under extreme wind conditions. Well-illustrated and clearly presented. One half of the report is devoted to detailed discussion of connectors in masonry wall construction. The other half illustrates fasteners used in timber wall construction.

Many of the solutions shown involve the use of manufactured metal parts (such as truss plates and sheet metal fasteners for timber construction or tiebars for masonry construction). These examples may provide ideas and patterns so that locally produced fasteners could be used to strengthen buildings.

The report is particularly useful in that it identifies the parts of masonry and timber houses in need of greater strength in high wind areas. It is particularly in the rapidly growing urban slums, where people live in makeshift housing often in precarious locations, that damage from hurricanes and typhoons is increasing. This is of great concern in the Philippines and the Caribbean nations. The techniques described in this report could be part of a low-cost strategy to minimize that damage.

When You Build a House: A Manual of Construction Details for Caribbean Houses with Emphasis on Protection from Strong Winds, MF 25-648, booklet, 18 pages, by E.H. Robinson, $2.50 from Caribbean Appropriate Technology Centre, Caribbean Conference of Churches, P.O. Box 616, Bridgetown, Barbados.

Clear diagrams illustrate simple and useful methods for building better, more wind-resistant houses. This is not a complete construction manual, but is well worth looking over for ideas to incorporate into housing design.

Thatching: A Handbook, MF 25-674, book, 51 pages, by Nicolas Hall, 1988, £6.50 from ITDG.

Well-made thatched roofs can last up to 50 years. This handbook takes the highly evolved craft of thatching and communicates the basic principles as they apply to the circumstances and materials common in the South. Tools and techniques are shown throughout.

Most parts of the world have some kind of thatched roof tradition. This book

aims to build upon that tradition to produce roofs that perform better than traditional thatched roofs while keeping the advantages of local production of renewable materials for local use. Suggestions for minimizing the risks of fire, decay, and insect damage are provided. A well-made thatched roof is very well insulated.

"Thatch should be laid on a roof pitch of at least 45 degrees, preferably 50 degrees. This applies to all grass and palm thatch. The steep slope is needed so that water will run off from the roof surface with minimal penetration into the body of the thatch coat. At a pitch lower than 45 degrees the thatch will decay very rapidly."

Grasses—Their Use in Building, MF 25-601, leaflet, 5 pages, 1964, Dept. of Housing and Urban Development, Office of International Affairs, Washington D.C. 20410, USA; out of print in 1981.

This is a very brief survey of the worldwide uses of grasses, primarily for thatching. Scientific names for the grasses are given, along with the regions in which they are used. In addition, there is a discussion of the simple tools and methods generally needed to make thatched roofs.

Small-Scale Production of Cementitious Materials, MF 25-665, book, 49 pages, by R.J.S. Spence, 1980, £4.95 from ITDG; also available from TOOL.

Increasing demand for cement and related building materials (lime, pozzolana, gypsum, etc.) is an established fact for developing countries, and this clear, well-documented study illustrates the good sense—in terms of investment, employment, energy consumption resource utilization, multiplier effect, and local self-reliance—of moving towards plants of small-scale, i.e. 2-200 tons/day production. Draws primarily on the divergent examples of India and China to show how market distortion, monopolistic tendencies, and dependent attitudes have shaped past policies and how they can be improved. Includes good basic descriptions of the production of cementitious materials. Recommended for anyone involved in housing, construction, and related small industries in developing countries.

Small-Scale Lime-Burning: A Practical Introduction, MF 25-675, book, 185 pages, by Michael Wingate, 1985, £9.95 from ITDG.

This is indeed a welcome and practical introduction to a topic not well-covered elsewhere. Lime can be an important, low-cost substitute for Portland cement in many applications. It is produced in many developing countries, and could be more widely and more efficiently produced on a small scale.

Raw materials, fuels, kiln design and operation, and hydration of lime are all well-covered.

Shaft Lime Kiln, Technical Bulletin #13, MF 25-634, leaflet, 11 pages, by S. Mason, 1974, Papua New Guinea, limited supply, from DWS.

This kiln is appropriate "where only small quantities of lime are required for building purposes, stabilization of soils and lime washes."

"The shaft lime kiln is a vertical circular opening cut into the side of a hill. The lining can be large boulders of limestone, which are replaced as they burn out, or bricks made from clay in the area. The capacity of the kiln is three tons of

hydrated lime per burn, which requires one week to produce."

Brief instructions are provided, covering testing for limestone, construction, and operation of the kiln. The lime that is treated in this kiln is usable as a stabilizing agent for soil construction. There are very clear, dimensional drawings with English measurements. Bricks are needed for construction.

Rice Husk Ash Cement: Progress in Development and Application, MF 25 657, book, 45 pages, by Ray Smith, 1984, £5.95 from ITDG.

This report documents some of the different methods for small-scale production of rice husk ash cement on the Indian sub-continent. Burnt rice husks are combined with lime to produce a cement that is cheaper and of lower strength than Portland cement, but still suitable for most rural requirements. The cost advantages of rice husk ash cement over Portland cement are not always as dramatic as might be hoped, particularly when similar strength mortar mixtures are produced, and quality control problems, government subsidies on Portland cement, and adulteration are taken into account.

Ferrocement: Applications in Developing Countries, MF 25-598, booklet, 89 pages, by a National Academy of Sciences panel, 1973, National Academy of Sciences, Washington, D.C., out of print.

"Ferrocement is a highly versatile form of reinforced concrete made of wire mesh sand, water, and cement, which possesses unique qualities of strength and serviceability. It can be constructed with a minimum of skilled labor and utilizes readily available materials. Proven suitable for boat-building, it has many other tested or potential applications in agriculture, industry, and housing.

"Ferrocement can be fabricated into almost any shape ... is more durable than most woods and much cheaper than imported steel, and it can be used as a substitute for these materials in many applications .... Ferrocement construction does not need heavy plants or machinery; it is labor-intensive."

The report examines the use of ferrocement for construction of boats in a Chinese commune, food storage silos in Thailand and Ethiopia, and water tanks in New Zealand. "The report considers the potential for further use of already discovered application, such as boats and silos, and identifies promising new application, such as roofs and food processing equipment."

Ferrocement, a Versatile Construction Material: Its Increasing Use in Asia, MF 25-597, book, 108 pages, edited by R.P. Pama, Seng-Lip Lee and Noel D. Vietmeyer, 1976, $2.00 (add $2.00 for airmail) from International Ferrocement Information Center, Asian Institute of Technology, P.O. Box 2754, Bangkok, Thailand.

These are the proceedings of a workshop held in Bangkok in November 1974. It offers a general survey of ferrocement use and research in Asia, including activities in Korea, Fiji, Thailand, India, Sri Lanka, Malaysia, Singapore, Papua New Guinea and Bangladesh. The economics, labor and materials requirements, versatility and durability are explored. Specific construction details are not usually included, although some of the things described—for example, the water jars—could be built using only the instructions in this book.

"In India ferrocement is being introduced for silos in sizes to hold about 1 to 30 tonnes of grain. Methods developed for ferrocement boat building are being

applied to these storage structures to obtain a structure of high quality."

Ferrocement products discussed include boats, housing, food and water storage silos and tanks, roofing, biogas plants, road surfaces and tube well casings.

Construction of Trail Suspended Bridges in Nepal: An Application of Traditional Technology, MF 25-666, paper, 21 pages, by Prachandra Pradhan, 1981, United Nations University, Toho Seimei Building, 29th floor, 15-1 Shibuya 2-chome, Shibuya-ku, Tokyo 150, Japan; working paper, not for sale.

Traditional suspended foot bridges in some areas of Nepal are technically quite sophisticated and linked to cultural and economic aspects of village life in many fascinating ways. While modern suspension bridges being built by the government may be technically superior to the locally built bridges, the local bridges are built at a fraction of the cost of the government ones, and they utilize broad community participation and locally available materials. Because they reuse cables which are purchased used, the traditional bridges may not be as strong as the government ones, but this seems to be offset by better maintenance by the community. This paper is a fine example of the important role of traditional and indigenous technology in community development.

Traditional Suspension Bridges in Taplejung District, MF 25661, book, 100 pages, by Jim Rutherford, Max Leisibach, and Herbert Rice, December 1978, SATA/SKAT, out of print.

Several traditional designs for effective suspended and suspension bridges have evolved in Nepal. This book contains the observations and conclusions of a study of 24 bridges built with one of these traditional bridge designs. The authors concluded that these bridges are structurally sound. Some suggestions are made regarding some of the minor disadvantages of these designs. Unfortunately, many of the photographs have reproduced poorly. Readers wishing to pursue the topic further are directed to sources of reports on post-1978 experiences of building improved versions of these bridges.

Standard Trail Suspended and Suspension Bridges, MF 25-641, 2 volumes 400 pages, by Ministry of Works and Transport, Roads Department, H.M.G. of Nepal and the Swiss Association for Technical Assistance, 1977, out of print in 1985.

"This manual for construction of suspension bridges will be quite helpful to the engineers who will construct suspension bridges in Nepal. It contains the details of methods of surveying, calculations, and design procedures."

This set of books is specific to steel cable unstiffened suspension and suspended trail bridges. Spans described range from 40 to 170 meters. Includes bridge design, structural analysis, survey of bridge sites, cost estimates, construction practices, and maintenance. Most sections have examples of calculations, necessary engineering tables, and ample photos, plans or sketches. The manuals contain a wealth of information, but this is mostly in a form only useful to engineers. Poorly organized, these books may be very confusing to one without previous experience in the subject. The many sections have different formats and no continuous explanatory text.

Traditional Bridges of Papua New Guinea, MF 25-644, book, 137 pages, by Jeff Siegel, 1982, $9.50 from the Liklik Buk Information Center, Papua New Guinea University of Technology, PMB, Lae, Papua New Guinea.

Numerous photographs and diagrams show how traditional suspended foot bridges are made in Papua New Guinea using only locally available materials. The materials include wood, bamboo, tree bark, vines, cane, and stones. Construction details for specific bridges are given including time and number of people required for construction, methods used, materials, and lifespan. The first of a series to be published by ATDI.

Recommended.

Wooden Bridges: UNIDO's Prefabricated Modular System, MF 25664, booklet, 16 pages, 1983, Dee (doc. PI/88) from UNIDO; also in Spanish and French.

This short booklet with color photos describes a simple road bridge design which can be prefabricated in 3-meter long wooden sections and hauled to the site. The span can be up to 30 meters, and the bridge can carry a live load of up to 40 tons. "The standardized components ... do away with the need for expensive and scarce engineering design for each bridge. The components can be made in small workshops, transported without heavy lifting equipment and, once the abutments are built, erected in a few days using various tripod, cable and winch arrangements. The expected lifetime of the bridge is between 15 and 25 years."

The Kenyan Low Cost Modular Timber Bridge, MF 25-653, paper, 34 pages, by J.D. Parry, publication no. PB81-214595, paper copies $17 domestic, $34 foreign; microfiche $8 domestic, $16 foreign; Tom NTIS.

Reporting on tests of the same bridge described above (Wooden Bridges UNIDO), the author concludes that this is indeed an interesting design with some advantages, but assigns it a lower safe span (24m maximum vs. 30m) and lower safe load limit (20 tons vs. 40 tons) than does the UNIDO booklet. The main disadvantage of this type of bridge appears to be that the road approaches at both ends must be at least 2.5 meters above the expected high water level so that the bridge trusses will remain above water; this may involve extra costs. Detailed construction drawings of the bridge are provided; these are not included in the UNIDO booklet.

"There are also several comparatively low cost alternatives to this design that should not be overlooked. In countries where locally-grown timber is available in the requisite sizes, whole log or rectangular section timber beam bridges can be built at low cost over spans of up to 10m, or up to 15m if hardwoods are available. If the site conditions are favourable for the erection of piers, multispan bridges with timber beam decks will be the cheapest solution, as has been adopted in the Kenya Rural Access Roads Programme .... Bridges constructed with other materials such as reinforced concrete, plain concrete (for arch bridges), rolled steel joists with timber or concrete decks, and prefabricated steel ... will normally be the choice for spans greater than 12m where permanent or semi-permanent bridges are required. They are however likely to be between two and four times as expensive as the Kenya modular timber bridge .... Simple reinforced concrete slab bridges are however very satisfactory for short spans and many are built on rural roads in Kenya each year, as in other developing countries."

Simple Bridge Structures, Project Technology Handbook No. 2, MF 25638, book, 28 pages, by Project Technology/Schools Council, 1972, Heineman Educational Books, out of print.

This British book introduces students to basic bridge designs. Included are class activities to test models made of different kinds of wood. A well-illustrated set of experiments demonstrates the properties and functions of beams, frames, and columns in bridges and other structures. Simple methods for calculating the forces acting on the members of a framework are explained.

Comparison of Alternative design Wheelbarrows for Haulage in Civil Construction Tasks, World Bank Technical Memorandum No. 1, MF 25-590, booklet, 22 pages, World Bank Transportation and Urban Projects Department, 1975, out of print.

Wheelbarrows can, in many situations, be a very efficient means for transporting heavy materials. This study compares wheelbarrows with one or two wheels, with solid and pneumatic (air-filled) rubber tires, and with ball bearing and bushed (simple, smooth-surface to smooth-surface) bearings. The report concludes "... that a lightweight, single-wheel barrow with a scooter tire and ball bearing wheels is the most economical type of wheelbarrow for earth haulage." Includes diagrams of three models.

The Use of Wheelbarrows in Civil Construction, World Bank Technical Memorandum No. 13, MF 25-646, booklet, 26 pages, 1975, World Bank, Transportation and Urban Projects Department, out of print.

This memorandum follows up on **Comparison of Alternative Design Wheelbarrows for Haulage in Civil Construction Tasks** (this section) with more discussion of design features relevant to civil construction applications.

ADDITIONAL REFERENCES ON HOUSING AND CONSTRUCTION

Design of Medical Buildings is a remarkable book on the use of local building techniques and architectural styles for low-cost medical buildings; see HEALTH CARE.

Small Farm Grain Storage also includes some information on ferrocement construction techniques; see CROP STORAGE.

The design of solar heated and cooled houses is the subject of books reviewed in ENERGY: SOLAR.

Small Scale Cement Plants describes the economics of small scale vertical shaft cement kilns in China; see LOCAL SELF-RELIANCE.