

International Studies in Vernacular Architecture
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Lecture 03
Adobe Construction and Religious Structures

Hey, everyone. I am Melissa Belz. This lecture in the unit of anthropology of shelter is about Adobe Architecture.

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Earthen construction

- Gain exposure to different forms of vernacular earthen architecture
- Understand thermal mass and the complementary landscape characteristics of desert settlements
- Understand the architectural symbolism in Djenne Mali
- Learn why concrete stucco can be detrimental to adobe construction

Western India

I want to begin with an overview of some examples of adobe architecture worldwide, components of the material as well as some common functional design components in adobe landscapes. I want to expose you to the technology, but also to some symbolism that can be present in vernacular structures, as well as some of the challenges of the material.

Your future module in adobe and earth construction materials, we will look more in detail at specific buildings of differing earth construction methods. Over 50% of the developing world's built environment is constructed with earth. A quick inventory of earthen structures throughout the world reveals that numerous forms are available to the builder depending on the group ideal.

Local ideals are the dominating factor in house form explaining why distant groups with similar environments will find exceedingly different shelter solutions. Amos Rapoport in *House Form and Culture* states that house form is not simply the result of physical forces of any single factor, but is the consequence of a whole range of socio-cultural factors.

Climate and site do not decide form, people do. Availability of materials may contribute to a design choice but the materials alone neither limit nor define the form. So let us take a look at the following slides.

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We tend to think of adobe in hot arid regions, and that is not wrong but the United Kingdom has a history of earthen architecture. Cob is a loaf or conical shaped ball of earth that has been historically used in the UK and Ireland, both pretty wet climates. It is a relatively straightforward technology that does not need any construction forms. It is layered up, allowing time between each course for it to dry.

It is load bearing and it tapers in, in thickness as it goes up, and it does not necessarily implement buttressing for the most part. Often used to form two-story walls as thick as 60 to 76 centimeters at the base, this type of construction is making a comeback in the natural building community because it is relatively owner-builder friendly.

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Wattle and Daub Construction

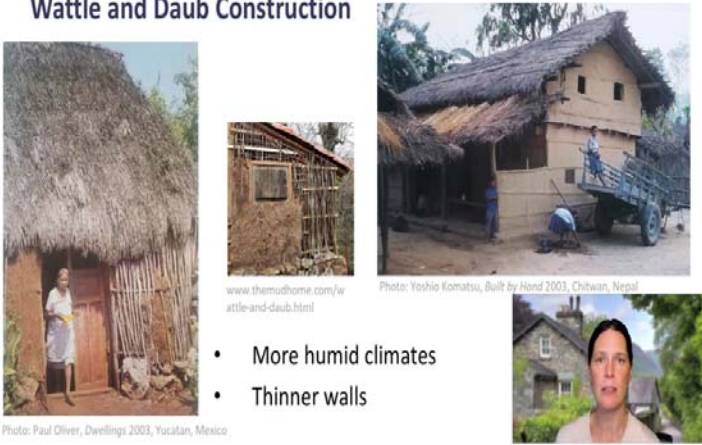


Photo: Paul Oliver, Dwellings 2003, Yucatan, Mexico

www.themudhome.com/wattle-and-daub.html

Photo: Yoshio Komatsu, Built by Hand 2003, Chitwan, Nepal

- More humid climates
- Thinner walls

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Next is Wattle and Daub. Wattle and Daub is a supported thin wall of earth and woven stick construction. Local plant materials act as the wattle, and mud similar to cob or adobe brick mix is used as the daub covering the sticks for airtight walls.

It is used in humid areas. Here, you can see examples from the Yucatan in Mexico and southern Chitwan in Nepal, which is much warmer and more humid than the higher elevation regions of Nepal.

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New Mexico adobe architecture



Taos Pueblo, New Mexico

Historic, Santa Fe, New Mexico

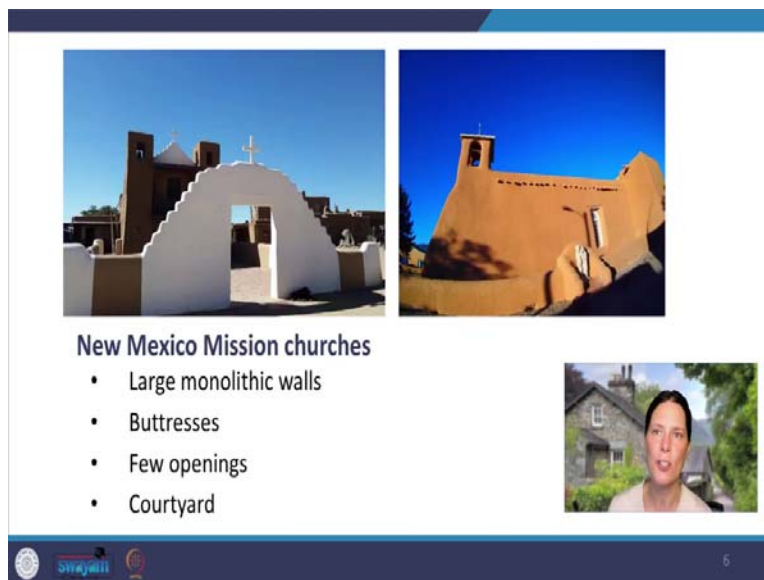
- Adobe construction
- Flat roof
- Few openings
- Vigas and latillas – beam ceilings

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The U.S southwest in Northern Mexico is a very arid region with a historic use of adobe brick. Like many other countries and cultures the roof is left flat and serves as a workspace and a sleeping space on hot nights. Vernacular construction incorporated vigas which are the long beams laid across the wall tops to serve as a roofing structure. They were left longer than the walls because wood is a scarce resource, and it ensured the ability to use a viga in a bigger structure in the future.

It would then use latillas or smaller branches crossed perpendicular to create a substrate for the earthen roof to be applied. Due to very strict historic preservation regulations in New Mexican cities like Santa Fe, they require that new construction look like the vernacular. However, it is still constructed with conventional methods of framing or cinder block, usually not adobe.

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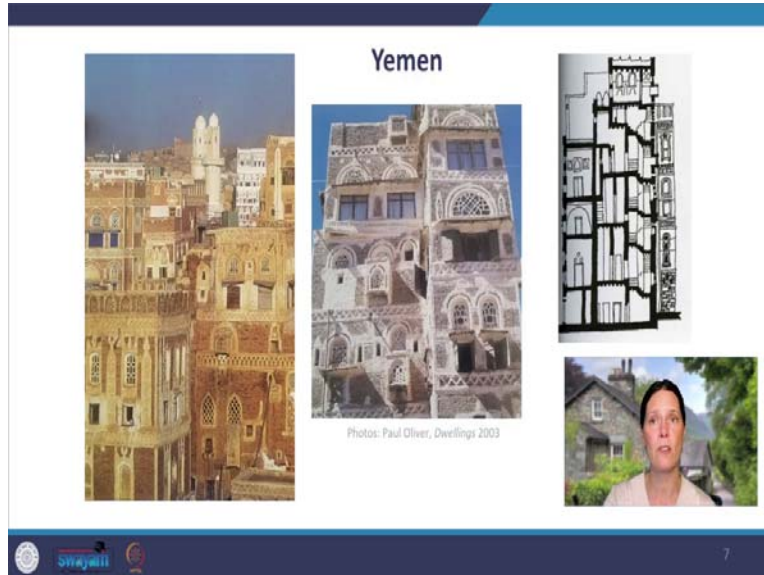
New Mexico Mission churches

- Large monolithic walls
- Buttresses
- Few openings
- Courtyard

The slide contains two photographs of adobe mission churches. The left photo shows a white adobe archway with a cross on top, set against a blue sky. The right photo shows a large, tan adobe church with a bell tower. A small video inset in the bottom right corner shows a woman with dark hair speaking. The slide footer includes a logo on the left and the number '5' on the right.

The Spanish mission churches of New Mexico have a distinct style, that with exaggerated buttresses to support the high adobe walls, making the churches appear very grounded in prominent parts of the landscape.

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The earthen stone construction of Yemen, conversely appears as a skyscraper reaching up to seven stories in height with light filigree decorations around the windows. They use stone foundations and adobe brick on the upper stories. The light colored paint is functionally used to reflect heat, but it is also used in a decorative pattern.

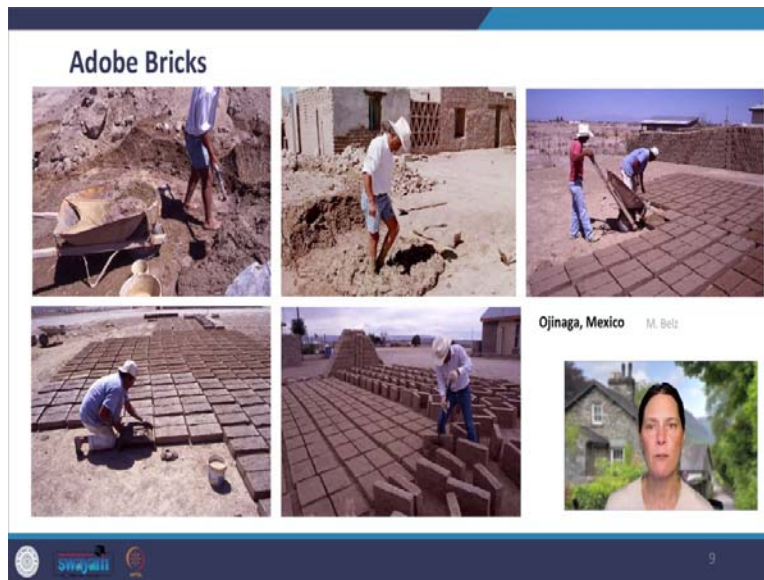
The walls are only very slightly tapered, but they rely on interior connections and lighter material as it ascends.

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The earthen and lime plaster that is used on earth construction serves a function of keeping the brick or mud construction protected from the elements, and also provides a place for decoration. And you can see here in these images from Gujarat, India, this allows a canvas on which to show pride, status, beliefs and celebration.

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Let us talk about what adobe is. Earth building can come in many forms as we have seen, and an earthen wall can be constructed with hand-molded clay, balls of earth, cast bricks or slow layering of earthen levels that are tamped down and rammed, to name only a few methods. Adobe often refers to a brick. Earthen construction is more general, and will encompass cob and those other methods as well as plaster.

The material is primarily clay with enough sand to stop cracking and straw and other fibrous material to add tensile strength and bulk. Raw clay often has an amount of sand already in it so there is no easy perfect recipe of clay, sand and fiber. Builders have to experiment with local materials that are available and make the best recipe that they can that will hold together but not crack too much.

For plaster, it has to be elastic and sticky enough to stay on the wall while not cracking significantly, yet it cannot be too sandy that it brushes off to the touch. Milk, animal dung, wheat flour, plants and colored clays are all often added to the adobe earth mix to

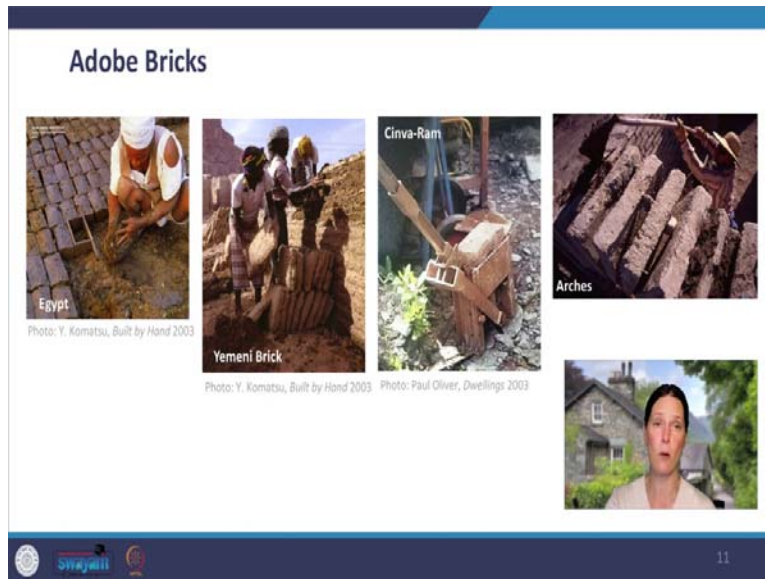
bring about more desirable qualities whether for the interior or exterior, such as hardness or color or sheen.

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Here, you can see a fermentation being made of Nopale cactus, common in Northern Mexico. After sitting in a bucket it gets a gel consistency and this liquid is added to the mud mixture to increase hardness and smoothness in the final plaster.

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Brick sizes vary depending on the regional style of construction. Bricks are sometimes small or very large and thin like the bricks used for the construction of skyscrapers in Yemen. Earth is often chosen because it is locally available and low cost, usually free. Economic and geographical factors dictate whether a building material is appropriate. An appropriate material must fit the climate and safety needs of the local population while working within the economic priorities and aspirations.

Throughout history, the skill of building was passed down through families. So there was a ready labor force that could build efficiently. Outside, specialized labor was not usually needed. In most cases, the homeowner was the builder working with the entire family as an informal labor bank. These aspects made it socially and economically appropriate, and still hold true in many instances around the world, but not all.

Labor has become more specialized as children move away and pursue alternative professions. In that case building, with earth can be a very expensive alternative because it is materially inexpensive generally but labor rich. It is a relatively slow construction process, making it too expensive for many communities to continue their vernacular traditions of adobe construction if they have to pay for professional builders.

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The slide, titled "Thermal Mass", illustrates the concept of thermal mass in buildings. It features two diagrams of a house: the left one shows the sun shining on the house with arrows pointing to the ground labeled "HEAT ABSORBED"; the right one shows the moon and arrows pointing away from the ground labeled "HEAT RELEASED". To the right is a photograph of adobe bricks. Below the diagrams is a line graph showing "Temperature (C)" on the y-axis (ranging from 10 to 30) and "Time - in hour" on the x-axis (ranging from 6 to 4). The graph shows a "Thermal comfort zone in" between 20°C and 25°C. Two lines are plotted: "The temperature inside" which stays relatively flat within the comfort zone, and "The temperature outside" which fluctuates significantly between approximately 10°C and 30°C. At the bottom right, there is a small video inset showing a woman speaking. The slide also includes a citation: "based on: <https://blom.eu/precast-concrete/what-is-thermal-mass/>" and "Sharif, F. and Zaman, P. (2020)". Logos for "Swayam" and "12" are visible at the bottom.

Earth construction offers thermal mass. That means it is not considered insulation primarily. Insulation would keep hot and cold in or out of a house. Earth is a regulator of heat. Thick earth walls absorb substantial amounts of heat from the sun during the day in hot arid regions, and slowly transmit it into the house, regulating the temperature inside, providing a comfortable environment.

The thick envelope of brick has the ability to retain the sun's heat for a long period of time before emitting it at night as it permeates into the interior space as the night temperatures drop. The brick then retains the night's cool temperatures for daytime disbursement. The bricks function as heat regulators that are slow to heat up and slow to cool down. The variable is the thickness of the brick to provide the correct lag time.

In climates where the winter can be cold, internal fires will warm the walls on the inside, storing the heat. The straw in the bricks acts as some form of insulation. So using a brick ram or press and compacting the soil slightly makes it less able to store heat. But again wall thickness is critical to the equation of local temperatures.

To clarify, adobe is an unfired sun-dried brick. Firing bricks makes them more compact and durable but often thinner. One could lose the heat regulating capacity of adobe by putting it through a firing process. Also, the firing process is not appropriate for every cultural group or region, primarily because access to significant amounts of firewood is not easy to come by or cost efficient for most places.

Some populations have rejected innovation of fired bricks for various reasons, including the absence of raw burning material but deeper reasons lie in the traditional division of labor. In Mali, West Africa for example, farming, digging and building is men's work. Collecting fuel, water and firing pottery is women's work.

So when French kiln-fired bricks were introduced, they came in direct conflict with these traditional structures, basically expecting men to fire kilns and make pottery. So they were never adopted. Mere contact with or exposure to an innovation will not automatically guarantee its acceptance. More important than the innovation is its ability to adapt and fit in with the local cultural paradigm.

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When earth is the primary building material, there are often other functional design components of the cultural landscape. Adobe is common in dry, hot regions, and housing settlements in these climates are often connected in rows of houses positioned back to back to expose as little wall surface as possible to the sun's heat.

This is not only a function of structural integrity of the material, as much as a response to climate and urbanization. Narrow streets and alleyways fend off both the sun's glare and often dusty winds providing shade throughout the day, while dead-end streets provide a higher level of privacy lessening traffic.

Small or infrequent windows can be a response to structural limits of adobe, but also are a reflection of hot and dusty environments, keeping the dust and heat out of the house. Small windows also increase privacy. Adobe houses have become synonymous with courtyards, partly because they moderate the heat.

The walled roofless space is rarely as hot at midday or as cold at sunrise, but it is also a response again to privacy needs. Providing the center of domestic activity, a combination of privacy and outdoor space where women can carry out their needed tasks in comfort. The majority of courtyard floors utilize some combination of compacted earth, porous brick or unglazed tile.

These materials have high heat capacity and they store water which helps with cooling during evaporation. Adobe houses have a high degree of user interaction as people move through the interior rooms seeking coolness on certain sides of the house, and they follow the shade of the courtyard and incorporate water as a means of cooling.

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I am going to focus a bit on the earth architecture of Djenné, Mali in Africa. The Niger delta floodplain soils have long been considered throughout the savannah as having the best workability and strength with nothing added. The floodplain is used for agriculture during the dry season.

So after the harvest, the short plant stocks and dung from livestock are naturally mixed together with the clay and the sand by the animals. It is said to make an excellent adobe straight from the source. Djenné is also known for the Great Mosque, which was first built in the 13th century and rebuilt a couple times, most notably in 1907.


Along with the old town of Djenné, the Great Mosque was designated a UNESCO world heritage site in 1988. It is an adobe structure with earth plaster and the community comes together every spring in a festival to replaster. The men plaster, the women's supply the mud and the food, and even the kids help.

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Sudanese Vernacular Architecture



Pillars on exterior of chief's home (after K. Dittmer in Prussin 1974).



Ancestral earthen grave or altar pillars (Prussin 1986).

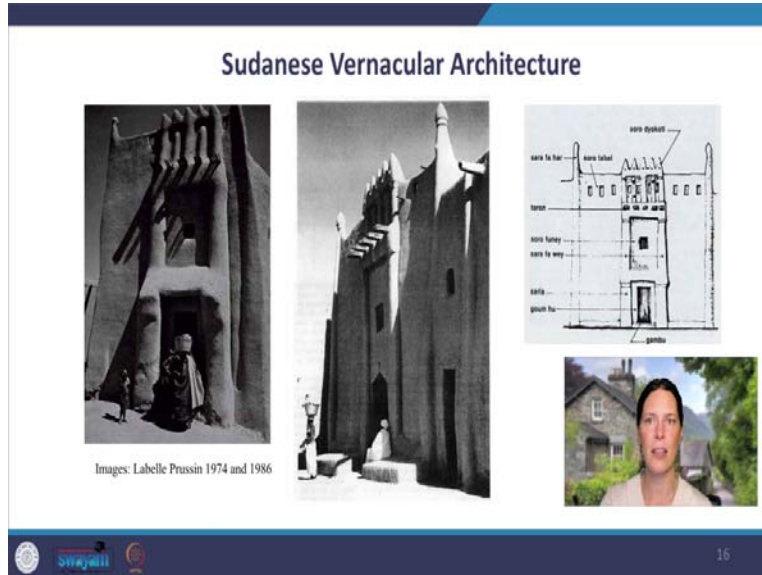


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The Mandé are the indigenous group, and their original domestic structures were generally small and round, made from hand-molded conical bricks or cobs. The rural environments, tall pillars were used as grave markers and placed at the entrance to the domestic compound to solicit the influence of their ancestors' well-being. They have a spiritual role then.

The trend to rectangular structures corresponds to the transition from nomadic to greater sedentary patterns, specialization of skills, the influence of Islamic traders from North Africa and the introduction of the brick mold. Mandé ancestral shrines and altars are identified as major iconic references within Djenné architecture. What developed from the indigenous Mandé traditions and the Islamic influence brought forth a distinct Sudanese style.

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The first renditions of the Djenné home incorporated four corner coins or pillars that protruded like vertical buttresses, suggesting symbolic ancestral pillars. It is unclear if the Djenné facade wall was too thin overall to support its height requiring the buttresses or if the buttresses were purely symbolic, because other examples of tall structures do not need buttresses.

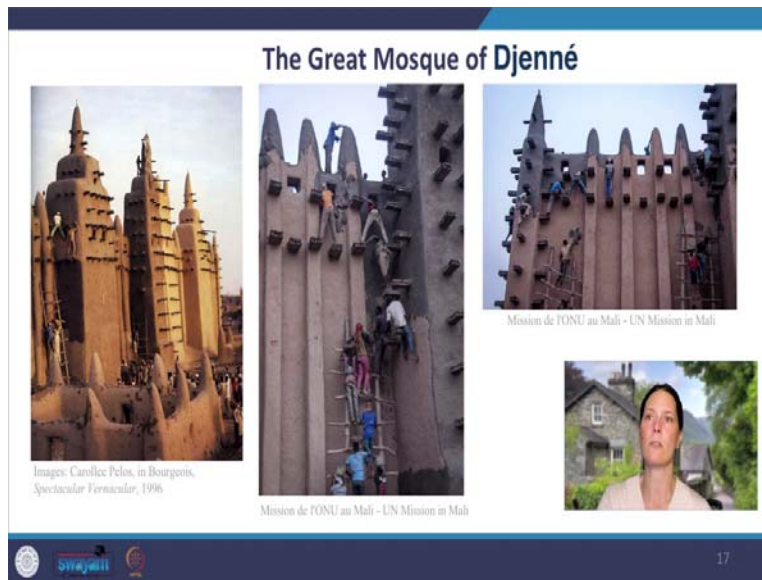
Labelle Prussin who is an authority on West African architecture, calls them required structural buttresses and describes them as the functional base upon which the iconography of the earthen ancestral shrine can be projected. The buttresses is gradually pared down to one on the edges of the front façade.

They have become the principal features defining where one house ends and the next begins, allowing symbolic expression embodying the iconography of the ancestral shrines and altars and creating a unique blend of traditional meaning on new architectural forms. The style sets Djenné apart from hundreds of neighboring villages in the delta.

The entire facade is said to represent a tapestry, holding meaning as the weavings of tent interiors of the nomadic tribes. The symbolism depicted in the earthen architecture shows the selective adaptation that took shape from those elements that most easily adapted to the new application and also adhered to the Islamic expectations. The pillars easily fit

within the square structure. In fact, they reinforced the construction and were therefore easily acceptable and transferable, and they are still meaningful.

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You can see in the mosque, reference to the tall pillars as seen on the house, but there is much more elaborate use of the protruding wooden members called toron in this case. The wooden cross members of toron could be easily identified as a component to add structural strength to the adobe construction.

They function as a collar tie and their protruding length could be explained by the fact that timber is often left uncut and or overhanging because it is such a valued resource across the globe as we saw in the American southwest. Cutting it short could preclude its use in a future larger structure.


The protruding lengths also function as scaffolding. In the community plastering sessions allowing people to climb the heights of the pillars for annual maintenance, but they are not designed purely for scaffolding because they are systematically underused in some places and overused in others.

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Mosques of Mali



Thin and close *toron* do not appear strong enough to hold a man while plastering.



Images: Carolee Pelos, in Bourgeois, *Spectacular Vernacular*, 1996

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They are also used on small shrines where some instances are too weak to hold a person on the small *toron* or wide stable structures that do not need collar ties or scaffolding down low. This is all reinforcing the symbolic function.

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Mosques of Mali



Broad and low "pillars" that do not need *toron* as structural bracing or scaffolding.



Carolee Pelos, in Bourgeois, *Spectacular Vernacular*, 1996



Mosque minaret representing the "tree of life" through the use of *toron*.



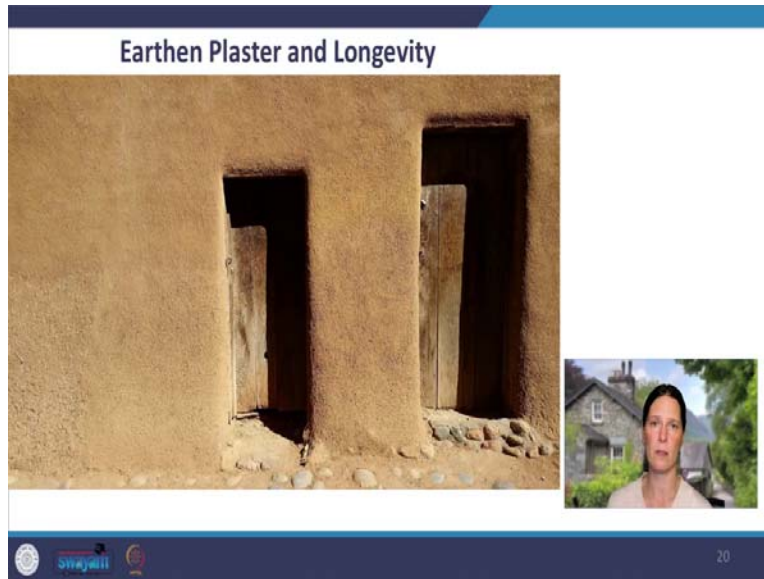
www.andygilham.com/mali.htm

Carolee Pelos, in Bourgeois, *Spectacular Vernacular*, 1996

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They are symbolic of the singular community tree that is commonly growing near a mosque. There is no doubt that the *toron* have been, have become the primary identifying feature of the mosque, simultaneously acting as icon and tulle.

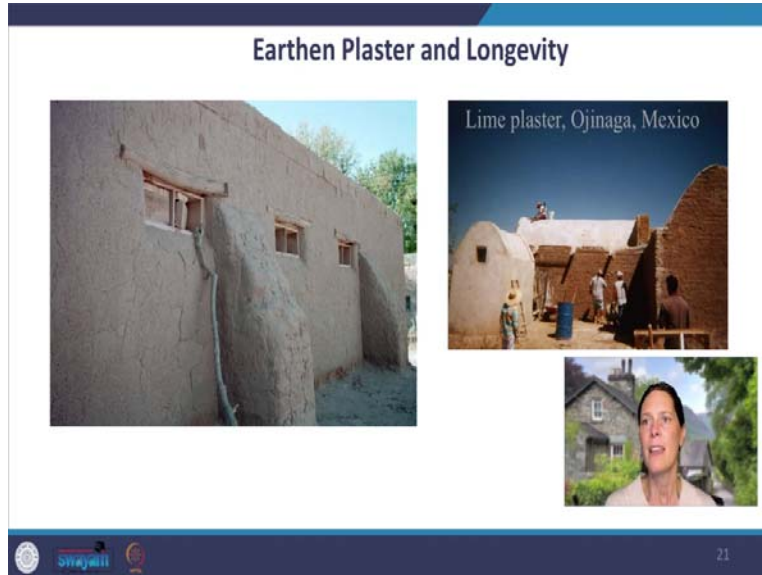
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In many African societies, the place holds as much or more importance than the structure, making earthen construction very appropriate. It can decay easily back into the earth as communities move on. For Djenné, the act of coming together as a community keeps the mosque relevant and keeps the community connected to it.

This has also been seen in the case of the pueblo mission churches in the American Southwest. The churches were built by colonizers but through community engagement coming together for their maintenance and the permanence of the structure, native people have deepened their relationship with their churches.

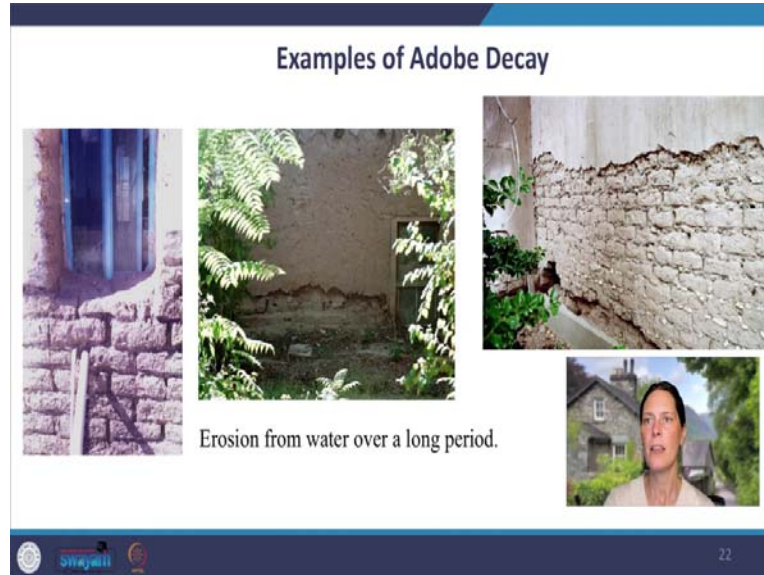
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Adobe does need annual maintenance. And this fact has been a major influence in the continuity of the building tradition worldwide. You can see in this image from Mesilla, New Mexico on the left, that the earth plaster is wearing. There are cracks and even more problematic, you can see the outline of the bricks in some instances on the buttress which will encourage water to repeatedly run the same course when it rains eroding the mortar.

In the other image, you see lime plaster being applied to adobe in Mexico. Lime offers an added layer of strength made from limestone, which is more difficult to prepare and apply, than clay in earthen plaster.

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Here are additional examples of what plaster and adobe will look like after a long time of neglect. Again, if yearly maintenance takes place, this is avoidable. With earth, plaster, it is fairly easy to repair. The last image here is concrete stucco, and that brings additional problems. In these images, you can see the window sill has accumulated some areas of water erosion, and in the center image there is a case where the drip line or splash back from, from the ground has created an area of erosion where the plaster began to just chip off.

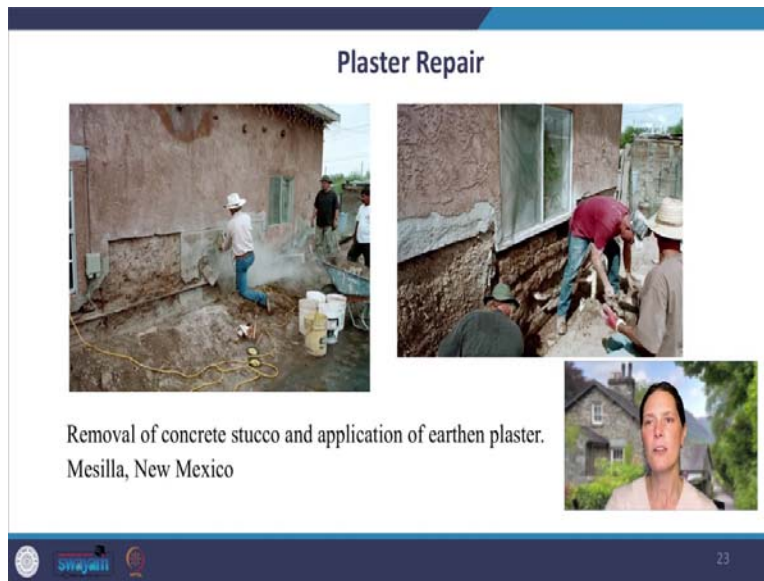
In the stucco case, to the far right, you can see an area of brick at the bottom that is completely undermined. Because plaster work is labor intensive and potentially costly today, many people want to take the seemingly easy best option of applying concrete stucco rather than earthen or lime plaster. Because you cannot see the slow erosion of the stucco, deeper damage occurs in the clay bricks. They will erode with the stucco, holding water but they look generally fine.

By the time the stucco shows problems, big cracks, areas detaching from the wall or falling off, spalling, there is much deeper damage beneath. So the relationship of clay bricks to clay or lime plaster is critical. The natural earth plaster made from the same material as the bricks or cob plays the role of pulling moisture out of the wall,

strengthening and protecting the brick so that the bricks continually dry to the outside of the plaster even after rain.

There are houses, mosques and churches around the world that are suffering the effects of concrete stucco over earthen construction. Many are now trying to revert to the traditional practices.

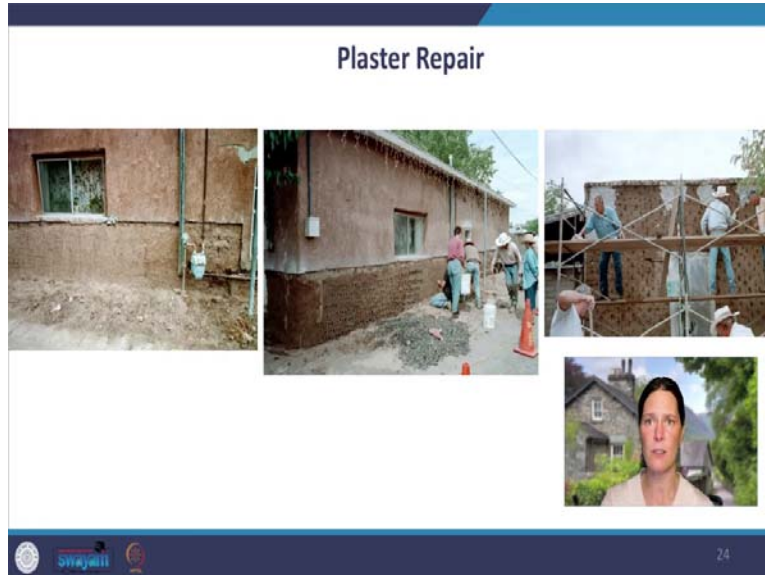
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Here, you see the process of removing concrete stucco that was applied to the base of an adobe home. Water was penetrating the concrete stucco and causing damage to the bricks. The concrete had to be sawed through and pried off, causing some increased damage to the bricks.

After cleaning up the bricks using earth plaster to infill the gaps and make a level coat, then they add small stones in that first coat of plaster to provide a stronger mechanical bond for the next layer of plaster to go on top.

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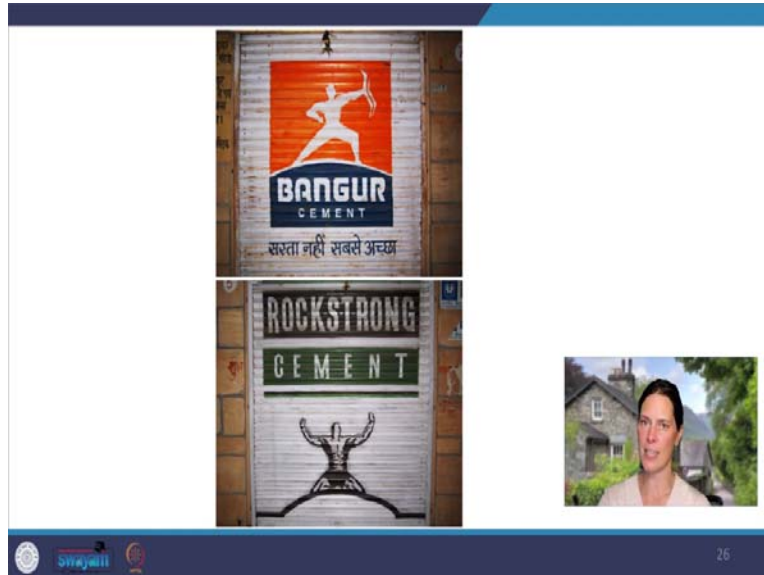
And then a full layer of plaster is added to the entire wall.

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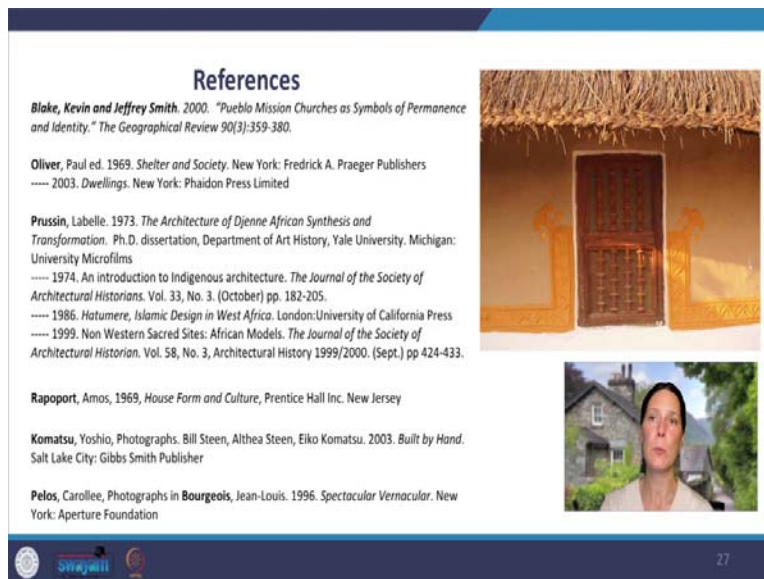
Some mission church organizations have decided to remove the concrete stucco that had been applied to the exterior and interior in years past, and reapply earthen plaster to promote longevity of the structure, with the community committing to engaging with the building's long life.

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So do not believe all of the advertising. Concrete is not appropriate in all cases so they make it look like the strongest material around.

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Earth can be an appropriate building material for many cultures who still have community engagement in the method and the material. Structures have lasted well over a hundred years using natural material of clay and sand in a variety of applications.

Provided here are the select references used in this presentation. I hope that you get a chance to read most of them. And your forthcoming lecture on earth construction will broaden your understanding of its many applications in vernacular and in contemporary architecture. Thank you.