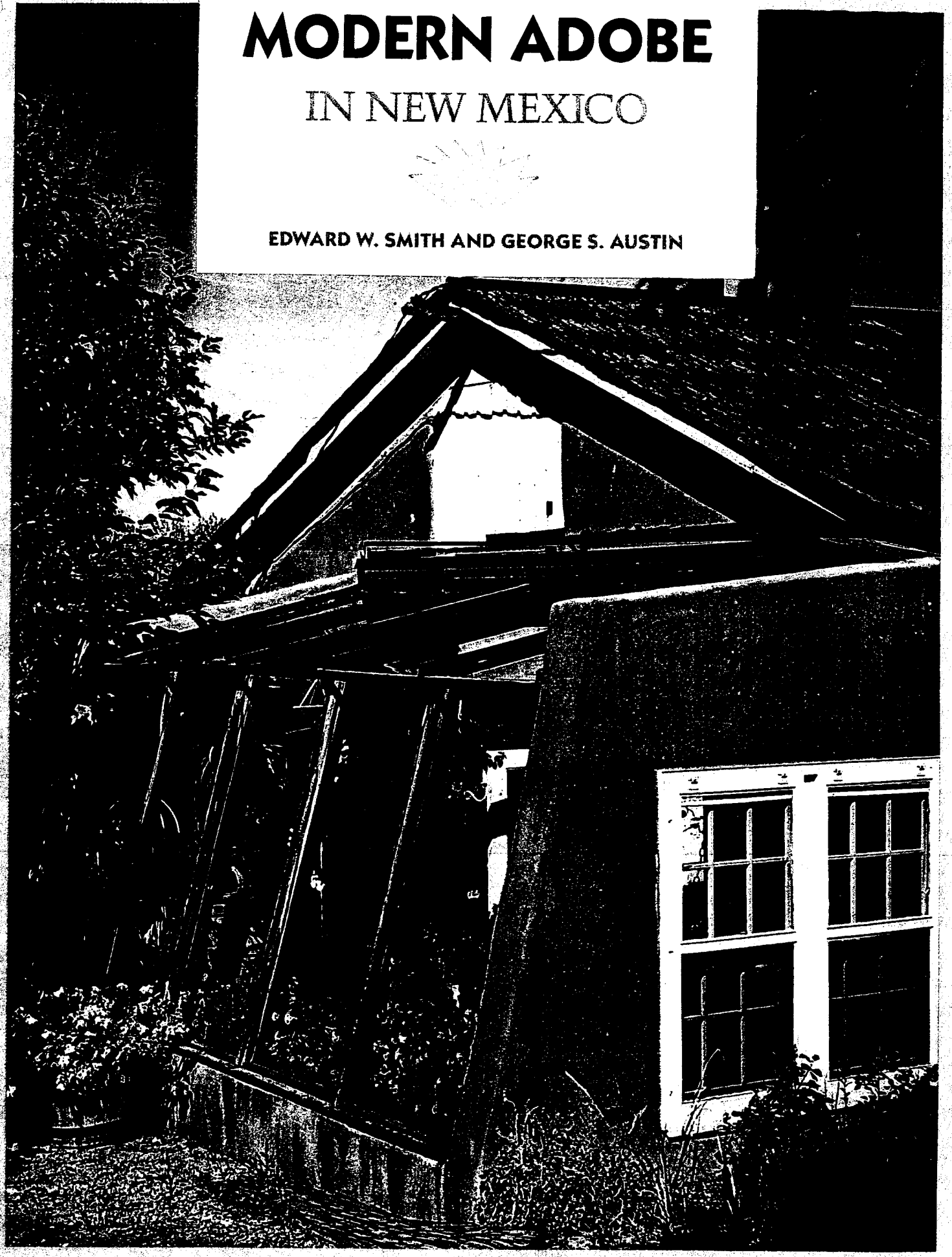
MODERN ADOBE

IN NEW MEXICO

EDWARD W. SMITH AND GEORGE S. AUSTIN



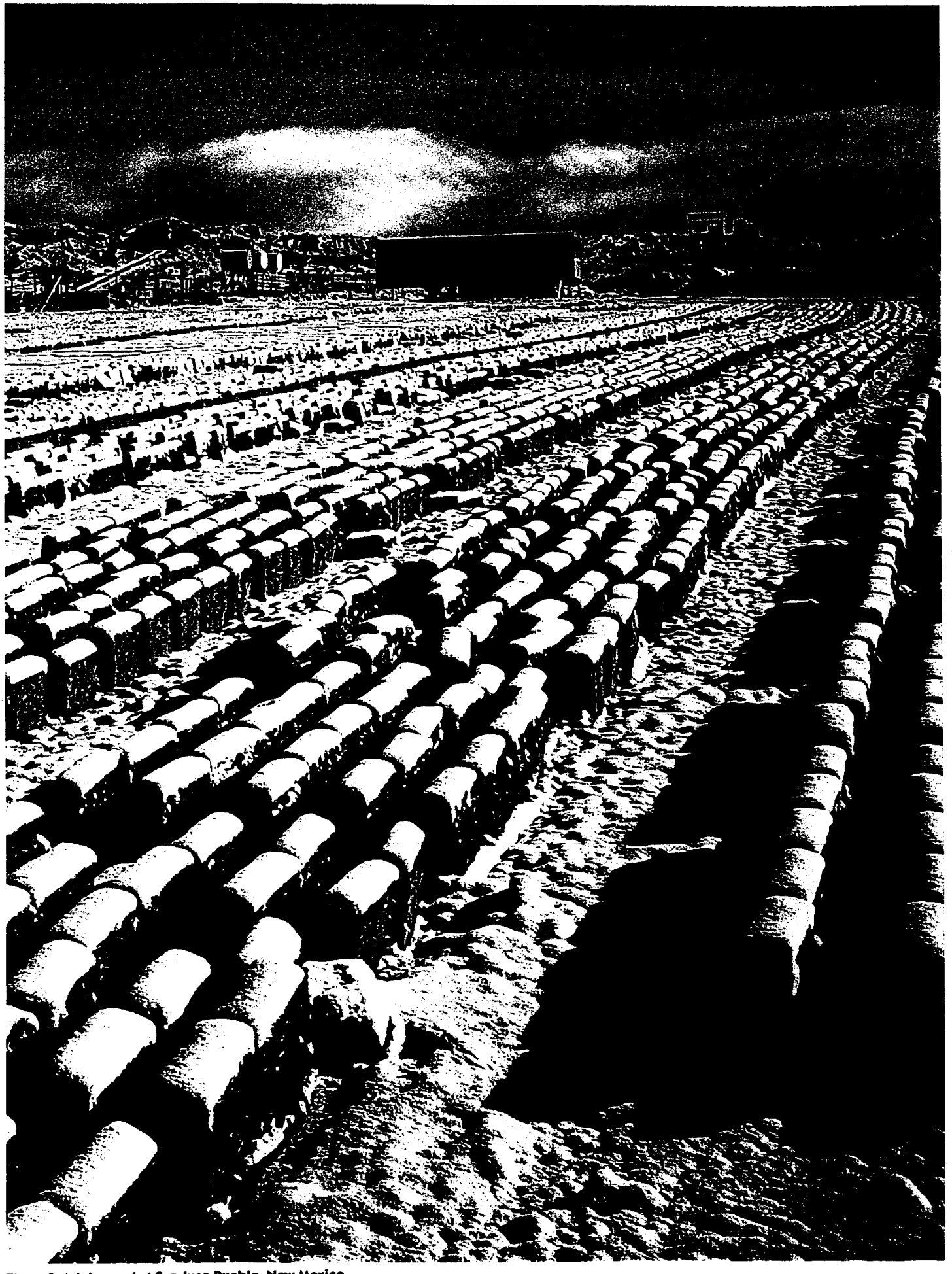


Figure 3: **Adobe yard at San Juan Pueblo, New Mexico**

CONTENTS

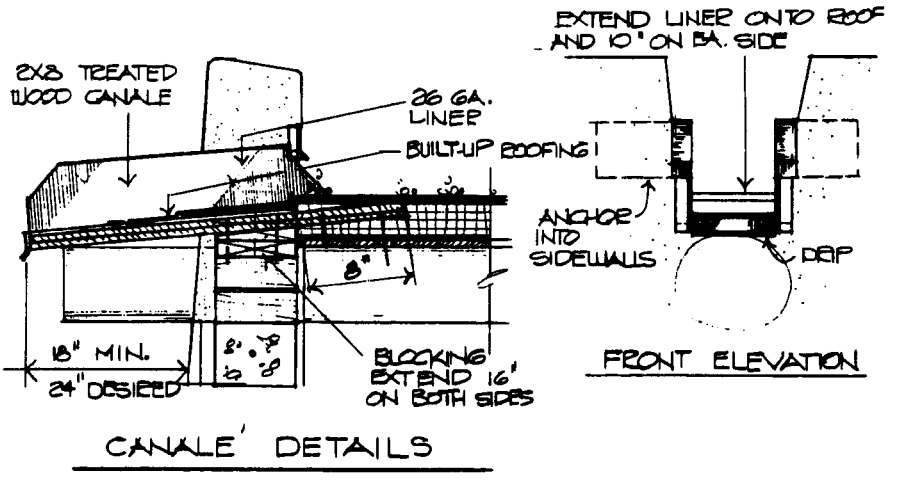


Figure 4: **Canale detail**

FIGURES

Cover Photo: Greenhouse in Rio Tesuque

INTRODUCTION

Among the oldest of building techniques mastered by early man, the use of mud as a building material parallels the birth and spread of the great ancient civilizations of the world. Even today, earth remains the primary building material for over 50% of the world's population. In the United States, the Southwestern areas have long had a love affair with adobe and the landscapes of New Mexico, Arizona, Texas, and California contain many examples of enduring adobe homes. Old military forts, churches, and commercial buildings also attest to its popularity.

New Mexico, both historically and to the present day, is the largest domestic producer and user of adobes. During the past decade, 3-4 million adobe bricks and pressed-earth blocks have been produced in New Mexico each year by about 50 commercial manufacturers. The popularity of adobe is due to the sculpture-like flowing lines of adobe structures, its thermal and acoustic characteristics, and its suitability for passive solar construction.

Over 59,000 adobe buildings representing one-third of the adobe dwellings in the United States are in use in New Mexico. Although today less than 3% of new homes built each year in New Mexico are constructed with adobe, the number usually averages between 500 and 600 new dwellings. From examination of building permits in New Mexico and discussions with local architects, real estate agents, and planners throughout the Southwest, it appears that most of new adobe dwellings are built for high income customers. The houses usually contain above-average square footage with the addition of extensive Southwestern architectural details and style. In some areas, particularly in parts of rural northern New Mexico, many of the backyard adobe producers build their own homes. This is often done on a part-time basis, while the producer is working full-time for a local business or government agency. In many cases the house is completed without an extensive debt or long-term mortgage payments.

Today, however, most builders purchase the adobe bricks from commercial yards located throughout New Mexico. The adobe-block operation is a labor-intensive but fuel-efficient seasonal industry with the production of blocks usually limited by the number of frost-free days. The principal standard-size adobe brick produced and used in New Mexico measures 4 × 10 × 14 inches and weighs approximately 30 pounds.

HISTORY

Mud is one of the oldest building materials used by man. Some of the earliest remains of adobe structures are those discovered in the ruins of Neolithic farming villages in Mesopotamia dating as far back as 7000 B.C. The word "adobe" has its roots in Egyptian hieroglyphs denoting brick, and evolved to its present form through Arabic and Spanish. Spanish conquest of the New World spread the use of wooden molds to produce a standard adobe brick. Today, the word "adobe" is used to describe various earth-building materials and techniques, usually referring to sun-dried adobe brick now used in the United States, but is also applied to puddled adobe structures, mud-plastered logs or branches (jacal or waddle-and-daub), pressed-earth blocks, and rammed-earth walls or pisé.

In the Americas, adobe was first used around 3000 B.C. in the Chicama Valley of Peru. Common use of earthen construction in the

American Southwest probably does not predate the 10th or 11th century, when the use of puddled adobe and rammed earth began. Examples of adobe structures of that period are the Picuris Pueblo and the multistoried Taos Pueblo (Fig. 5).

What is known as the Indian period of construction ended in 1598 with the arrival of the Spanish colonists, who introduced new techniques and forms of architecture into New Mexico. Yet, because of the isolation of the region and bare-survival conditions for the settlers, the Spanish Colonial period was characterized by little general technical or cultural advancement. Most buildings of this period were constructed much the same way and of the same materials that Indians had used before.

The opening of the Santa Fe Trail in 1821 signaled the beginning of influence from midwestern and eastern states and lessening of the adobe influence in New Mexico. The occupation of the region by the U.S. Army in 1846 and the annexation of the Territory of New Mexico in 1848 brought a flow of new materials and ideas. In the 1880's, the railroad passing through the Southwest brought new settlers and eastern building materials that included milled lumber, window glass, burned brick, and corrugated iron, but whereas these and other eastern building materials were commonly used elsewhere, they were only slowly introduced and established in New Mexico. As a consequence, the American Southwest remained the center for adobe construction of homes, churches, commercial buildings, and military forts (Fig. 6).

Types of Earthen Bricks and Walls

everal varieties and sizes of earthen brick have been produced throughout the American Southwest; these include traditional adobe, semistabilized and stabilized adobe, New Mexican terrónes (cut-sod brick), quemados (burnt adobe), and machine-pressed-earth block; in addition, rammed-earth walls are constructed without brick. The two major types of adobe brick currently produced in New Mexico are the traditional adobe brick and the semistabilized adobe brick.

Figure 5: **Taos Pueblo, five-story, oldest 900 + yrs continuously occupied adobe structure in the United States.**

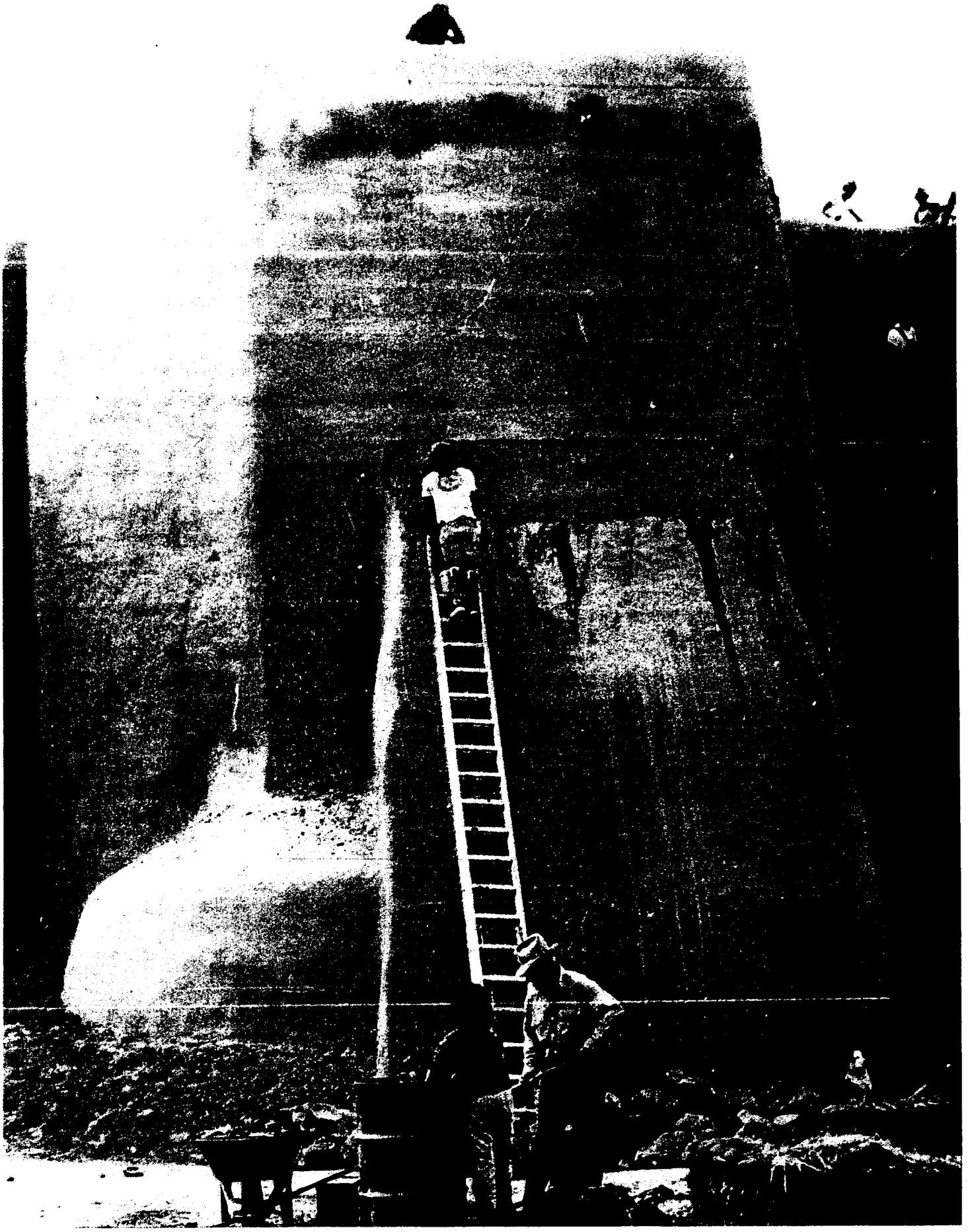


Figure 6: **Adobe plastering of the Ranchos de Taos Church.**

Traditional (untreated) adobe bricks

Often referred to as untreated or sun-dried adobe brick, traditional adobe is made with soil composed of sand with some larger particles, and of silt and clay. Straw is sometimes added for strength and to prevent excessive cracking during drying. The moistened soil mixture commonly is packed into a brick-like mold, released (Fig. 7), and allowed to dry and "cure" for several weeks before use.

Figure 7: **Mixing the mud, straw and water for traditional adobes at Nambe, N.M.**

Semistabilized adobe bricks

Semistabilized adobe brick has been developed by major adobe producers in New Mexico and is classified as a water-resistant brick because of the addition of 3-5 wt% of a stabilizer or water-proofing agent. The stabilizer is used to protect the brick from rainstorm damage during the curing process. Asphalt emulsion is the primary stabilizer because of the ease of use and the low cost, but 5-10 wt% portland cement is also used. Semi-stabilized adobe is made the same way as traditional adobe, except for mixing the stabilizer into the adobe soil prior to packing it into a form (Fig. 8).

Stabilized adobe bricks

Fully stabilized adobe brick is defined by the New Mexico Building Code as water-resistant adobe made of soil with certain admixtures that limit the brick's seven-day water absorption to less than 4 wt%. A fully stabilized adobe brick usually is made with 6-12 wt% of asphalt emulsion. Exterior walls constructed with stabilized mud mortar and brick require no additional protection and can be left exposed without stucco. The production of fully stabilized adobe brick is very low because most walls are stuccoed with water-resistant plaster, and the additional water-proofing agent adds extra cost.

A breakdown of New Mexican 1987 adobe-brick production shows that 27% were traditional (untreated) bricks, 69% were semistabilized bricks, and 5% were stabilized bricks. These percentages appear to be fairly typical of the 1980's, as semistabilized adobes were generally accepted as the adobe brick of choice. Before 1970, most adobe buildings were built with traditional adobes.

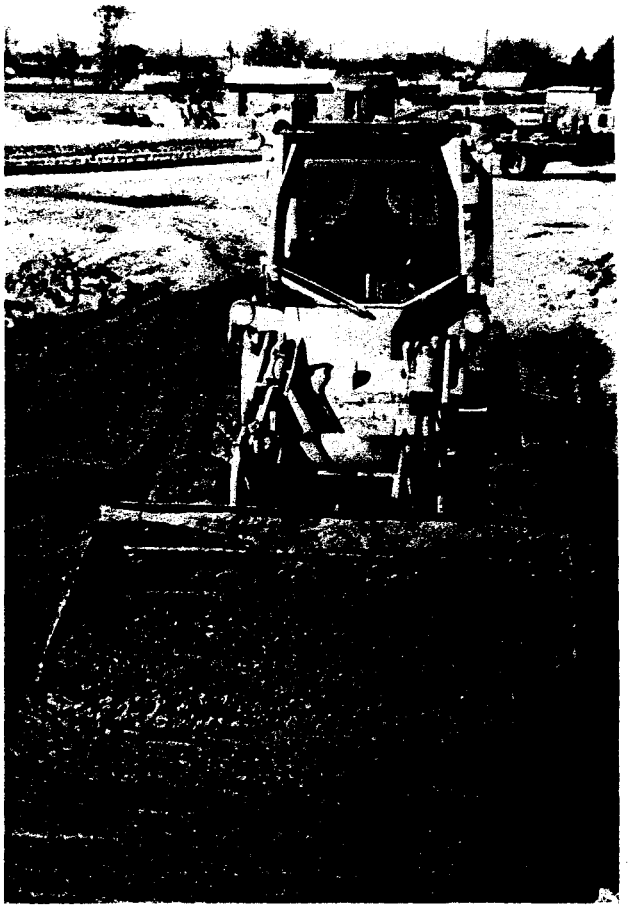


Figure 8: **Use of pugmill and front-end loader for the blending of adobe soil and asphalt emulsion at New Mexico Earth Adobe yard in Albuquerque, N.M.**

Pressed-earth blocks

Pressed-earth blocks presently make up a small portion of earth brick used in New Mexico. The CINVA-Ram hand-operated press was developed by a Chilean engineer in the 1950's and has been used in New Mexico, but the majority of pressed-earth blocks in the state are made by gasoline- or diesel-powered machines (Fig. 9). Several have been designed and used in the past in New Mexico to press the adobe soil mixture into a form, minimizing the amount of time required between forming the block and placing it into the wall. Portland cement or asphalt emulsion has been used to partly or fully stabilize pressed-earth blocks. Most producers are small-volume and/or part-time, or non-commercial.

Rammed-earth walls

Rammed-earth homes commonly have much thicker walls than most other earthen dwellings, up to about 36 inches (0.9 m) thick. Wooden or metal concrete-type forms are put in place on stone or concrete footings and layers of moistened soil 6-8 inches (15-20 cm) thick are put between the walls of the forms. Hand or hydraulic tampers are used to pound the soil into the shape of the form, compacting and reducing the volume of the mixture by 25-30%. Once the layers of tamped soil reach the desired height, the forms are removed and the wall is allowed to dry (Fig. 10). Portland cement is the common stabilizer used. Producers indicate that rammed-earth walls continue to harden, or cure, during the first year after construction. During 1987, the state's two rammed-earth construction firms built three homes.

Advantages in Using Native Soil

1. Adobe soil is a native material that is widely available, at low cost, throughout the state of New Mexico.
2. Manufactured adobe bricks and pressed-earth blocks are most reasonable. In 1989 and 1990 adobe bricks and pressed-earth blocks sold for 25 to 55 cents each at the local production yards.
3. The adobes are adaptable to all types of housing, solar adobe structures, walls, farm/ranch buildings, and certain types of commercial structures.
4. Adobe buildings are fire-resistant, unaffected by termites, and are good sound insulators.
5. The adobe soils can be stabilized at reasonable costs to produce a water-resistant or waterproof adobe brick or pressed-earth block. Major stabilizers include asphalt emulsions, portland cement, and lime.

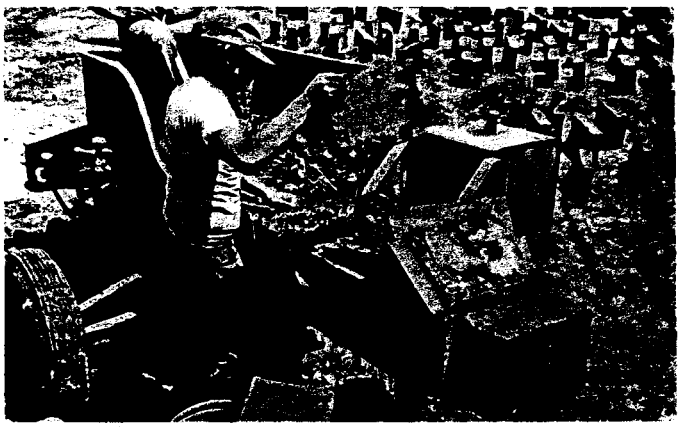


Figure 9: **David Griego of Ledoux, N.M. using a porta press to produce pressed earth blocks.**

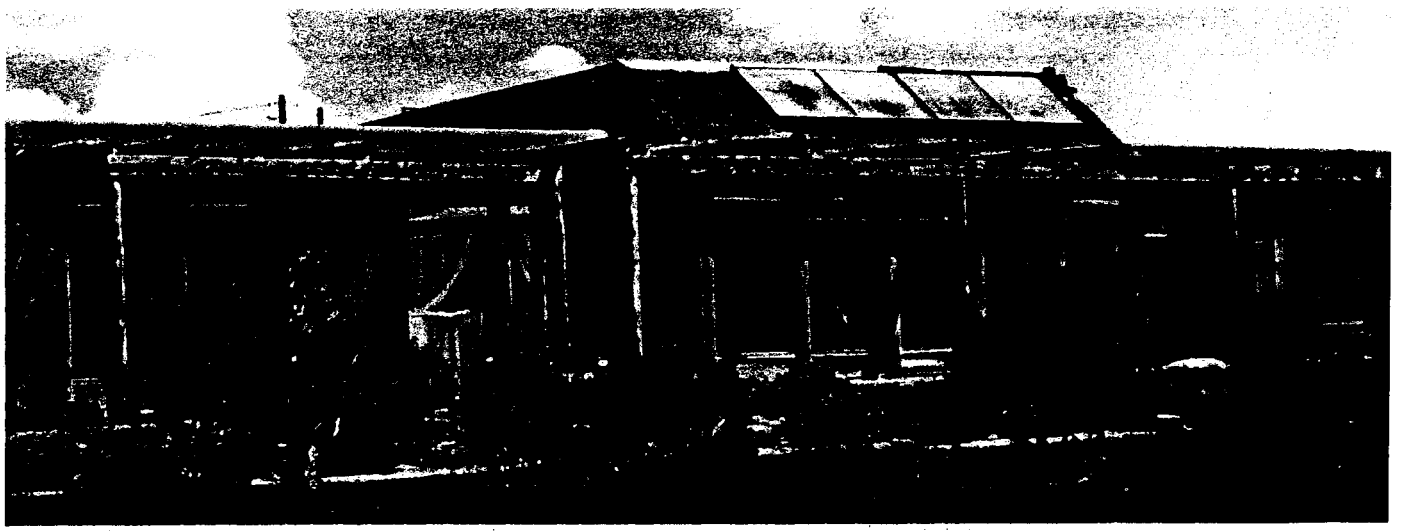


Figure 10: **Rammed earth house of Stan E. Huston located at Edgewood, N.M.**

Production Techniques

Six techniques of adobe, pressed-earth, and rammed-earth production are currently in use in New Mexico. They are classified according to the degree of mechanization they involve. In 1990 and 1991, roughly 70% of the 38 commercial producers were manufacturing adobe bricks by the traditional, semi-mechanized and mechanized methods (Table 1), and 25% were producing pressed-earth blocks (Table 2). Their total annual production was 3.4 million earth blocks. The remaining 5% (two firms) produced rammed-earth walls (Table 3).

Of the 2.7 million adobe bricks commercially produced in 1990, 1% was by traditional, 55% by semi-mechanical, and 44% by mechanical methods. Only a small number of fully stabilized adobe bricks or pressed-earth blocks were produced during 1990 and only by special order. Commercial production was principally of semi-stabilized earth blocks (adobe or pressed earth), with unstabilized blocks coming a distinct second.

Traditional manual adobe production

This relatively simple process involves the mixing of soil, water, and sometimes straw in a shallow mudpit using a hoe or foot treading. Wooden forms that will produce a single brick or multiple bricks are laid out on smooth and level ground, and the mud is placed in them and tamped into the corners. The top is smoothed off and the form removed. The forms are then washed clean and the process is repeated. As the bricks dry (2-3 days in summer), they are turned on edge, trimmed of excess material or rough edges, and when fully dry, are stacked for delivery. Utilizing two to three adobe makers, this system can produce 300-500 adobe bricks per day (Fig. 11, Table 1).

Semi-mechanized adobe production

This method of production is similar to the traditional manual method except for the addition of mechanical equipment, most frequently a front-end loader. The loader is used to move or excavate the soil, to mix the soil in the mudpit, and to carry the adobe mud to the wooden ladder-type forms. Depending on the weather, the bricks are allowed to dry in the forms for several hours or until they have shrunk and sepa-

Figure 11: **Tamping adobe mud into corners of wooden form at Eloy Montano's adobe yard in Santa Fe, N.M.**

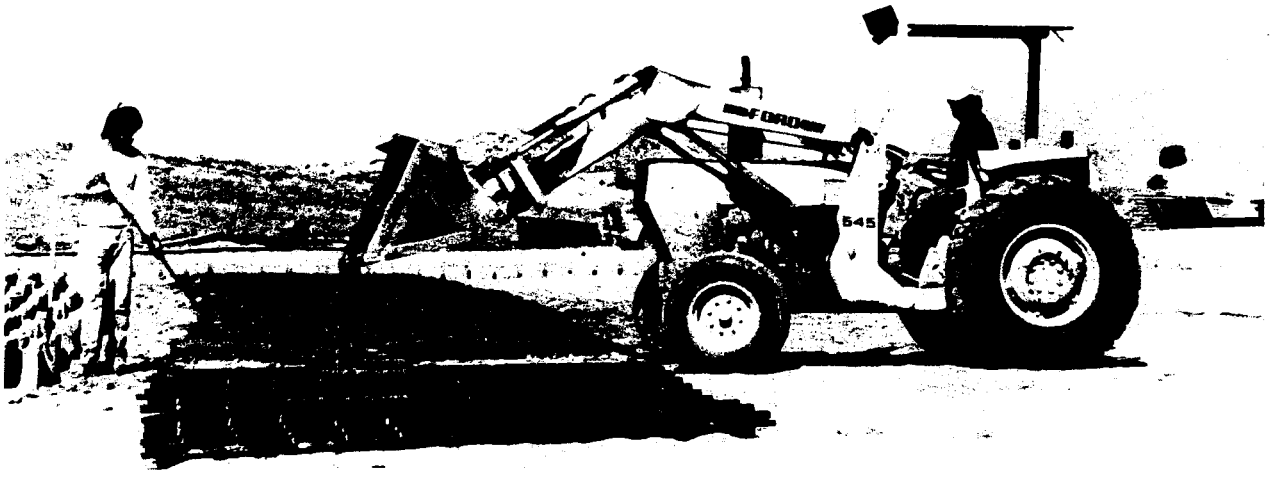


Figure 12: **Pouring mud into a series of ladder molds at the Adobe Bricks of New Mexico yard located at Santa Cruz, N.M.**

rated from the form walls. The forms are then removed and the adobes allowed to dry for 2-3 days, at which time they are turned on edge, trimmed, and later stacked for delivery or storage. The adobe makers may use several hundred wooden forms at a time to achieve a production capacity of 1500-3000 adobes per day (Fig. 12, Table 1).

TABLE 1—Major commercial adobe-brick producers active in New Mexico in 1991.

Name and mailing address	*Telephone*	*County*	*Approx. annual production (1991)*
Adobe Bricks of New Mexico Box 733 Santa Cruz, NM 87567 Dennis Duran, Owner	753-6189	Santa Fe	200,000
Adobe Factory Box 651 Alcalde, NM 87511 Mel Medina, Owner	852-4131	Rio Arriba	700,000
Aguires Services P.O. Box 475 Ranchos de Taos, NM 87557 Ismael Aguires, Owner	758-9181	Taos	7,000
Juan Aragon, Contractor General Delivery Aragon, NM 87820 Juan Aragon, Owner	533-6411	Catron	0
Big "M" Sand & Cinder Box 33 Bernalillo, NM 87004 Randy Montoya, Owner	867-5498	Sandoval	0
De La O Adobe Brick Mfg. P.O. Box 1283 Anthony, NM 88021 Antonio De La O, Owner	882-5278	Doña Ana	50,000
Eloy Montano Sand & Gravel 14 Calle Chuparosa Santa Fe, NM 87501 Eloy Montano, Owner	471-4747	Santa Fe	200,000
Gilbert Montano 503 Barela Lane Santa Fe, NM 87501 Gilbert Montano, Owner	983-2838	Santa Fe	50,000
New Mexico Earth P.O. Box 10506 Alameda, NM 87184 Richard Levine, Owner	898-1271	Bernalillo	550,000
Otero Brothers 2725 Highway 47 Los Lunas, NM 87031	864-4054	Valencia	50,000
Picuris Pueblo Box 127 Peñasco, NM 87553	587-2519	Taos	18,000
Rio Abajo Adobe Works 1343 Gabaldon Road Belen, NM 87002 Jerry Sanchez, Owner	864-6191	Valencia	150,000

TABLE 1—(Continued)

Name and mailing address	*Telephone*	*County*	*Approx. annual production (1991)*
Jim Rivera Rt. 1, Box 4 Glorieta, NM 87535 Jim Rivera, Owner	471-1380	Santa Fe	0
Rodriguez Brothers Rt. 6, Box 22 Santa Fe, NM 87501 George and Jim Rodriguez, Owners	471-3375	Santa Fe	60,000
Steve Romero 200 Camino Rio Santa Fe, NM 87501 Steve Romero, Owner	983-1304	Santa Fe	0
Ernest Sanchez 6000 Powers Way SW Albuquerque, NM 87121 Ernest Sanchez, Owner	873-1065	Bernalillo	20,000
Roman Sandoval Box 423 Ranchos de Taos, NM 87557 Roman Sandoval, Owner	758-3856	Taos	5,000
Candelario Saucedo c/o P.O. Box 1031 Socorro, NM 87801 Candelario Saucedo, Owner	NA	Socorro	5,500
Sol Systems Adobe Co. Box 104 Corrales, NM 87048 Manuel Ruiz, Owner	898-2218	Sandoval	150,000
Sun and Soil, Inc. Box A Edgewood, NM 87015 Don Huston, Owner	281-9006	Santa Fe	0
Taos Mudd P.O. Box 3016 Taos, NM 87571 Joe Cimino, Owner	758-4084	Taos	150,000
Tim's Adobe Box 1534 Bernalillo, NM 87004 Tim Montoya, Owner	867-4847	Sandoval	8,000
Sabino Varela Rt. 2, Box 47 Pecos, NM 87552 Sabino Varela, Owner	757-6205	San Miguel	3,000
Trini Velarde Box 726 Rancho de Taos, NM 87557 Trini Velarde, Owner	758-4185	Taos	15,000
Western Adobe 7800 Tower Rd. SW Albuquerque, NM 87105 Dean Leach, Owner	836-1839	Bernalillo	264,000

Mechanized adobe production

The mechanized technique of adobe production utilizes the pugmill mixer with a mechanical adobe layer, identified as the Hans Sumpf adobe laydown machine, in addition to front-end loaders. This high-production-type operation uses several thousand cubic yards of adobe soil per year and is capable of producing over 1,000,000 bricks per yard annually. The stockpiled soil is first screened and conveyed to one end of the pugmill trough. A shaft studded with paddles rotates in the trough of the pugmill and an operator controls the feed of soil, water, and asphalt emulsion. The materials are thoroughly mixed in the trough and dumped into a mudpit from where a front-end loader carries the mud mixture to a nearby molding machine. This self-propelled mechanized adobe layer, mounted on wheels, molds twenty-five 10 × 14 × 4-inch adobe bricks at a time. Different molds of various sizes and brick shapes can be mounted on the machine. With good weather and few mechanical breakdowns, an average of 5000 to 7000 adobes per day can be produced (Fig. 13, Table 1).

Pressed-earth-block production

Pressed-earth-block machines produce in far less time than older methods blocks that look like traditional adobe bricks. The resulting block is called a pressed-soil block in Australia and a pressed-earth block in New Mexico. The development of greatly improved and portable (trailer-mounted) pressed-earth-block machines and accessory equipment occurred during the early 1980's. Today, several New Mexico manufacturers are producing and selling in the U.S. and on foreign markets a variety of machine models that, with a crew of two or three employees, are capable of producing several thousand blocks per day (Table 2). In 1987, 16 block machines located throughout New Mexico produced a total of 642,000 pressed-earth blocks. Most were the standard 4 × 10 × 14-inch blocks that sold for prices ranging from 25 to 40 cents each and were produced at the builder's homesite using local soils or soil hauled to the lot site.

A major advantage of pressed-earth-block machines is their ability to produce the block at the construction site, where finished blocks go from the machine directly to the block layer for immediate placement. The blocks are usually placed into the wall without further drying, sometimes using only a thin mud-slurry or wetting of the block surface for bonding (Fig. 14).

Figure 13: **Self propelled Hans Sumpf lay-down adobe machine at the Adobe Factory yard located at Alcalde, N.M.**

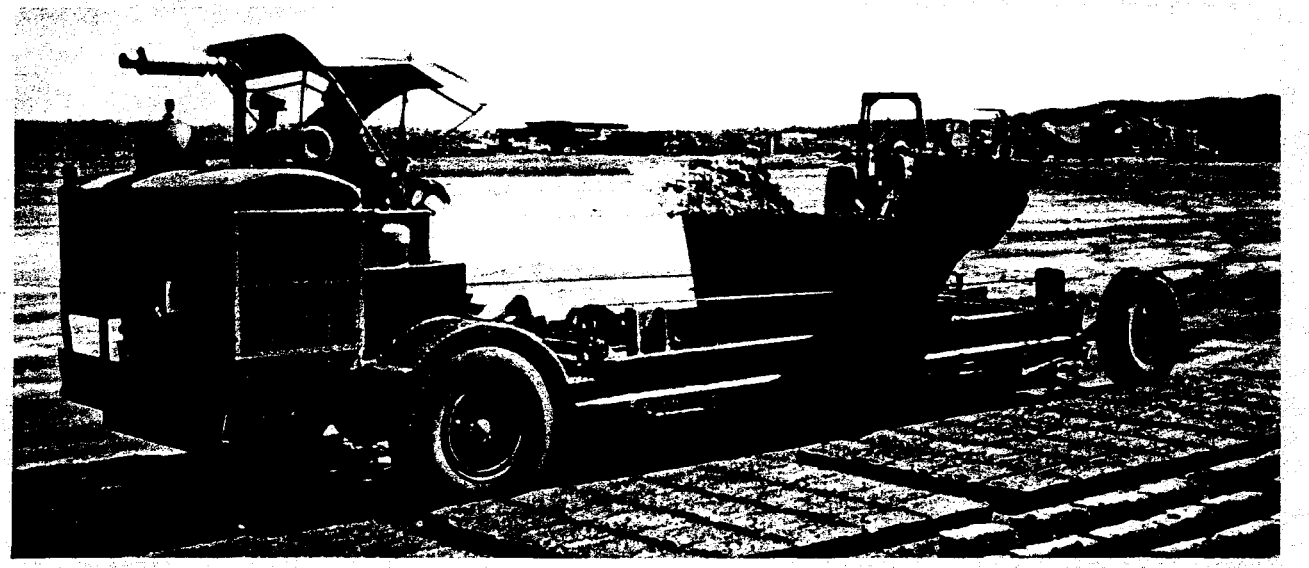


Figure 14: **Pressed-earth-block machine in operation at building site located at Nambe Pueblo, N.M.**

TABLE 2—Commercial pressed-earth block producers and pressed-earth-block machine manufacturers active in New Mexico in 1991.

Name and mailing address	*Telephone*	*County*	*Approx. annual production (1991)*
Adobe International Box 1284 Grants, NM 87020 Henry Elkins, Owner	287-3961	Cibola	200,000 Manufacturer and producer
Adobe Unlimited 10820 Cruz Place SW Albuquerque, NM 87105 Richard Marquez, Owner	832-4656	Bernalillo	175,000
Alternative Block, Inc. Box 7397 Grants, NM 87020 John Wright, Owner	285-5468	Cibola	100,000
Chical Haystack Feed Store Rt. 9, Box 84 Bosque Farms, NM 87068	869-3500	Valencia	0
Coyote Adobe 247 Rosario Blvd. Santa Fe, NM 87501 Robert W. Higginson & Paul Romero, Owners	989-7224	Santa Fe	50,000
Northern Pueblo Housing Auth. P.O. Box 3502 Pojoaque, NM 87501 David Perez, Director	455-2246	Santa Fe	17,000
Overview Consulting and Mfg. Box 1363 Corrales, NM 87048 David Lineau, Owner	898-6609	Sandoval	Manufacturer
Ridge Adobe Box 4396 Santa Fe, NM 87502 Chester Berridge, Owner	983-7624	Santa Fe	125,000
Rustech 163 Piedra Loop Los Alamos, NM 87544 Ken Rust, Owner	672-9692	Los Alamos	Manufacturer
Snyder Enterprise Rt. 3, Box 670-B Apache Creek, NM 87830 Cliff Snyder, Owner	533-6463	Catron	0
T. D. Adobe Works Box 315 Arrey, NM 87930 Guy Bennet, Owner	267-9277	Sierra	0
Terra Manufacturing Co. c/o 8325 Washington NE Albuquerque, NM 87113 Mike Riddle, Owner	822-9170	Bernalillo	Manufacturer
The Adobe Machine P. O. Box 681 Gallup, NM 87301 Perry Merrill and Kevin Mowrer, Partners	722-9206	McKinley	0
Worldwide Adobe, Inc. P.O. Box 7397 Grants, NM 87020 John Wright, Owner	285-5468	Cibola	Manufacturer

CINVA-Ram brick press

Although no production of CINVA-Ram-type pressed blocks was noted in 1990 in New Mexico, because of the widespread use of the press by the Peace Corps throughout the world we have included it in this report. In 1980-81, W. S. Carson of Columbus, New Mexico, had hired a work crew to produce the CINVA-Ram blocks that were used to construct a 3000-square-foot, two-story house at the Columbus airport building site (Fig. 15).

Rammed-earth production

Building using rammed-earth techniques (pisé de terre) is nothing new. Pliny mentioned it in his *Natural History* in the 1st century and the Romans introduced it into what is now France. Various rammed-earth buildings have been constructed in England, Africa, Australia, New Zealand, Mexico, and California, representing a wide range of climates and soil types. New Mexico has two construction firms that use this technique (Table 3).

The rammed-earth wall is similar to a pressed-earth block, but because of size and the equipment and forms used to construct the walls, the technique is very different. Continuous rammed-earth walls are built by thoroughly tamping layers of moist soil to form a layer several inches deep between wooden, steel, or aluminum forms. When a section of the wall is completed, the forms are moved upwards or sideways and the process is repeated. The ramming is done with hand or pneumatic tampers to reduce the volume of the soil material by 25% to 30%, until the soil has become dense and firm.

Rammed earth is a stable building material that has many advantages for the construction of homes, commercial buildings, garages, and barns. The walls, if thick enough (16-24 inches), have certain insulating and thermal characteristics that produce a well-known comfort factor (Fig. 16).

TABLE 3—Rammed-earth construction companies active in New Mexico in 1991.

Name and mailing address	*Telephone*	*County*
Huston Construction Company Box A Edgewood, NM 87015 Stan E. Huston, Owner	281-9006	Santa Fe
Soledad Canyon Earth Builders P.O. Box 274 Mesilla, NM 88046 Mario Bellestri, Owner	521-3246	Doña Ana

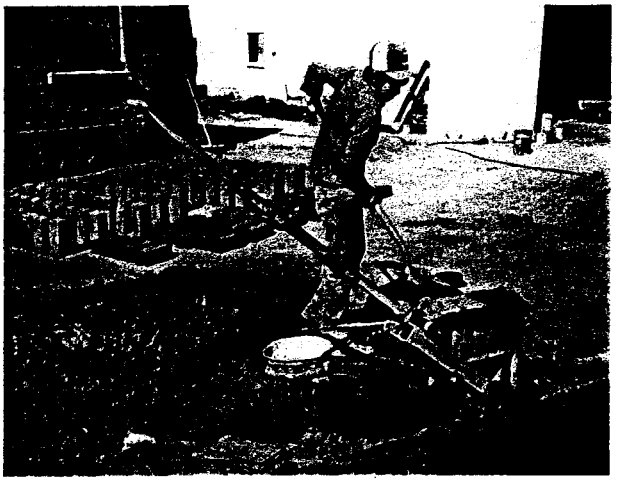


Figure 15: **Use of a CINVA-Ram in the production of pressed-earth-blocks at Columbus, N.M.**

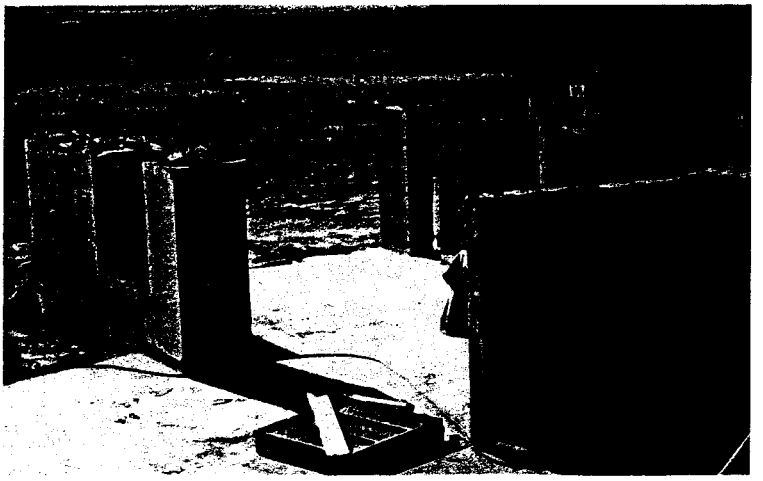


Figure 16: **Stan E. Huston rammed earth house under construction at Edgewood, N.M. Note thickness of the walls.**

Figure 17: **El Zuguan, Canyon Road, Santa Fe**

BIBLIOGRAPHY

ANONYMOUS, 1982, A handbook of adobe codes from around the southwest: Adobe News, Inc., Albuquerque, New Mexico (editing, revision, typesetting, and graphics by Kahaleola Chong and Joe Tibbets), 95 pp.

BUNTING, B., 1976, Early architecture in New Mexico: University of New Mexico Press, Albuquerque, New Mexico, 85 pp.

BUNTING, B., BOOTH, J. L., AND SIMS, W. R., JR., 1964, Taos adobes—Spanish Colonial and Territorial architecture of the Taos valley: Museum of New Mexico Press and Fort Burgwin Research Center, Santa Fe, New Mexico, Publication 2, 80 pp.

CALIFORNIA RESEARCH CORPORATION, 1963, The manufacture and use of asphalt emulsion stabilized adobe bricks: California Research Corporation, Richmond, California, 17 pp.

FERM, R., 1985, Stabilized earth construction—an instructional manual: The International Foundation for Earth Construction, Washington, D.C., 74 pp.

GERBRANDT, H., AND MAY, G. W., 1986, The extent of adobe use in the United States: Solar Earthbuilder International, 505/524-1416, P. O. Box 16119, Las Cruces, New Mexico, Issue 47, pp. 12-15, 56-59.

LUMPKINS, W., 1977, Adobe (from the Arabic 'Atobe'): unpublished paper, Museum of New Mexico, Santa Fe, New Mexico, 25 pp.

LUMPKINS, W., 1986, La Casa adobe: Ancient City Press, Santa Fe, New Mexico, 52 pp.

MCHENRY, P. G., JR., 1985, Adobe, build it yourself: University of Arizona Press, Tucson, Arizona, revised edition, 158 pp.

MCHENRY, P. G., JR., 1984, Adobe and Rammed Earth Buildings, design and construction: John Wiley and Sons, . New York, 217 pp.

MIDDLETON, G. F., 1987, Earth-wall construction: Australian Government Publishing Service, National Building Technology Centre, P. O. Box 30, Chatswood 2057, Bulletin 5, 4th edition (revised by L. M. Schneider), 65 pp.

SCHEUCH, K. E., AND BUSCH, R. D., 1988, New Mexico Conservation Code application manual, residential buildings: Energy, Minerals and Natural Resources Department, Santa Fe, New Mexico, 1988 edition, 108 pp.

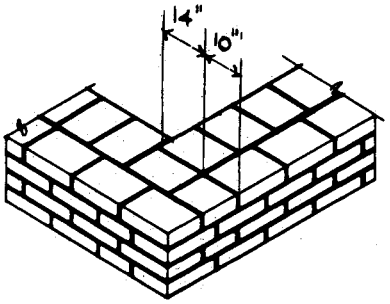
SMITH, E. W., 1982, Adobe bricks in New Mexico: New Mexico Bureau of Mines and Mineral Resources, Circular 188, 89 pp.

SMITH, E. W., AND AUSTIN, G. S., 1989, Adobe, Pressed-earth, and rammed-earth industries in New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 127, 60 pp.*

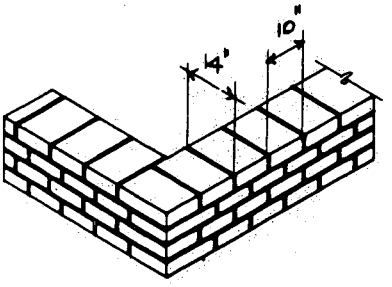
STEEN, C. R., 1972, An archaeologist's summary of adobe: Museum of New Mexico Press, Santa Fe, New Mexico, El Palacio, v. 77, no. 4, pp. 29-39.

WOLFSKILL, L. A., DUNLAP, W. A., AND GALLAWAY, B. M., 1970, Handbook for building homes of earth: Department of Housing and Urban Development, Office of International Affairs, Washington, D.C., 160 pp.

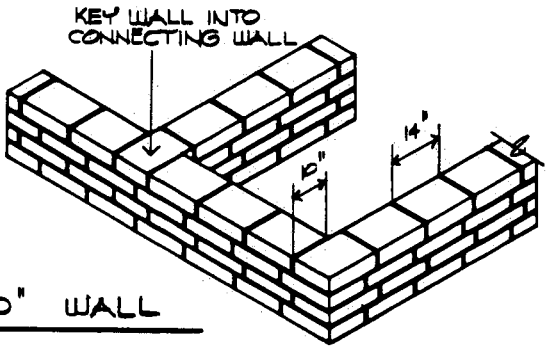
*More information on the New Mexico adobe industry is available in this publication (Bulletin 127), which may be obtained from the New Mexico Bureau of Mines and Mineral Resources, Socorro, NM 87801, 505/835-5410.



24" WALL

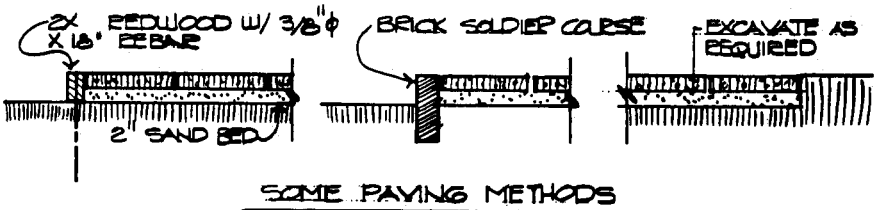


14" WALL

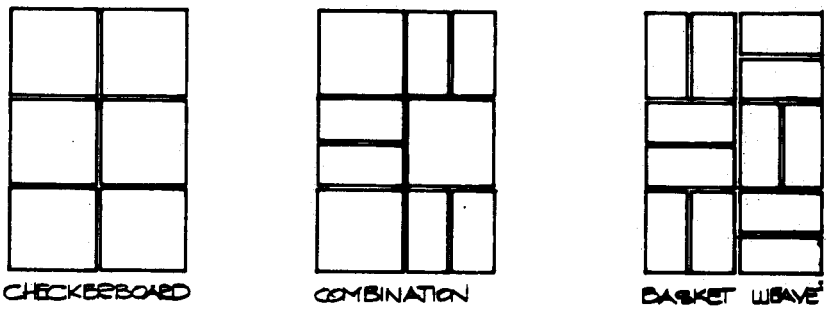


10" WALL

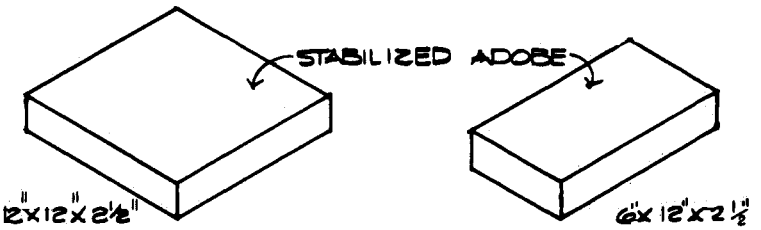
STANDARD ADOBE WALLS



SOME PAVING METHODS



PAVING PATTERNS



STANDARD PAVERS

STANDARD 10"x14"x4" MAY BE USED WHEN PAVER'S ARE UNAVAILABLE.

Figure 18: **Standard adobe wall thickness**

APPENDIX 1—NEW MEXICO BUILDING CODE, SECTION 2412

In most regions of the United States where adobe is widely used in construction, locally adopted amendments to the Uniform Building Code establish standard building specifications. In New Mexico, specifications for adobe are covered in Section 2412 of the 1988 New Mexico Building Code; an older version was approved and adopted by the Construction Industries Committee of the New Mexico Construction Industries Division on July 22, 1977. Prior to this 1977 version, which was developed under the auspices of the adobe industry and written by a team of four New Mexican adobe experts, the section on adobe had been regarded as severely limited and inconsistent in its coverage of the material and its specifications.

The method by which building codes in general are put together combines objective data gathering with the subjective interpretation of that data. Information derived from extensive engineering and construction experience and statistics collected from standardized laboratory tests all contribute to the store of practical and scientific knowledge about how a material behaves under a variety of conditions. However, the transition from raw data and information to a meaningful and workable building code relies on an interpretive and analytical process and ultimately on the quality of judgment of those individuals who produce the final written code.

Adobe codes have traditionally suffered from deficiencies in both areas of objective data gathering and subjective interpretation of the data. Until 1982, the amount of "official" data concerning adobe had been quite small relative to that of many other building materials.

Among the major revisions in the 1977 edition of the New Mexico Building Code were the legalization of untreated (traditional) adobes, already used throughout the state, and the removal of the requirement that buildings constructed with sufficiently stabilized adobe and mortar be coated with some other protective substance. In addition, many other minor revisions were included, such as the allowance of the use of wooden "gringo" blocks and soil for mortar, as well as changes in the required thicknesses of load-bearing walls.

The second revision of the adobe code was approved in 1983. This revision recognized stabilized adobes, untreated adobes, hydraulically pressed units (pressed-earth blocks), terrónes, burned adobes (quemados), and rammed earth. In the 1988 revision, characteristics of hydraulically pressed units (pressed-earth blocks) were qualified; a curing period of 14 days and physical-property tests were recommended. In addition, the allowed percentage of water absorption for stabilized adobes was increased from 2½ to 4 wt%.

Section 2412 of the New Mexico Building Code (Construction Industries Division, 1988) is reprinted below in its entirety. Any further questions concerning the code should be addressed to the Construction Industries Division, 725 Saint Michaels Drive, Santa Fe, New Mexico 87503 (telephone: 505/827-7030).

Chapter 24-Masonry

SEC. 2412. UNBURNED CLAY MASONRY

A. GENERAL: Masonry of unburned clay units shall not be used in any building more than two (2) stories in height. The height of every wall of unburned clay units without lateral support shall be not more than ten (10) times the thickness of such walls. Exterior walls, which are laterally supported with those supports located no more than 24 feet apart, are allowed a minimum thickness of 10 inches for single story and a minimum thickness of 14 inches for the bottom story of a two story with the upper story allowed a minimum thickness of 10 inches. Interior bearing walls are allowed a minimum thickness of 8 inches. Upward progress of walls shall be in accordance with acceptable practices.

B. SOIL: The best way to determine the fitness of a soil is to make a sample brick and allow it to cure in the open, protected from moisture. It should dry without serious warping or cracking. A suitable adobe mixture of sand and clay shall contain not more than 2% of water soluble salts.

C. CLASSES OF EARTHEN CONSTRUCTION:

(1) STABILIZED ADOBES. The term "stabilized" is defined to mean water resistant adobes made of soils to which certain admixtures are added in the manufacturing process in order to limit the adobe's water absorption. Exterior walls constructed of stabilized mortar and adobe require no additional protection. Stucco is not required. The test required is for a dried four-inch (4") cube cut from a sample unit which shall absorb not more than four percent moisture by weight when placed upon a constantly water saturated porous surface for seven (7) days. An adobe unit which meets this specification shall be considered "stabilized."

(2) UNTREATED ADOBES. Untreated adobes are adobes which do not meet the water absorption specifications. Use of untreated adobes is prohibited within 4 inches above the finished floor grade. Stabilized adobes and mortar may be used for the first 4 inches above finished floor grade. All untreated adobe shall have an approved protection of the exterior walls.

(3) HYDRAULICALLY PRESSED UNITS. Sample units must be prepared from the specific soil source to be used and may be cured for a period of fourteen (14) days. The building official may require additional test procedures outlined in paragraphs D, G, H, and I at his discretion.

(4) TERRÓNES. The term terrón shall refer to cut sod bricks. Their use is permitted if units are dry and the wall design is in conformance with this code.

(5) BURNED ADOBE. The term "burned adobe" shall refer to mud adobe bricks which have been cured by low temperature kiln firing. This type of brick is not generally dense enough to be "frost proof" and may deteriorate rapidly with seasonal freeze-thaw cycles. Its use for exterior locations is discouraged in climate zones with daily freeze-thaw cycles.

(6) RAMMED EARTH.

(a) SOILS: See Section 2412 (b).

(b) MOISTURE CONTENT: Moisture content of rammed earth walls shall be suitable for proper compaction.

(c) FORMS: Suitable forms shall be used.

(d) LIFTS AND COMPACTION: Uncompacted damp soil shall be compacted in lifts not to exceed 6" until suitable compressive strength is achieved.

(e) TESTS: Testing of rammed earth construction shall be in accordance with approved standards.

(f) CURING: The building officials may allow continuous construction of rammed earth prior to the full curing process, provided proper compaction methods are followed.

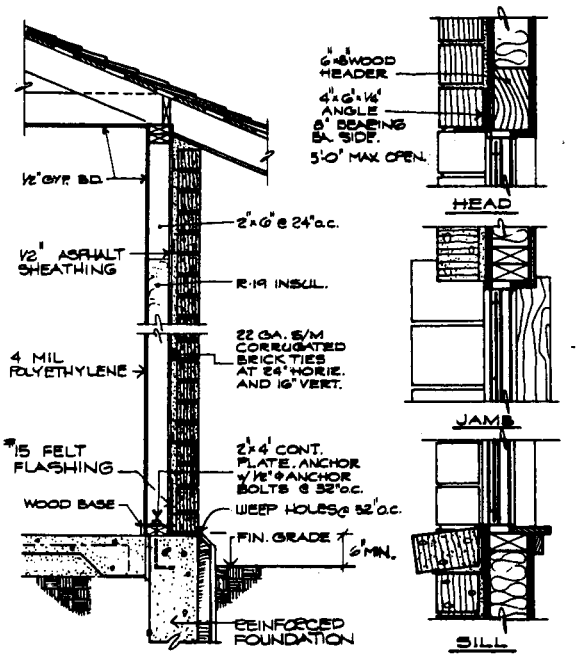
D. SAMPLING: Each of the tests prescribed in this section shall be applied to sample units selected at random at a ratio of 5 units/25,000 bricks to be used or at the discretion of the building official.

E. MOISTURE CONTENT: The moisture content of untreated units shall be not more than four percent by weight.

F. ABSORPTION: A dried four (4) inch cube cut from a sample unit shall absorb not more than four percent moisture by weight when placed upon a constantly water saturated porous surface for seven (7) days. An adobe unit which meets this specification shall be considered "stabilized."

G. SHRINKAGE CRACKS: No units shall contain more than three shrinkage cracks, and no shrinkage crack shall exceed two (2) inches in length or one-eight (⅛) inch width.

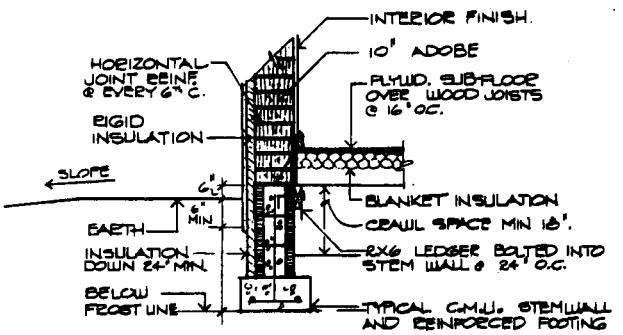
H. COMPRESSIVE STRENGTH: The units shall have an average compressive strength of 300 pounds per square inch when tested. One sample out of five may have a compressive strength of not less than 250 pounds per square inch.



TYP. WALL SECTION

ADOBE VENEER ON WOOD FRAME

Figure 19: **Adobe veneer over stud-wall section**



10" STEM WALL-JOIST FLOOR

NOTE: ALL FOOTINGS AND FOUNDATION WALLS ARE SHOWN FOR AVERAGE SOIL AND LOADING CONDITIONS. ALL FOOTINGS SHOULD BE DESIGNED FOR THE SPECIFIC CONDITIONS OF EACH PROJECT.

THE THICKNESS OF INSULATION REQUIRED BY ENERGY CODES VARIES WITH PROJECT, SITE, CLIMATE AND THE R-VALUE OF THE INSULATION TO BE USED.

Figure 20: **Typical foundation for 10" adobe wall**

I. MODULUS OF RUPTURE: This unit shall average 50 pounds per square inch in modulus of rupture when tested according to the following procedures:

(a) A standard 4 × 10 × 14 cured unit shall be laid over (cylindrical) supports two (2) inches from each end, and extending across the full width of the units.

(b) A cylinder two (2) inches in diameter shall be laid midway between and parallel to the supports.

(c) Load shall be applied to the cylinder at the rate of 500 pounds per minute until rupture occurs.

(d) The modulus of rupture is equal to $3WL/2Bd^2$
W = Lode of rupture
L = Distance between supports
B = Width of brick
d = Thickness of brick

J. MORTAR: The use of earth mortar is allowed if earth mortar material is of same type as the adobe bricks. Conventional lime/sand/cement mortar of Types M, S, N are also allowed.

Mortar "bedding" joints shall be full SLUSH type, with partially open "head" joints allowable if surface is to be plastered. All joints shall be bonded (overlapped) a minimum of 4 inches.

K. USE: No adobe shall be laid in the wall until fully cured.

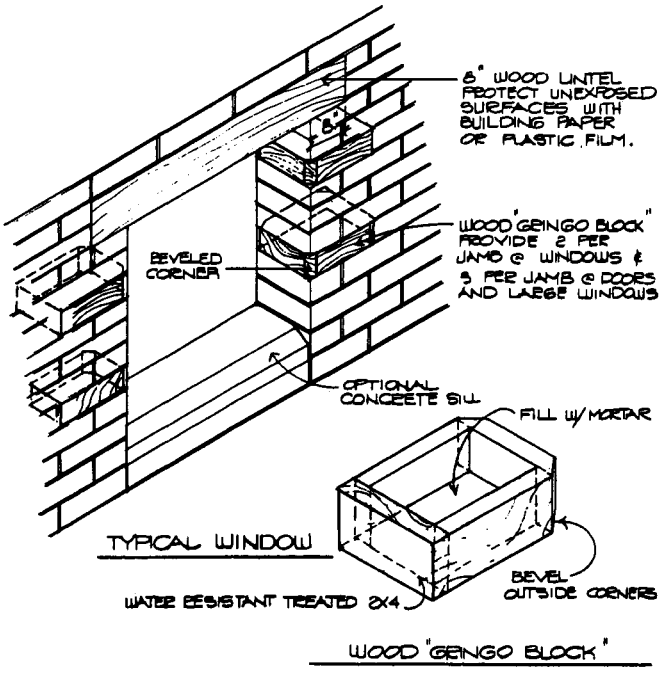


Figure 21: **Wood "gringo" blocking detail**

L. FOUNDATIONS: Adobes shall not be used for foundation or basement walls. All adobe walls, except as noted under Group M Buildings, shall have a continuous concrete footing at least eight (8) inches thick and not less than two (2) inches wider on each side that support the foundation walls above. All foundation walls which support adobe units shall extend to an elevation not less than six (6) inches above the finish grade.

Foundation walls shall be at least as thick as the exterior wall. Where perimeter insulation is used, a variance is allowed for the stem wall width to be two (2) inches smaller than the width of the adobe wall it supports. Alternative foundation systems shall be approved by the building official.

All bearing walls shall be topped with a continuous belt course or tie beam (except patio walls less than six (6) feet high above stem).

M. TIE BEAMS:

(a) CONCRETE: Shall be a minimum of six (6) inches thick by width of top of wall. A bond beam centered to cover ⅔ of the width of the top of the wall by 6 inches thick shall be allowed for walls wider than 24 inches. All concrete tie beams shall be reinforced with a minimum of two No. 4 reinforcing rods at each floor and ceiling plate line. All bond beam construction shall be in accordance with accepted engineering practices.

(b) WOODEN TIE BEAM: Shall be a minimum of 6 inches by wall thickness except as provided for walls thicker than 10" above. Wood tie beams may be solid in the six (6) inch dimension or may be built up by applying layers of lumber. No layer shall be less than one (1) inch. The building official shall approve all wooden tie beams for walls thicker than ten (10) inches.

N. WOOD LINTELS: Shall be minimum in size six (6) inches by wall width. All ends shall have a wall bearing of at least twelve (12) inches. All lintels, wood or concrete, in excess of nine (9) feet shall have specific approval of the building official.

O. ANCHORAGE: Roof and floor structures will be suitably anchored to tie beams. Wood joists, vigas, or beams shall be spiked to the wood tie beams with large nails or large screws.

Fireplaces shall be secured to the wall mass by suitable ladder reinforcement such as "durowall" or equivalent.

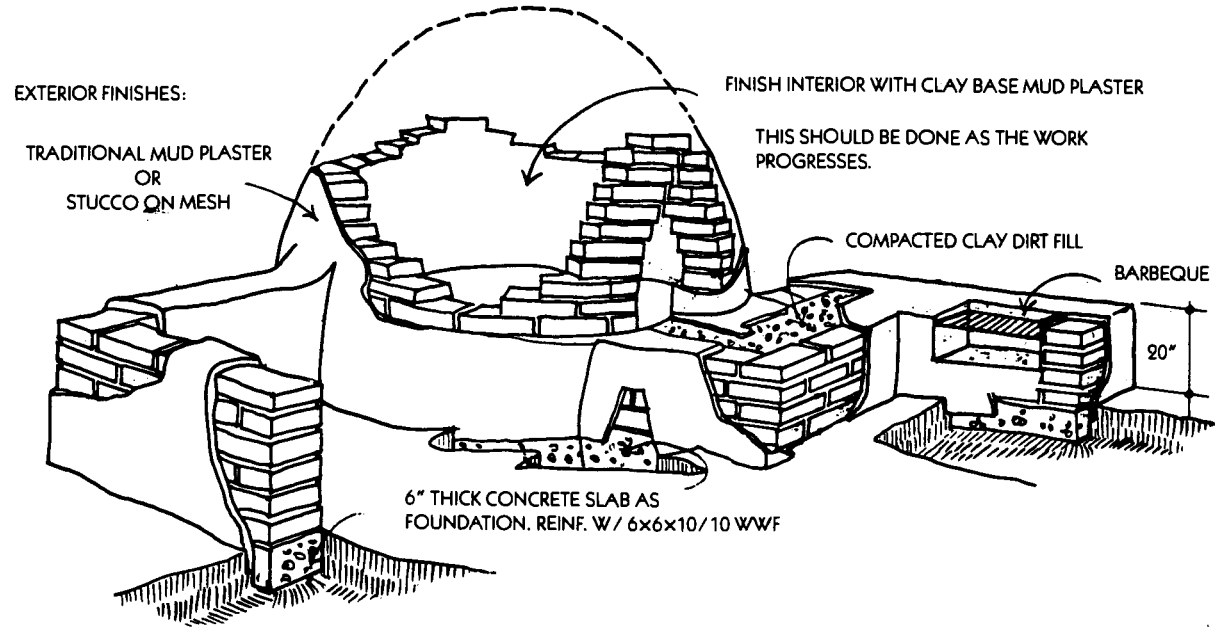


Figure 22: **Adobe "horno," or Indian oven**

Partitions of wood shall be constructed as specified in Chapter 25 of the 1988 Uniform Building Code; wood and metal partitions may be secured to nailing blocks laid up in the adobe wall or by other approved methods.

P. PLASTERING: All untreated adobe shall have all exterior walls plastered on the outside with portland cement plaster, minimum thickness ⅞". Protective coatings other than plaster are allowed, provided such coating is equivalent to portland cement plaster in protecting the untreated adobes against deterioration and/or loss of strength due to water. Metal wire mesh, minimum 17 gauge by one (1) inch opening, shall be securely attached to the exterior adobe wall surface by nails or staples with minimum penetration of one and one-half (1½) inches. Such mesh fasteners shall have a maximum spacing of sixteen (16) inches from each other. All exposed wood surfaces in adobe walls shall be treated with an approved wood preservative before the application of wire mesh. Alternative plastering systems shall be approved by the building official.

EXCEPTION:

(1) Exterior patio, yard walls, etc. need not have portland cement coating.

Q. FLOOR AREA: Allowable floor area shall not exceed that specified under Occupancy. Adobe construction shall be allowed the same area as given in Type V-N construction.

R. WALL INSULATION: All methods of wall insulation shall comply with the manufacturer's recommendations.

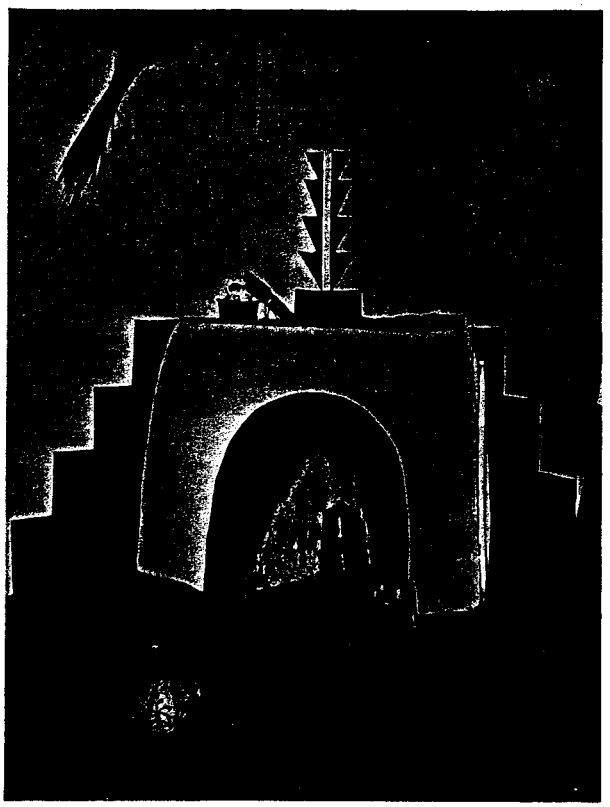
S. STOP WORK: The building inspector shall have the authority to issue a stop work order if the provisions of this Section are not complied with. (See Section 202(b) of this code.)

APPENDIX 2—CONSTRUCTION SPECIFICATIONS FOR ADOBE

Recommended Specifications for Adobe and Construction Details

INTRODUCTION—Specifications are written instructions that accompany drawings on a construction project and are issued to further explain the intent of the drawings. Specifications spell out exactly how a material or system is to be handled and installed and indicate the size, type, and quality of materials to be used.

In the following suggested adobe specifications, the instructions are generalized for use with most



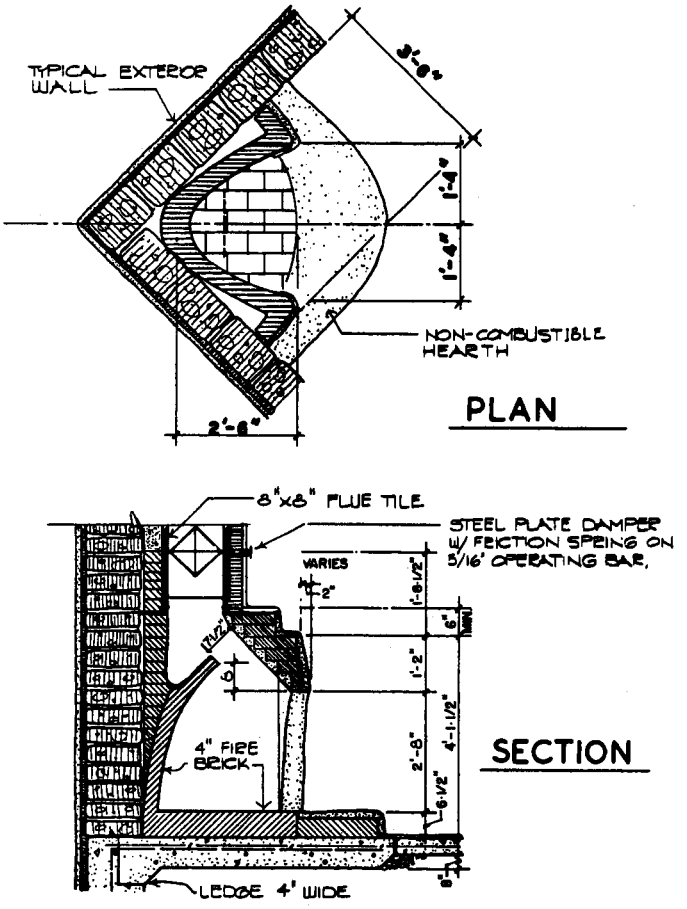


Figure 23: **Adobe corner fireplace with construction detail, Bandelier National Monument Visitor Center**

adobe projects, and more explicit instructions should be written for each project as necessary. The general notes and drawings are provided only as a guide to assure that basic elements relating to the adobe construction are considered. Additional notes accompany some drawings where not all conditions are shown; however, the details have been reviewed and reflect the latest in energy efficiency coupled with the simplicity of adobe. All drawings and specifications should be the responsibility of the person who prepares the construction documents, the owner, the designer, the architect, or the engineer.

ACKNOWLEDGEMENTS—Construction details (Figs. 13-26) were drawn by Dale Zinn, an architect with Architecture Planning Group, Santa Fe. Architects William Lumpkins, also of Santa Fe, and Allen McNown of Nambé reviewed the drawings.

GENERAL NOTES

All adobe walls should be erected on solid bearing foundations. The foundations should be at least 16 inches wide and rest on undisturbed earth or rock at a point below the frost line. Check with the building official for the depth of the frost line in the project vicinity. All foundation walls should extend above the ground at least 6 inches to protect the adobe walls from erosion. Earth around the structure should slope away from the walls.

For minimum foundation reinforcement two ½-inch continuously running reinforcing bars should be placed horizontally side by side and 6 inches apart in the footing 2 inches above the earth. Vertical ½-inch bars should extend from the bottom of the footing up through the foundation wall every 4 ft. Another horizontal bar should be run continuously at the top of the stem wall and should be tied to the verticals. All splices should be overlapped 24 bar diameters or a 12-inch minimum. The concrete for the footing and the foundation wall or to fill the cells of a concrete-block foundation should have a minimum of 2,500 psi compressive strength.

Perimeter insulation is required by the New Mexico State Energy Code. This is a rigid-board insulation that is moisture protected or impervious to moisture. The perimeter insulation is most effective if it is 2 inches thick and if it is placed on the outside of the foundation walls extending at least 2 ft down into the earth.

The New Mexico Energy Code requires that walls meet the criteria for insulative qualities. Adobe walls that are to be insulated should have the insulation fitted to the exterior to preserve the thermal-mass effect of the adobe shell. The insulation can be a sprayed-on material, or board stock can be mechanically attached to the outside. The outside should be

additionally protected by a stucco or other finish. This finish must be anchored through the insulation into the adobe.

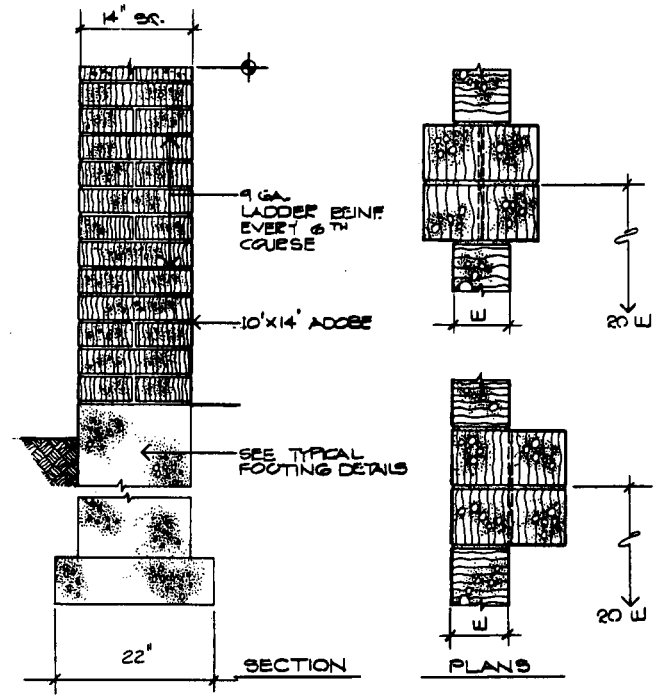
Either cement or adobe-mud mortar can be used effectively for adobe construction. Cement mortar is more expensive; however, the cement sets up faster and stronger so that work can progress more quickly. Mud mortar is inexpensive, but walls may take weeks and even months to dry completely. Working too fast with adobe mud mortar can cause structural failure.

Horizontal joint reinforcing can be used to add strength to the walls. Usually 9-gauge wire in a ladder or truss configuration is laid in every sixth-course mortar joint. Wider walls require wide reinforcing. A ⅜-inch reinforcing bar also may be used in the joint.

The height of adobe walls is limited by code. The maximum height of a bearing wall of adobe is 10 times the width of the unit being used. Therefore a 10-inch-wide adobe wall can be laid 8 ft 4 inches high, and a 14-inch-wide wall can be 11 ft 8 inches high. Higher walls should be designed by an architect or engineer. Most walls of a house are not over 20 ft long without an intersecting wall. A wall that is over two times the allowable length should have an intersecting wall, reinforcing pilaster, or adobe post built into the wall for lateral bracing.

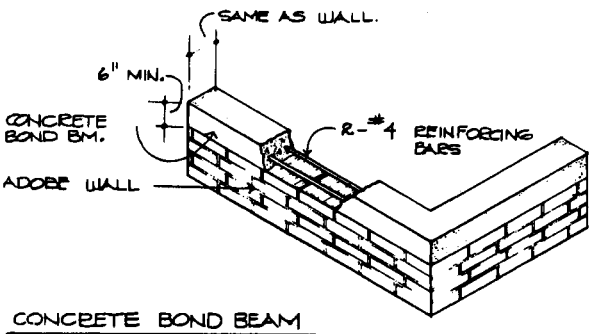
All openings in adobe walls have to be spanned with a supporting member. The member can be steel, reinforced concrete cast in place or precast, or wood. The lintels should extend 12 inches past the opening on both sides and be the full width of the wall. The depth of the member depends on the width of the opening and the strength of the material. In wood an 8-inch-deep member can be used in an opening up to 6 ft wide. A 12-inch-deep member can be used in an opening up to 10 ft wide. The supporting structure of wider openings should be designed by an architect or engineer.

Structural damage from water runoff is the worst and most frequent problem with adobe construction. All details of the roof, whether it is pitched or semi-flat, should take into consideration that the runoff of rain water should be carried away from the outside adobe walls by canales, scuppers, gutters, or roof overhangs.

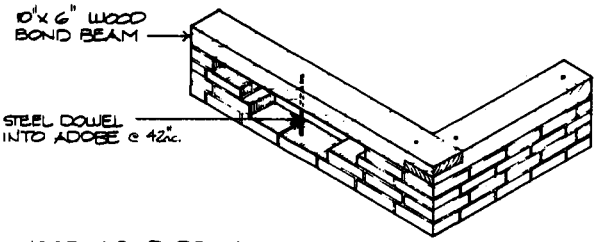


PILASTER DETAIL

Figure 24: **Adobe post or pilaster detail**



CONCRETE BOND BEAM



WOOD BOND BEAM

BOND BEAMS AS REQUIRED BY CODE

Figure 25: **Bond beams as required by code for wood, timber and concrete**

BOND BEAMS

The bond beam is a continuous member placed at the top of a wall where the roof structure is to be anchored. The bond beam as called for on the drawings can be either concrete or treated wood as specified in the Uniform Building Code. The bond beam shall be set on adobe-mortared walls only after the wall has dried for at least 7 days; cement-mortared walls can be ready for the bond beam after only 1 day. The size of the bond beam as required by code is a minimum of 6 inches deep and equal to the wall width. A wood bond beam may be made up of layers of boards not less than 1 inch thick; however, wood joints shall be lapped at least 6 inches and spiked together. All bond beams should be anchored into the adobe wall. This can be done with ⅝-inch steel reinforcing bars (or bolts) cut long enough to extend down through the bond beam and into the adobe for at least four courses (± 16 inches). These anchors should be placed every 6 ft and solidly grouted into the wall.

WALL FINISHES

Upon completion of the work, rake out all defects in joints of exposed surfaces, fill with mortar, retool, and rub. Leave all surfaces clean, free of mortar daubs, and with tight mortar joints throughout. Exterior and interior walls may be left unfinished. The following wall-finish alternatives are quoted from the California Research Corporation report (1963).

1) SMOOTHING AND WASHING—The wall surface shall be cleaned by wetting and rubbing smooth with wet burlap, then washing [with an adobe mortar wash].

2) PAINT COAT, PRIME COAT, TRANSPARENT SEALER—

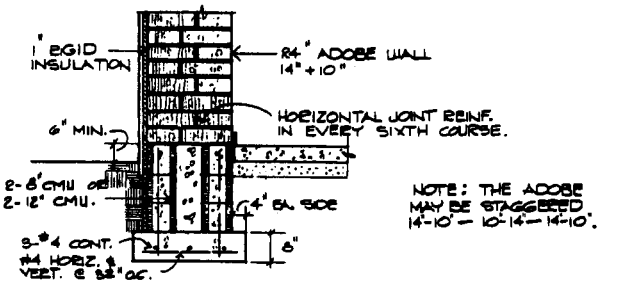
   a) PAINT. The following paints are satisfactory when applied on emulsified asphalt treated soil brick dry surfaces to serve as finish paint coat, exterior or interior. No prime coat is required . . . [Alcyd resin, an oil base exterior masonry paint, or acrylic latex flat exterior finish may be used].

   b) ASPHALT BASE ALUMINUM PAINT. After the walls are smoothed and cleaned (Sec. 1) and are thoroughly dry, a good grade of asphalt base aluminum paint, formulated with drying oils, shall be used as prime. When the coating is dry, one or more coats of a good grade of exterior or interior paint may be applied. (Note: Aluminum paint is not recommended to be applied during wet seasons, or on walls when damp. When wall is damp, use instead cement wash, Par. "c," below.)

   c) CEMENT WASH. The clean wall surface shall be wetted, then primed with a cement wash consisting of one sack of Medusa or equal White Cement mixed with about 6 gallons of water to a paint consistency, applied by vigorous brushing. After initial set, the prime coat shall be fogged with water several times daily for 5 to 6 days, until the cement is fully set and hardened.

   A second application of cement wash, tinted with pigment if desired, may be applied as final coat; or after setting, the cement-primed surface may be painted with a good grade of exterior or interior paint. (Cement wash coats are best applied when damp; cloudy weather aids most curing.)

   d) TRANSPARENT PROTECTIVE SEALER. A nonglossy protective finish, not altering natural color of the bricks, may be obtained by applying on the clean wall surface . . . [a clear acrylic sealer or a silicone masonry sealer, either clear or tinted].



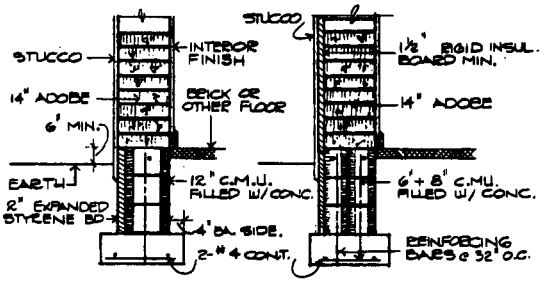


Figure 26: **Typical foundation for 14" and 24" adobe wall**

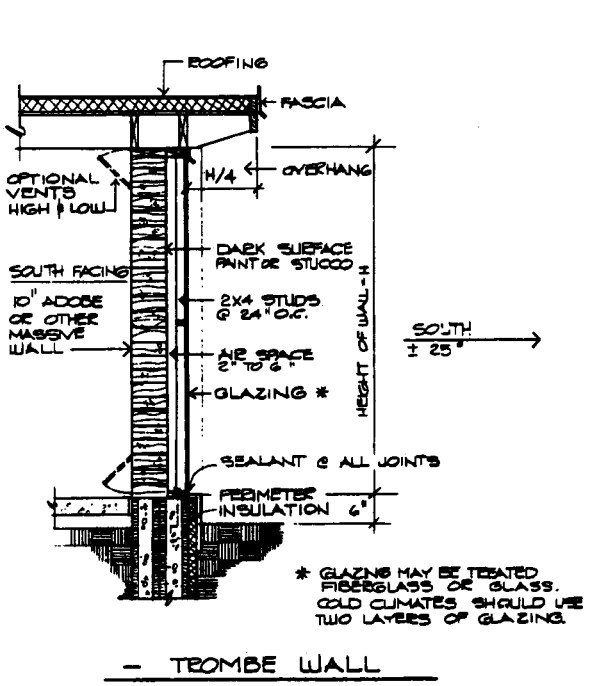


Figure 27: **Passive solar adobe trombe-wall detail**

e) LINSEED OIL, FOR INTERIOR FINISH ONLY. For harder, tougher interior surfaces a prime coat or a transparent protective seal coat may be provided by painting with raw linseed oil (imparting to the brick surface a richer, darker color). When used as prime coat, allow to cure thoroughly, at least two weeks, then paint with 50% raw linseed oil, 50%. . . [alcyd resin, and oil base interior masonry paint].

3) PLASTER—Expanded metal lath or 1-inch 18-gauge galvanized wire shall be fastened to the walls with furring nails driven into the bricks. Cement stucco or hardwall plaster is then applied in scratch, brown, and finish coats according to standard practice.

ESTIMATING QUANTITIES OF ADOBES

Several methods are used for estimating the number of adobe bricks necessary to build a wall or partition. The method described here known as the wall-area method is the simplest and is as accurate an any. The quantities shown are based on an adobe brick of 10 × 14 × 4-inch nominal dimensions. If the adobe is other than this size the quantities will not be accurate.

ESTIMATING PROCEDURE

Given the modular (standard and consistent size) nature of adobes made in quantity, the wall-area method of estimating adobe quantities assumes that a consistent number of adobe bricks are contained in any 1 ft² of wall area. In estimating quantities of other masonry units for a specific area, such as bricks, the size and consistency of the mortar units are very important. The adobe unit is much larger than a fired brick; therefore, consistency and size of the joints are less critical in the determination of the quantity of units in the adobe wall. The quantities below reflect an assumption that the joints are approximately ½-¾-inch thick.

The first step is to estimate the amount of area for each wall thickness. For example, take the length of a 10-inch-thick wall and multiply by the height, excluding bond beams. Subtract the window and door areas. This will be the net wall area. Repeat this procedure for all other 10-inch-thick walls until the net wall areas of all 10-inch-thick adobe walls are calculated. Estimate the net wall area in the same manner for other thicknesses of walls. Multiply the net areas by the units per ft² given below for each of the different wall thicknesses. This number will be the preliminary quantity of adobes needed. An estimation of the breakage and waste must be made and then added to

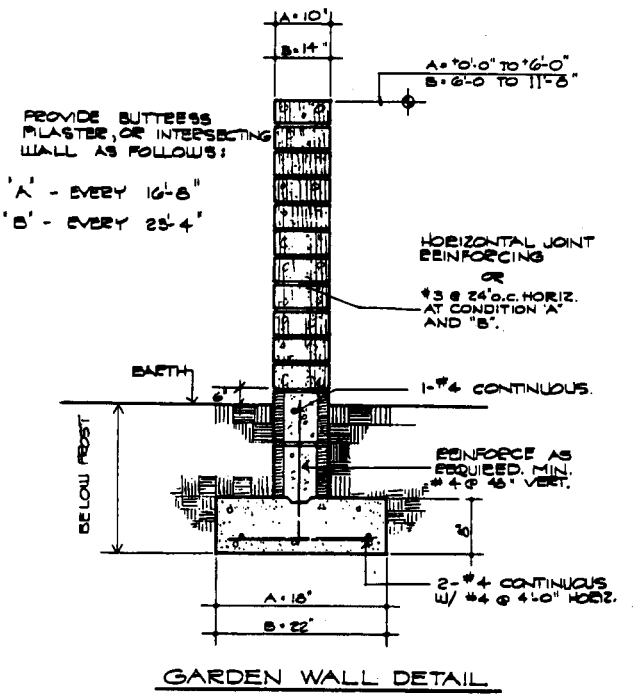


Figure 28: **Garden wall detail**

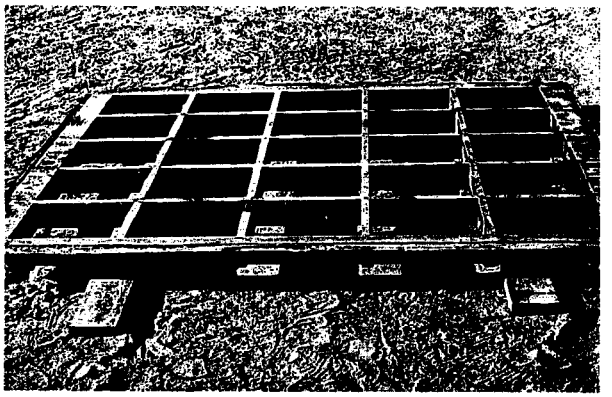
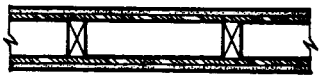
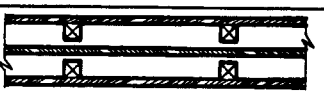
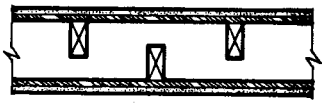
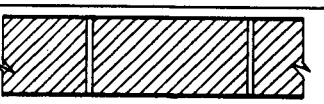


Figure 29: **Standard adobe form, 8 Northern Indian Pueblos Council, San Juan, New Mexico**

this quantity. At least 10% should be added; however, various factors will increase this percentage. Some of these factors are quality of the adobes, the exposure that the stacked units are subject, the amount of handling necessary to bring the units to the construction site, and the number of doors and windows in a wall panel. Following are the units per ft² for different wall thickness:

10-inch-thick wall = 2.60 units/ft²
14-inch-thick wall = 3.63 units/ft²
24-inch-thick wall = 5.52 units/ft²

To determine the amount of mortar required for ½-inch joints, multiply ⅛ of the net wall area by the wall thickness in feet, then divide by 27. The result is the yards³ of mortar required with some allowance for wastage.

TEST NO.	CONSTRUCTION	WEIGHT LBS./S.F.	TRANSMISSION DB.	CLASS
1x	 ½" INSULATING BOARD ON 2×4 STUD @ 16" OC	3.8	32.2	FAIR
2x	 2×4 STUDS @ 16" OC ½" PLASTER 3/8" GYP. LATH	15.0	34.9	FAIR TO GOOD
3x	 2×4 STUDS @ 16 " OC ½" INS. ON 2×6 PLATE BD. LOOSE W/ ¾" INSUL BD.	6.2	42.8	VERY GOOD
4x	 2×4 STUDS STAGGERED - ½" 16" OC 2×6 PLT. PLAST. & LATH	13.1	53.7	EXCELLENT
5	 10" ADOBE BRICK	109	63	EXCELLENT

x: TESTS SHOWN WITH (✚) ARE RESULTS OF TESTS SPONSORED BY THE INSULATION BOARD INSTITUTE. FROM A REPORT DATED SEPT. 14, 1956. EXAMINATION 308691 AFTER HANS STUMPF COMPANY, INC.

Figure 30: **Test of sound transmission through adobe walls**

GENERAL SPECIFICATIONS

SCOPE—Furnish and install all adobe masonry where shown on drawings and where required by the project manual, complete with all necessary accessories.

HANDLING—Stack adobe units on planks or platforms and protect adobes from moisture by covering with tarps, felt paper, or polyethylene sheets. Broken units and those with damage (2-inch maximum breakage or more than three surface cracks ⅛ inch in width and 3 inches long) shall be discarded from the stack and not used.

CODES—Local, state, and national codes in effect at the site of the work shall be observed during all phases of the work.

WEATHER CONDITIONS—Discontinue adobe-masonry construction when the ambient temperature is below 40°F (4°C) or when the probability of such conditions could occur within 48 hrs. Special conditions for cold-weather laying shall be subject to prior approval by the architect or building official. Do not build upon frozen material. Remove any work that has become frozen prior to resuming construction. In hot weather, protect concrete and cement mortar from drying too rapidly.

TESTING—The adobe manufacturer shall attest by certificate or otherwise guarantee that the adobes furnished meet or exceed the physical requirements stated in the building code adopted by the State of New Mexico.

MATERIALS

SEMISTABILIZED ADOBES—Nominal 4 × 14 × 10-inch units shall be made from adobe clay soil that shall contain not less than 25% and not more than 45% clay/silt material passing a no. 200 sieve. The soil shall contain sufficient clay to bind the particles together and shall contain not more than 0.2% water-soluble salts. Each adobe unit shall contain from 2 to 4% asphalt emulsion stabilizer. The remainder of material shall be a combination of fine sands and silts containing no particles larger than ⅜ inch and shall be free of large organic objects. The water used to mix the material shall be potable (drinkable). All units shall be formed in standard wood or metal molding forms. No units shall be used that are less than 30 days old.

TRADITIONAL ADOBES—Nonstabilized adobe shall be made in the same manner as the semistabilized units with the exception that the asphalt shall be deleted, and small quantities of straw can be used as a binder in the mix.

STABILIZERS—Type CSS-1 or CSS-1h asphalt emulsion or the following cement, lime, and sand mixture—portland cement, ASTM C-150 Type II-2500 psi; hydrated lime, ASTM C-207 Type S; sand, clean sharp, ASTM C-144; water, clean, nonalkali, and potable, and joint reinforcing, ASTM A-82, Truss Type 9 gauge.

ANCHORS AND TIES—Galvanized, 20 gauge minimum, and of approved design or expanded metal, 3.4 lbs/yard^2. All metals shall be free of loose rust or scale.

GRINGO BLOCKS OR WOOD SLEEPERS—Wood blocks in the same shape as the adobe unit shall be made of 2 × 4 ft stock material and treated with an approved wood preservative.

MORTAR—Mortar shall be mixed as follows—1 part cement, 1 part lime, and not more than 6 parts sand with adequate water to produce a workable mix.

ADOBE MORTAR—Adobe mortar where allowed by the building official shall be mixed of the same materials as the adobe units. Mortar joints should be waterproof to prevent expansion and contraction as a result of moisture variations and should be about ½-inch thick (California Research Corporation, 1963). Soil found suitable for use in mortar is best mixed in a small powered plaster or cement mixer. Usually approximately ½-¾ gal of stabilizer (asphalt emulsion) per ft^3 of dry loose soil is required. To produce a 5-8% mix use a 55-gal oil drum, pour in 5-5½ gal of asphalt emulsion, fill the drum with water, stir, and then add the mixture into the plaster or concrete mixer with soil in the ratio mentioned above to make a workable adobe mortar.

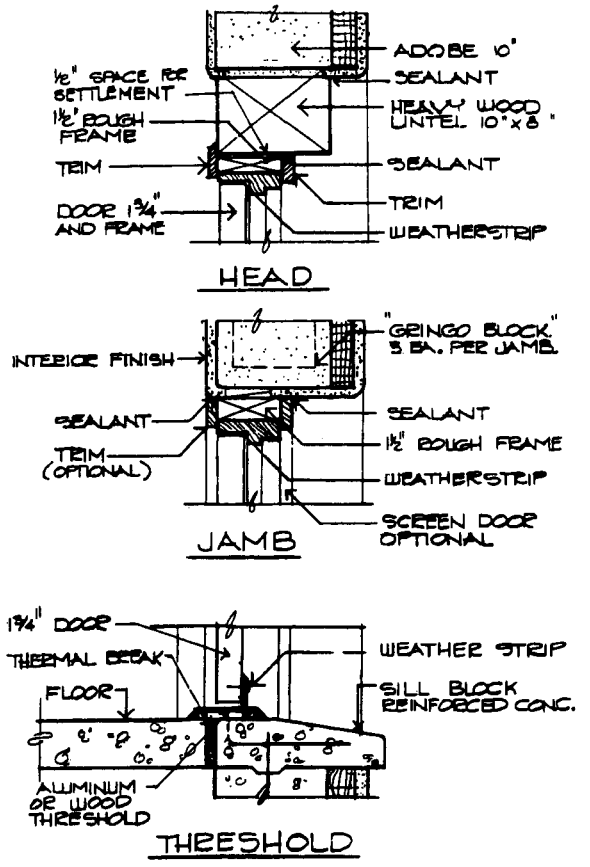


Figure 31: **Typical exterior wood door details**

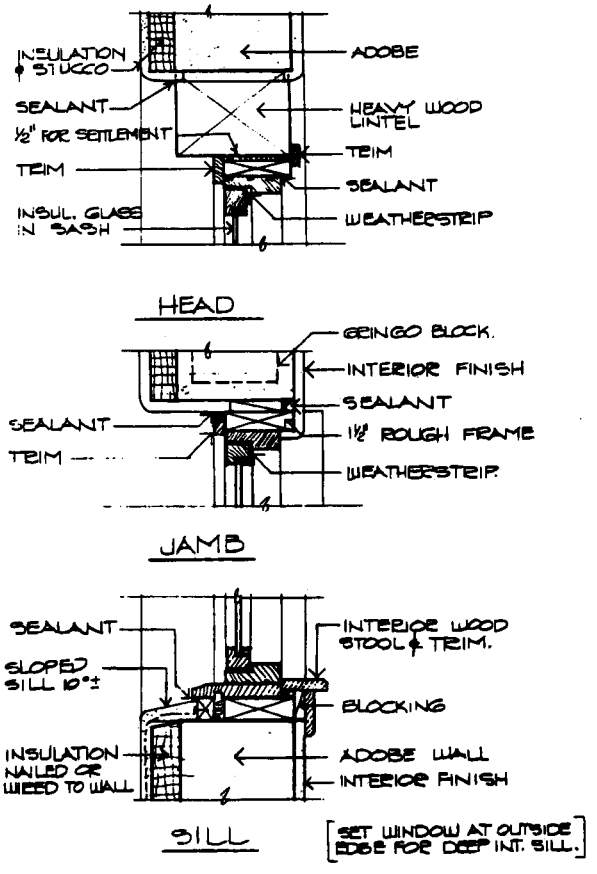


Figure 32: **Typical wood window detail in adobe wall**

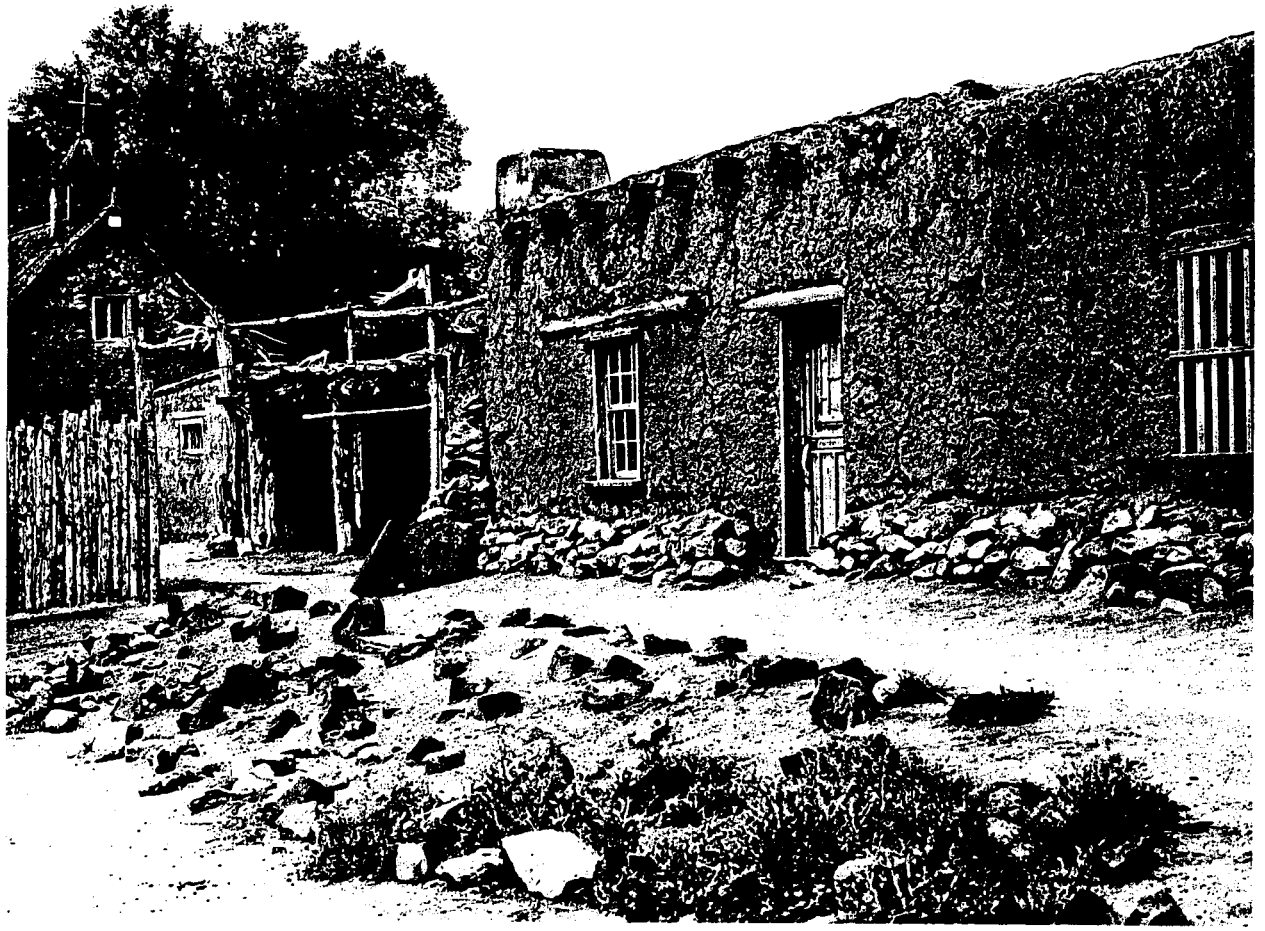


Figure 33: **Adobe structure, El Rancho de los Golondrinas Museum, La Cienega, New Mexico**

EXECUTION

WALL CONSTRUCTION—The contractor shall inspect the foundation for suitability for laying of the adobes. Do not proceed if the earth is within 6 inches of the first course of adobe or if any other condition exists that would be detrimental to the adobe.

Mix cement mortar in a mechanical mixer for at least 10 minutes, not more than 2½ hrs before it is to be used. Retempering (rewetting) of cement mortar shall not be allowed.

Lay adobe units in running bond with a minimum 4-inch overlap of the vertical joints between the bricks of adjacent courses. Mortar joints shall be flush with a ½-¾-inch maximum thickness. Tool mortar joints slightly concave on interior surfaces scheduled for an exposed finish. Rub with burlap prior to subsequent finishing. Any unit that has been disturbed after the mortar has stiffened shall be removed and relaid in fresh mortar.

Install horizontal joint reinforcements as indicated on framings, or if not called for, place reinforcements in every sixth course and in the first joint above lintels. Extend reinforcements 2 ft on both sides of all openings. Lap reinforcement 6 inches minimum at all splices and maintain a ⅝-inch mortar coverage on the weather side of the joint.

Install built-in items such as wood sleepers, blocking, door frames, anchors, lintels, or other framing members as required as the work progresses. Space around frames and anchors shall be filled solidly with mortar.

Step back unfinished walls for jointing with new work. Cover all partially completed work with a waterproof material and anchor securely. Protect surfaces of walls from damage and keep free of excess mortar. Walls may be channeled to embed pipes or conduit up to ½-inch maximum diameter. Adobe walls may be thickened to embed larger diameters. Pipes or conduits may pass through the walls.

CLEAN UP—Remove all debris created by the work in this section from the job site.