THE EXTENT OF ADOBE USE IN THE UNITED STATES

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ABSTRACT

The extent of the use of adobe as a building material in the United States is examined in this paper. Since almost all of adobe use is limited to the Southwest, some estimates of its extent are made for the states of New Mexico, Arizona, Texas and California. It is estimated that there are over 17,000 adobe residences now in use in the United States, with over 1,500 new ones being built each year.

Introduction

With increased interest in adobe as a construction material in the southwestern United States, where there is a relatively high potential for seismic activity, the need arises to assess the extent of adobe use. This requires an estimate of the number of adobe structures as well as the current state and future trends of the adobe construction business. While there is insufficient information to provide definitive answers to those questions, this report attempts to estimate the extent of use of sun-dried brick in the United States, both today and during the last century.

A survey of literature reveals a paucity of statistical information about production of adobe bricks, housing starts or total number of adobe structures. Although numerous details of housing types and facilities are included in the national census figures, the U. S. Bureau of Census does not classify buildings by wall type. Generally, even county or city building departments do not keep records of houses by construction type. Moreover, it is generally accepted that many adobe residences are constructed by individuals in rural areas. Thus, it is almost impossible to find comprehensive numerical data in published form.

For this reason, figures used in this report should be viewed as estimates rather than as hard figures. The statistics are derived from scant bits of information in the literature plus opinions of builders and producers, and includes extrapolation of this information. The figures should be regarded as a starting point for future research.

The report focuses on four southwestern states: New Mexico, Arizona, Texas and California. Although isolated use of adobe is widespread, and rammed earth was used fairly extensively in colonial times, its primary use is in the semi-arid Southwest, where climatic conditions and soil types are suited to adobe. Moreover, all four states have been influenced by Spanish colonization. Scarcity of wood not only discouraged construction with lumber, but also presented a problem in fueling kilns for firing brick. From various sources, it is estimated that 97 percent of existing adobe buildings in the United States lies in these four contiguous southwestern states.

A Short History of Adobe in North America

By the time the Spanish colonized the New World, sun-dried mud brick construction in the Americas could claim antiquity: Peruvian ruins dating to as early as 3000 B. C. revealed mastery of an earthen block construction in which bamboo molds were used to form the Andean mud and straw mixture, and the arid Mexican plateau invaded by Cortez in 1519 had seen the use of earthen bricks in the pyramids at Teotihuacan as well as in common housing.

In the last half of the 18th century, as Spanish settlers moved into northern Mexico and into what is now the United States, they encountered civilizations using two types of non-brick earthen construction: puddle and Pise´ (rammed earth). Although thirteenth-century ruins along Navajo Creek in northern Arizona were made of bricks that were hand-formed in place in the wall, the indigenous people of the southwest United States were largely ignorant of sun-dried brick formation and construction. Under the influence of the Spanish, these North American Indians quickly adopted both the method and the Spanish term for the brick--adobe. By the nineteenth century, when English-speaking colonists moved into the southwestern desert region, adobe was synonymous with housing.

Mexican influence in the region diminished steadily following Santa Ana's ephemeral victory at the Alamo in 1836. The U. S. victory in the Mexican War (1846) and the 1853 Gadsden Purchase spelled the end of Spanish dominance in the region. The U. S. Army occupation of New Mexico in 1846 brought a movement to "Americanize" the Mexican villages in the territory. Rumors and nuggets of California gold (1849) precipitated a deluge of "gringo" settlers to the previously Spanish-speaking west coast.

This new influx of aggressive settlers brought not only new faces and new architecture, but also new means of transporting previously scarce building materials; the passing of the railroad through the Southwest in the 1880's provided the means to haul the favorite construction materials of the newcomers--rock, brick, and lumber. Brick kilns and sawmills sprang up. And as the frame house flourished, the time-proven adobe fell into disrepute. During the following century adobe construction in the U. S. was practiced mainly by a few rural people in the Southwest, most with Spanish surnames, who dried bricks in their backyards and built their own adobe homes. A few commercial producers sold to wealthy patrons enchanted with "territorial style" adobe haciendas. Only the very poor and the artistic types were reputed to be building with adobe.

Today, adobe is receiving renewed, although limited, interest. The increasing cost and growing scarcity of energy have forced builders to take a hard look at traditional energy-intensive construction materials.

The adobe, which features cheap and indigenous ingredients and a solar drying process, is becoming a viable alternative to wood and cement block. While the steady-state thermal resistivity of adobe is not as great as some high-technology materials, aficionados have always recognized its value in storing and stabilizing temperatures, the "thermal mass" effect. Earthen colors of adobe and its stuccoed exterior make it aesthetically pleasing with a desert backdrop as well as in an urban setting.

For these reasons, adobe production is seeing a modest rebound. For instance, Hans Sumpf, California's largest adobe producer, sold 280,000 units in 1958. From 1970 to 1980, however, Sumpf's sales have increased to around 1,125,000 sun-dried bricks per year. A long-time Albuquerque architect, author, and adobe builder, P. G. McHenry, states that, while fifteen years ago only three or four builders in Albuquerque constructed adobe houses, today, over twenty adobe builders ply their trade. This same pattern is evident in Santa Fe, Tucson, and other communities throughout the Southwest. Adobe, then, is regaining popularity as a building material in the United States. Time will tell whether it will again see wide-spread use in forming the portals and partitions of America's homes.

Methodology

A count of the total number of dwellings in each state is provided once every ten years by the U. S. Bureau of the Census, but the census does not classify houses according to wall type. The basic methodology used in this report was to estimate what percent of those dwellings listed by the census represented adobe houses. This percentage was then multiplied by the census figures to obtain the number of adobe houses.

Having established from the census the number of adobe dwellings at the beginning of each decade from 1850 to 1980, an estimation of the number of adobe dwellings built per year could be obtained. As an example, consider the statistics for Texas for the decade between 1850 and 1860. The number of adobe dwellings in 1850 is calculated as 19,590. The 1860 statistics on Table IV of this report show 55,240 adobe homes. 19,590 subtracted from 55,240 yields an increase of 35,650 adobe dwellings. Dividing this figure by ten years indicates approximately 3565 adobe houses per year were built during the decade. Since this procedure ignores the demolition of adobe homes during the ten-year period, the actual figure for houses constructed should be slightly higher. Of course, any variations within the 10 years could not be determined.

Of primary importance was the estimation of the percentage of adobe homes included in the total number of dwellings. As previously stated, statistical information on adobe structures is practically non-existent. The information leading to estimates of percentages falls into three main categories: 1) historical events and figures pertaining to Spanish influence in the region of interest, 2) production statistics from adobe makers, and 3) opinions of builders, producers, and adobe buffs. Additional information was found in Sanborn Fire Insurance maps. The assumption was also made that the percentages did not vary greatly or unpredictably from decade to decade. Using the census figures, estimates of percentages of adobe homes, and information on the number of adobe homes built per year results are calculated and presented in Tables I to V. In most cases, continuous data are not available, and trends are estimated and total numbers accumulated. Basic assumptions for each state are discussed below.

New Mexico

New Mexico is the acknowledged "adobe capitol" of the United States. Edward Smith, geologist for the Eight Northern Indian Pueblos Council states, "It is apparent that New Mexico is the leading manufacturer and user of adobe bricks in the U. S. with a total of 4,133,000 adobes produced by 47 active adobe makers this year (1980). Also, according to reports received by my office,this total production of adobes was sold by the end of November." Additionally, Smith estimates that again as many sun-dried bricks may be produced in "backyard" operations in the state. Albuquerque producer Richard Levine estimated that only 20,000 backyard adobes are made per year in New Mexico. Assuming a conservative estimate of 300,000 bricks produced in backyard operations in 1980, and the possibility of up to 100,000 imported adobes from Mexico would bring the total estimated use in New Mexico up to 4,533,000 adobes. A 1900-square foot house requires around 6,000 adobes, and it is assumed that 70% of the 4,533,000 bricks were used for house construction (as opposed to office buildings, walls, and other non-dwelling uses). The following calculation results in an approximation of the total number of adobe houses built in 1980 in New Mexico:

$$\frac{4{,}533{,}000 \text{ adobes}}{6{,}000 \text{ adobes/house}} \times .70 = 530 \text{ houses}$$

The New Mexico Business Current Economic Report of December 1980 lists 1305 building permits issued through October of 1980 in the City of Albuquerque. Using extrapolation to include the months of November and

December, and considering residential starts only, it can be assumed that around 1,400 house permits were issued in Albuquerque in 1980. The population ratio of Albuquerque to the total state population is 1:3.8 (from the 1980 census). If the number of housing starts per capita statewide is considered to be about the same as in Albuquerque, then the State of New Mexico saw approximately 5,320 housing starts during 1980. Dividing the number of adobe homes (530) by the number of total housing starts (5320) yields 10 percent adobe construction for the year statewide.

Albuquerque city building inspector Ed Ordonez estimates that 100 permits for adobe homes were issued per year in Albuquerque during the last 10 years. For Albuquerque, then, this estimate yields 7.1 percent adobe homes for 1980. Of interest here is the indication that adobe is utilized more extensively in rural areas than in the urban, as the state use was 10%, but Albuquerque's use of adobe was found to be only 7%. This is not an unreasonable conclusion, since the state is largely rural.

This unexpectedly high percentage of adobe use is not typical of years previous to 1980. The number of housing starts in New Mexico in 1979, for instance, was more than double that of 1980. Using the same estimate of adobe starts (100/year), results in an average of only 3 percent adobe construction, which probably is more typical of the 1970-80 decade. This report postulates the following explanation for the discrepancy: while the housing industry in general fluctuates greatly from year-to-year, the adobe business remains fairly constant. For instance, production figures from the Hans Sumpf Company of California for the last ten years reveal a mean adobe production of 1,177,677 adobes with a standard deviation of only 166,000 bricks. Sales varied slightly more, but were, in general, steady over the ten year period. From an economics viewpoint, the backyard producer who builds his own home out of adobe and makes a few thousand additional bricks to sell is more apt to engage in these activities during a slow economic period, thus damping out fluctuations. If the above postulate holds true, then the short-term percentage of adobe homes built per year is more a function of the overall housing market than of any change in the use of adobe, which varies only gradually. If conventional housing construction is down (such as in 1980), then the percentage of houses built of adobe appears high. If conventional construction is booming, then the adobe percentage is less.

Less information was available from the previous 130 years. A USDA publication, Farmers' Bulletin #1720, issued in January of 1934 states, "Eighty percent of all structures in Las Cruces, New Mexico are adobe." A reading of the 1919 Sanborn Fire map of Albuquerque reveals 776 adobe dwellings and 175 other adobe structures. The 1920 census lists 3,280 dwellings in Albuquerque. However, the Sanborn map illustrated only about 90% of the city. This report estimates that the total number of adobe houses was closer to 900.

Historical implications on New Mexico adobe use have been mentioned earlier in this report. Weighing these considerations, it was concluded that in 1850, 97% of the dwellings in what is now New Mexico were made of adobe. Subsequent intrusion by white settlers coincides with the demise

of adobe in the state.

Arizona

Second in importance in the use of adobe is the state of Arizona. A comparison of the 1850 data from both Arizona and New Mexico shows identical percentages of total dwellings which were adobe--97%. However, significant differences between the population growths in the two states led to consequential differences in the use of adobe. The 1870 census shows only 9,658 inhabitants in Arizona. (This figure may ignore the Indian populace.) By 1890 the population had swelled to 88,243. During the previous decade, the railroad had arrived in Arizona. The growth in population consisted mainly of an influx of U. S. settlers bringing their distinctive architecture and building materials. The use of adobe dwindled much faster in Arizona than in New Mexico, where the larger indigenous population (in New Mexico) preserved the traditional ways much longer.

Tucson architect/engineer and adobe expert E. D. Herreras states that in Tucson, approximately 1,000 adobe homes were occupied in 1980. The 1980 census lists Tucson with 138,211 total dwellings. This calculates to 0.7 percent adobe homes. The percentage is undoubtedly higher in rural areas where Spanish influence is stronger, but lower in the great population center of Phoenix. In 1970, half the population of the state lived in Phoenix, and few of the new houses built to accommodate this populace were built of adobe.

Texas

No statistics concerning adobe structures were obtained for analysis in this report. Instead, a comparison was made between Texas and its western neighbors, New Mexico and Arizona, in a historical context. The 1850 census lists 27,988 dwellings housing "white and free colored" residents. A population count of 212,592 inhabitants was also cited. It can be inferred that a sizable anglo populace lived in the area at that time and that many lived in non-adobe dwellings. Thus, the percentage of adobe

houses in 1850 was estimated to be 70%, rather than the 97% in New Mexico and Arizona. After the turn of the century, Texas saw an average gain of population of over one million each ten years. Table IV reflects this growth and its effect on the number of adobe homes. The number of adobe homes actually decreased from 120,725 in 1890 to 30,635 in 1970.

California

Historical implications again directly affected the estimated percentage of adobe homes in 1850 in this state. While Mexican influence had earlier been strong in the southern half of the state, by 1850 it was fast decaying. Non-Spanish settlers were well-established by this time in the central and northern parts of California. A wetter climate and bountiful timber led to the use of wood as a primary building material in the north. The California Gold Rush in 1849 brought a deluge of non-Spanish prospectors and settlers. Between 1850 and 1860 the population of the state quadrupled.

Production figures were obtained from the Hans Sumpf Company, California's largest adobe producer. For the years 1970 through 1980, Sumpf has sold an average of 1,250,000 sun-dried bricks per year. Of these bricks, approximately two-fifths are used for structural purposes. Using the same analysis as was used with production figures from the State of New Mexico and considering backyard production and Mexican adobe imports, California had the production capacity of 150 to 200 adobe homes per year during the last decade. This represented 0.09 percent of the houses built in the state.

All Other States

The U. S. Department of Agriculture's Farmers' Bulletin #1720, issued in January of 1934 includes a map picturing the geographical use of earthen wall construction in the U. S. Besides the four states specified in this report, the map included the southeast quarter of Oregon, the southern one-eighth of Utah, the southern tip of Nevada and an enclave in

the center of that state, scattered areas in southern Idaho, and the western third of Kansas. The map encompassed not only adobe but sod houses and any other type of earthern wall construction. This report accounted for adobe use in these states by estimating that all but 3 percent of the adobe use in the United States is found in the four states of New Mexico, Arizona, Texas, and California.

Finally, Table VI shows a summary of estimates of total adobe dwellings in the United States, plus the number of adobe houses being built each year.

Conclusions

An estimated 176,000 adobe homes stand in the United States today, sheltering half a million Americans. Ninety-seven percent of these dwellings are found in the states of New Mexico, Arizona, Texas, and California, with the other three percent scattered among the states of Oregon, Idaho, Utah, Nevada, and Colorado. 1560 new adobe homes are being built each year. The State of New Mexico is the largest producer and user of adobes, and contains within its borders a third of the adobe dwellings in the United States. Ten percent of the homes built in 1980 in New Mexico were made of adobe (although 3 percent is a more reasonable longer term average). The percentages in Arizona, Texas, and California were 1%, 0.1%, and 0.09%, respectively.

The use of adobe has decreased steadily since the end of Spanish domination in what is now the southwest United States. Although the total number of adobe dwellings has increased in the last twenty years from 154,000 units in 1960 to 176,000 units in 1980, the percentage of adobe homes over the total number of homes has continually decreased. Only in the State of New Mexico has the percentage of adobe homes being built per year increased. By 1970, the percentage of adobe homes being built compared to conventional houses had dropped to two percent per year in New Mexico. In the following ten-year period, however, the percentage increased slightly to three percent.

It would be improper to view these figures as anything more precise than a first estimate. The difficulty in providing this sort of data lies in the fact that the statistics are cumulative. Assumptions are generally made on the conservative side, but much more analysis would need to be done, including a careful census, before more confidence could be assigned.

The fact does emerge that substantial numbers of homes in the United States are being built of adobe. The trends, certainly in New Mexico and Arizona, are toward steady or even increasing absolute numbers each year, although the percentages vary. Solar thermal applications, now being researched or experimented with by individuals, promises to make the use of adobe with passive solar heating more and more popular. The prognosis for the use of adobe is positive.

Thus, it is important to note that the areas of greatest use of adobe also are areas of seismic risk. A significant portion of the states of California, Arizona, and New Mexico lies in zones designated as seismic risks by the U. S. Department of Agriculture's Farmers' Home Administration and by the Uniform Building Code. Seismic zones 2. 3, and 4 are considered unsafe without specially engineered construction. While Texas contains only zero and one zones, New Mexico's large population concentrations lie in a #2 zone. Half of Arizona is rated #2, and southern California is divided between zones #3 and #4. In this light, the increase in total number of adobe houses and in the number of people housed within gains immediate significance. From visual inspection of the FAHA map, one would estimate that at least 50% of the adobe homes in the United States lie within zones of seismic risk. This represents a quarter of a million citizens housed in buildings which are vulnerable to seismic activity.

It is of paramount importance, then, that consideration be given to retro-fitting those dwellings already constructed to protect the inhabitants, and to devise technology for future construction of safe adobe homes. Since many adobe home owners and builders are among the less wealthy portion of the nation, these retro-fitting and new construction techniques must be economical in cost and practical in nature. Such technology would be of use not only in the United States but to the half of the world's population housed in adobe structures.

ALBUQUERQUE

	Population	Total number of dwellings	Adobe % of total	Number of adobe dwellings	Number of adobe dwellings built per year during decade	Percentage of homes built per year which were adobe
1890	3,785	820[1]	56	460		
					20	30
1900	6,238	1,435[1]	45	650		
					30	27
1910	11,020	2,555[1]	37	950		
					—[3]	—
1920	15,157	3,280[1]	27	900[2]		
					10	6
1930	26,570	5,810[1]	18	1,050		
					10	4
1940	35,449	8,147	14	1,150		
					70	3
1950	96,815	30,652	6	1,850		
					0	—
1960	201,189	60,930	3	1,830		
					110	3
1970	315,774	98,638	3	2,950		
					100	3
1980	328,837	132,267	3	3,950		

TABLE I. Albuquerque Statistics

[1] Extrapolation from state ratio of houses to population.
[2] 1919 Sanborn map estimate.
[3] Blanks denote net reduction

NEW MEXICO

	Population	Total number of dwellings	Adobe % of total	Number of adobe dwellings	Number of adobe dwellings built per year during decade	Percentage of homes built per year which were adobe
1850	61,546	13,453[1]	97	13,050		
1860	93,516	21,000[2]	95	19,950	690	91
1870	91,874	21,052	94	19,800	—[3]	—
1880	119,565	26,311	89	23,400	360	70
1890	160,282	34,671	85	29,500	600	72
1900	195,310	44,903	80	35,900	650	63
1910	327,301	75,888	71	53,900	1800	58
1920	360,350	78,024	63	49,000	—	—
1930	423,317	92,530	50	46,300	—	—
1940	531,818	145,642	34	48,900	270	5
1950	681,187	199,706	25	51,100	—	—
1960	951,023	281,976	19	52,500	210	4
1970	1,019,060	325,762	16	53,600	170	2
1980	1,299,968	503,676	12	59,000	620	3

TABLE II. N. M. Statistics

"Population" and "Total dwellings" figures without subscripts are taken from the U. S. Bureau of Census

[1]Dwellings occupied by "white and free colored" populace - U. S. Bureau of Census.
[2]Estimated from 1870 census.
[3]Blanks denote net reductions.

ARIZONA

	Population	Total number of dwellings	Adobe % of total	Number of adobe dwellings	Number of adobe dwellings built per year during decade	Percentage of homes built per year which were adobe
1850	No census		97			
1860	No census		97		—	—
1870	9,658	2,822	97	2,700	—	—
1880[1]	40,440	9,033	78	7,100	440	70
1890	88,243	13,338	69	9,200	210	50
1900	122,931	28,763	54	15,400	610	40
1910	204,354	45,386	45	20,400	500	30
1920	334,162	73,673	35	26,100	570	20
1930	435,573	98,633	29	28,500	250	10
1940	499,261	147,079	21	30,900	240	5
1950	749,587	240,750	14	34,700	370	4
1960	1,302,161	415,834	10	40,000	520	3
1970	1,770,900	584,171	7	43,300	340	2
1980	2,717,866	1,110,360	4	48,600	530	1

TABLE III.

[1]Railroad arrived in Arizona in 1880's bringing anglos and new building materials.
[2]Tucson architect/engineer, E. D. Herreras said Tucson has approximately 1,000 adobe homes in 1980. 1980 census figures list 138,211 dwellings in Tucson.

TEXAS

	Population	Total number of dwellings	Adobe % of total	Number of adobe dwellings	Number of adobe dwellings built per year during decade	Percentage of homes built per year which were adobe
1850[4]	212,592	27,988[1,2]	70	19,600		
1860	604,215	92,065[3]	60	55,200	3,560	56
1870	818,579	141,685	50	70,800	1,560	31
1880	1,549,749	287,562	40	115,000	4,420	30
1890	2,375,527	402,422	30	120,700	570	5
1900	3,048,710	575,734	20	115,100		
1910	3,896,542	779,177	10	77,900		
1920	4,663,228	946,629	7	66,300		
1930	5,824,715	1,281,876	4	51,300		
1940	6,414,824	1,864,884	2.5	46,600		
1950	7,711,194	2,393,838	1.5	35,900		
1960	9,579,677	3,153,127	1.0	31,530		
1970	11,196,730	3,829,502	0.8	30,600		
1980	14,228,383	5,534,490	0.6	33,200	257	0.1

TABLE IV.

[1] "White and free colored" populace according to Census Bureau
[2] U. S. victory in Mexican War in 1946 brought large influx of Anglos.
[3] Census data not available. 1850 and 1870 dwellings per capita used for extrapolation.
[4] Alamo battle in 1836.

CALIFORNIA

	Population	Total number of dwellings	Adobe % of total	Number of adobe dwellings	Number of adobe dwellings built per year during decade	Percentage of homes built per year which were adobe
1850[4]	92,597[1]	23,742[2]	50	11,900		
					2,800	39
1860	379,994	95,000[3]	42	39,900		
					300	10
1870	560,247	126,307	34	42,900		
					—	—
1880	864,694	161,036	26	41,900		
					60	0.8
1890	1,213,398	235,925	18	42,500		
					140	2
1900	1,485,053	313,217	14	43,900		
					—	—
1910	2,377,549	513,481	8	41,100		
					—	—
1920	3,426,861	778,861	4	31,200		
					—	—
1930	5,677,251	1,403,181	2	28,100		
					—	—
1940	6,907,387	2,340,373	1	23,400.		
					70	0.06
1950	10,586,223	3,590,660	0.7	24,200		
					110	0.06
1960	15,717,204	5,465,870	0.5	25,300		
					140	0.09
1970	19,963,134	6,996,990	0.4	26,700		
					200	0.09
1980	23,668,562	9,253,290	0.3	28,700		

TABLE V.

[1] Census "incomplete" according to U. S. Census Bureau.
[2] "White and free colored" populace according to Census Bureau.
[3] Extrapolation from 1850 and 1870 dwellings per capita.
[4] Gold rush in 1849.

1980 ESTIMATED ADOBE STATISTICS

	Total number of adobe dwellings	Percentage of homes built in 1980 which were adobe	Number of adobe homes built in 1980
New Mexico	58,930	3	530[2]
Arizona	48,600	1	525
Texas	33,205	0.1	260
California	28,690	0.3	200
All Other States[1]	6,500		50
Total	175,925		1565

TABLE VI. 1980 Estimated Adobe Statistics

[1] Oregon, Idaho, Utah, Nevada, Colorado.
[2] See calculation in the "New Mexico" section of this report.