International Studies in Vernacular Architecture
Associate Professor Yenny Gunawan
Center for Adaptation and Resilience Environmental Design Studies
Unversitas Karalik Parahyangan Bandung, West Java, Indonesia
Lecture 07
Earth as Vernacular Resource Material

Hi everyone, welcome to International Studies on Vernacular Architecture Course. In this lecture, we are going to learn about Earth as Vernacular Resource Material. We will begin with the general introduction, followed by how it is used in vernacular architecture, and how it is used in the contemporary world today.

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Across the world Earth is available in abundance. It is everywhere locally available. For 1000s of years humans have been building with Earth. The oldest manmade Earth construction were found in Mesopotamia and dated back around 10,000 BC.

They consist of stack Earth bricks, and according to KEIV in 2005, it is estimated that around 1.5 billion people, or about 30 percent of the world's population today live and work in buildings constructed of Earth. In developing countries, even more than half of the population lives in Earth construction. When referring to earth or soil in building construction, both terms mean the same materials.

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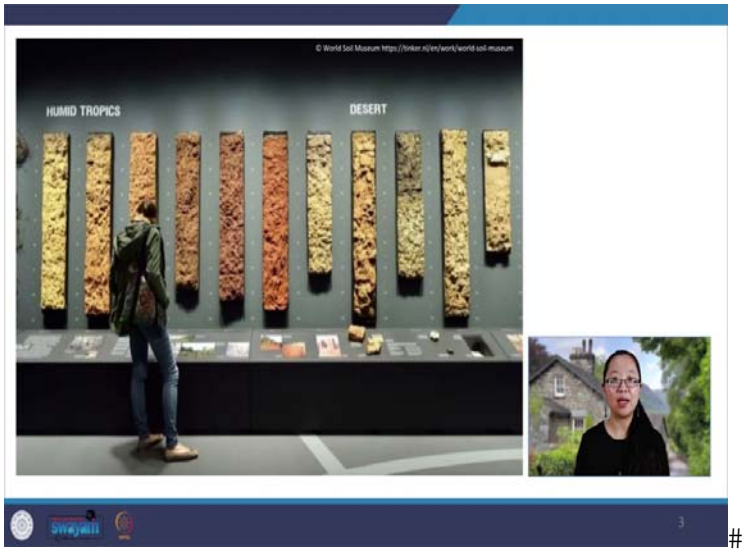

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Earth has variations of color, texture and characters. Depending on the soil content, geography and climate. As can be seen in the picture, soil in the tropic and desert is different. The World Soil Museum in Wageningen, the Netherlands showcases 100 Earth profiles from more than 90 countries in the world.

The display represents the 32 major Earth group and the variation of earth within those groups. Each of the soil groups has different content, which affects its color, texture and characters. Some are softer, stickier or clay like mud. Some are harder, rockier and drier.

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Based on those different qualities climatic condition as well as local knowledge and technique, a variety of techniques are developed. With this technique different culture use herbs to create many buildings, not just home and dwellings, but also religious buildings, fortresses and palaces that have stood the test of time. Depending on the state of hydration, soils can generally be workable in three different forms, monolithic, structure, and brickwork.

Within these three construction classifications, there are 12 different techniques, which are shown here in the graphic wheel. In this lecture, we will discuss 4 out of 12 Earth construction technique, duck out, rammed earth, earth shelter space, and Adobe architecture.

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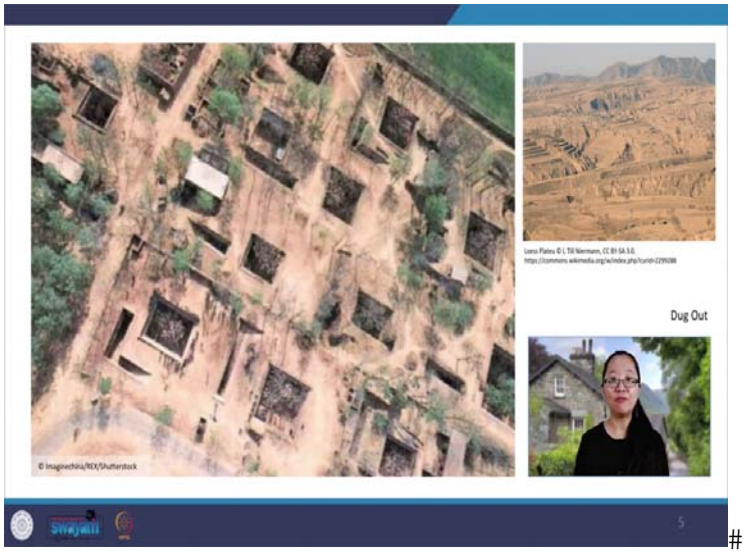

The first construction to be discussed here is that our technique which falls into the monolithic construction, where one use only the soil, Earth is dug out of the ground to create underground shelter. In most cases, this kind of dwelling occurs in zones with arid climate, and with soft and easy yellow Earth to dig into, but also has a high capacity to maintain the standing posture and less prone to collapse even without support.

Moreover, the arid climate is in favor of the soil to keep dry and rigid, which improve the surface life of Earth dwelling architecture. Examples shown here is the China's dug out binocular dwellings are also called pit dwelling spread across loess plateau featuring localized flat and wiped up perform in North China.

The climate there is characterized by hot summer and cold winter, drought limited rainfall relatively strong wind, strong wind with entrained sense and intensive sunlight.

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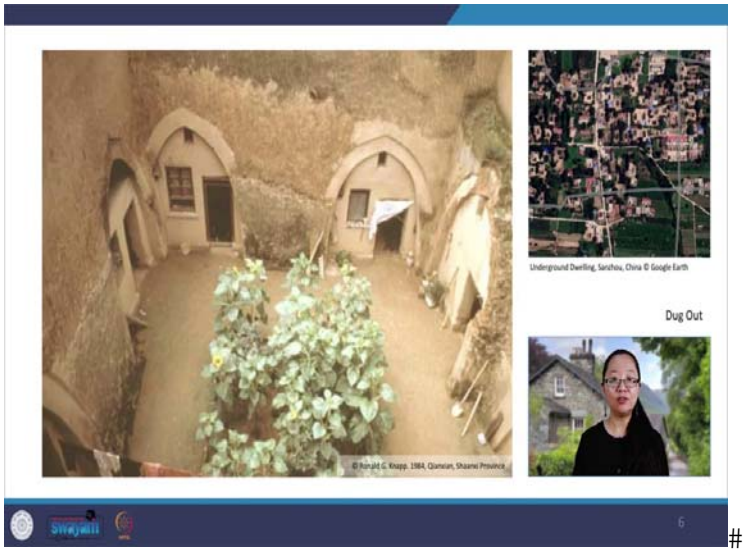

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And the two sides climate feature and landforms binocular residents living their innovative Lake reconstructed dwellings penetrating into the ground to create a relatively comfortable windproof and warm keeping environment for living. The indoor environment is warming in winter and cool in summer, the room temperature can maintain above 11 degree in winter and below 20 degree in summer.

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The dwellings are dug 6 to 10 meters deep for the sunken courtyard. A ram is also cut into the sides of the courtyard to allow residents to move easily from their homes to the ground level above. Then the rooms are carved out from the four walls of the sunken courtyard, the interior of the rooms may also be reinforced with stone and clay walls or columns.

The small downward excavated courtyard can effectively block strong wind and therefore dust and also the noise to create an environment applicable to human dwelling and for storage. Clearly, this kind of dwelling serve as protective shield between humans and has natural climatic condition.

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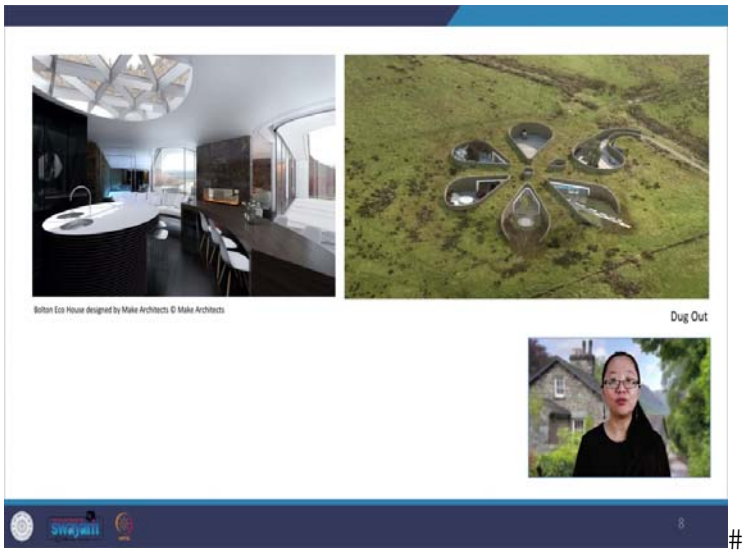

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Today in contemporary architecture, some architects inspired by these vernacular dwelling and design underground houses in order to create low energy consumption housing, such as this Bolton Eco House designed by Make Architects. The client wants a family home that makes as little impact as possible on the surrounding environment. Both physically and environmentally.

So, the architect responds with a half-buried residence in the contours of the hillside with a roof meadow grasses integrating it seemingly into the surrounding more land. Designed to consume less energy than it uses, the house generate renewable energy on site powered by a ground source heat pump, photovoltaic panels and wind turbine.

While it is a far from traditional home, the architect proposed to build it with traditional construction methods and locally sourced materials. The structure has already been selected as an exemplary project within the UK government's planning performance agreement for renewable and low carbon energy seams.

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The second one is Rammed Earth technique, which also belongs to monolithic construction. This technique is basically making use of simple tools to compact soil in order to produce rock-hard structure. The construction of rammed earth includes aggregate portions of silt, sand and clay and adding this mixture to the soil.

The work is done using a wooden formwork in the form of box sites, no top no base, in which the Earth is rammed or dammed until it is compacted. It is done by layers to make it more solid. These layers can be rammed continually until the wall is complete. With no need to wait for each layer to dry out. The walls are then allowed to dry naturally once the frame is removed.

Because of the layered construction rammed earth walls are characterized by a horizontal strip pattern. And by using different colored soil, this effect can deliberately be emphasized. Such rammed earth walls function as structure and can be extremely durable. The walls are built in a more damp and humid climate. It is used widely in countries as far apart as French, Spain, Morocco, Chile, Mexico, India and China.

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One of the oldest biggest and best-preserved Rammed Earth building found is the Castillo de Banos built in 968 AD. The fort was originally built by the Andalusian. It is one of the oldest castle in Spain and the second oldest in Europe. It is also known as Burgalimar Castle and fortress of the Second King. The fortress is a rammed earth fortified complex and oval shape with over 100 meters in length with a crenelated wall studded with 14 square turrets and one large tower.

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The other earth building in Europe shown here is the rammed earth houses in Southern France. It is believed that the construction spread to France by the Roman through the Rhone River Valley, where they built a capital city goal which is called Leon today. In the city of

Leon, there is a substantial evidence of agricultural buildings and houses made of rammed earth that are still visible today.

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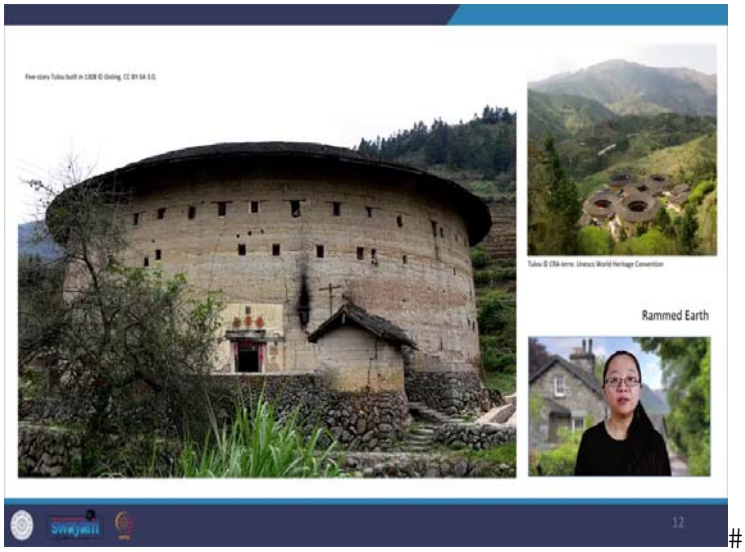

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Another rammed earth buildings still occupied until today is the Tulou, a haka tribe rural dwellings in the mountainous areas in South Eastern Fujian, China. They are mostly built between 12 and 20 century. A Tulou is usually a large enclosed and fortified earth buildings, most commonly rectangular or circular in configuration, 3 to 5 stories high and can house up to 800 people.

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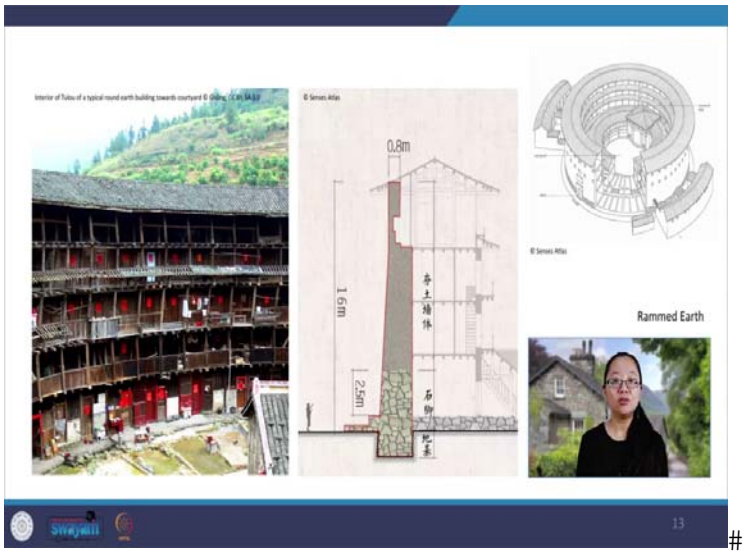

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These Tulou are also communal buildings. Their form allows to unite several families within the same buildings or a whole clan within their very thick loadbearing rammed earth walls, the thickness of the walls can be up to 1.8 meters thick, the walls are formed by compacting Earth mix with stone, bamboo, wood and other readily available materials. The building is windproof and earthquake proof that is warm in winter and cool in summer.

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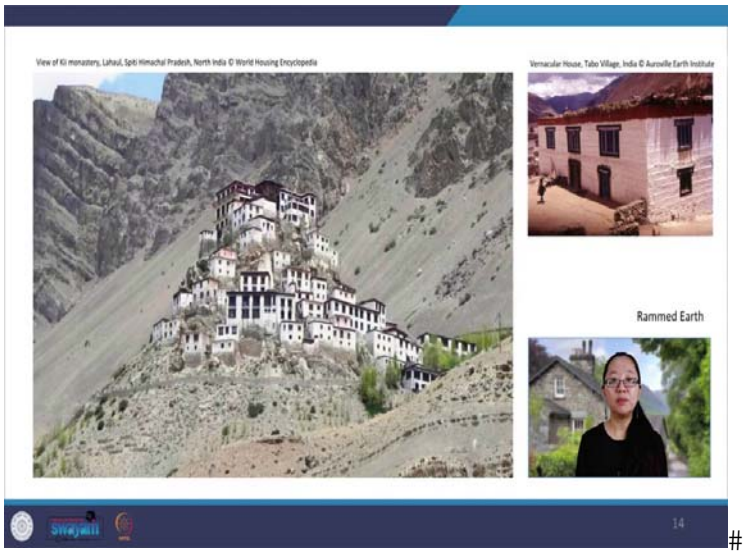

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Another old but still standing is the rammed earth buildings in the Spity River Valley la hole in Himachal Pradesh, India, the region is a desert area, and like many desert area, it has very hot days and chilly nights. Precipitation usually only occurs in the form of snowfall with almost no to very little rainfall. With that climatic condition timber is curse.

So, mud is the main locally available construction material. Therefore, the building here are made of rammed earth walls. Timber is solely used for floors and roofs, as well as for doors and windows frame. Natural stones are also scarce and thus only used for foundation. This construction type is predominately used for residential houses and temples. And it has been practiced for more than 200 years until today.

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There are many more great historic example of rammed earth still standing today, a testament to the durability and strength to this technique and clearly one of the reason it has been accepted by the modern construction industry as a legitimate building construction technique. The contemporary architecture shown here is the desert Cultural Center in Canada, designed by DIALOG, built in 2006.

The architect stated that the project is designed to be a specific and sustainable response to the building's unique Canadian desert. Found in the south on Okanagan Valley in British Columbia. Cited adjacent to a remnant of the Great Basin Desert. The extreme climate with temperature ranging from minus 18 degree to plus 40 degrees Celsius on summer days.

The project uses rammed earth walls at 80-meter-long 5.5-meter-high and 60-centimeter thick. This is the largest rammed earth walls in North America. The wall acts as an insulation with stabilizes temperature constructed from local soil mixed with concrete and color additives.

It retains warmth in the winter, and its substantial thermal mass cooling the building in the summer. Its color variation of the facade is a beautiful addition to the landscape. There are many more contemporary architecture around the world built with rammed earth, showcasing those beautiful horizontal earth layers.

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The third technique is the earth sheltered space. It is a traditional technique, but nowadays commonly referred to as green roof. For 1000s of years in arid climate earth has been traditionally used to cover roofs, it acts as a thermal mass regulating the inside temperature. Earth material absorbs heat and retains it before gradually releasing it into its surrounding.

And due to the high density of Earth it is changed in temperature occurs slowly in what is known as thermal lag, resulting in a fairly constant temperature compared to the fluctuation experienced in the outside, or shelter spaces is commonly used in European and Scandinavian countries as lodges and cellars.

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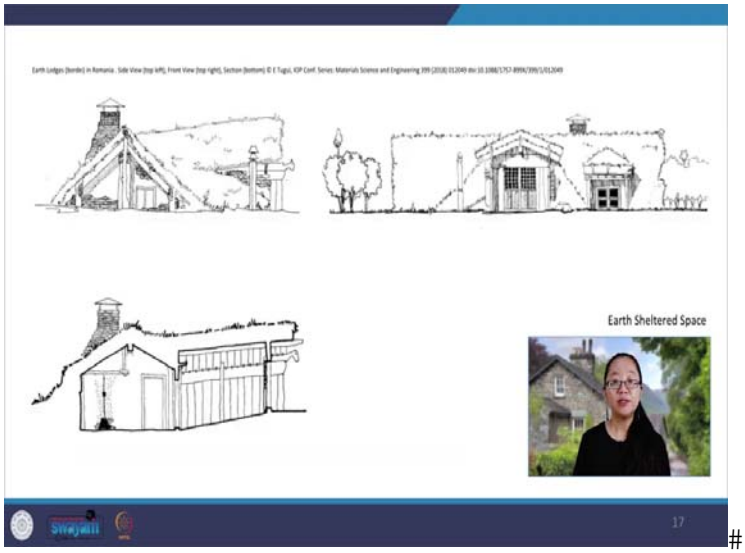

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The picture shows an earth lodge called borde, which exists before mid-19th century. In 1950, such building was still present in some villages in Norway. Earth lodges constructed partially below and partially above ground level. It could have two or more rooms and some configuration allowed for the construction of windows. The building was covered with a thick layer of Earth, the interior level was generally at 1-meter below ground. The walls were either wood or stone and covered with a layer of clay to create a flat surface.

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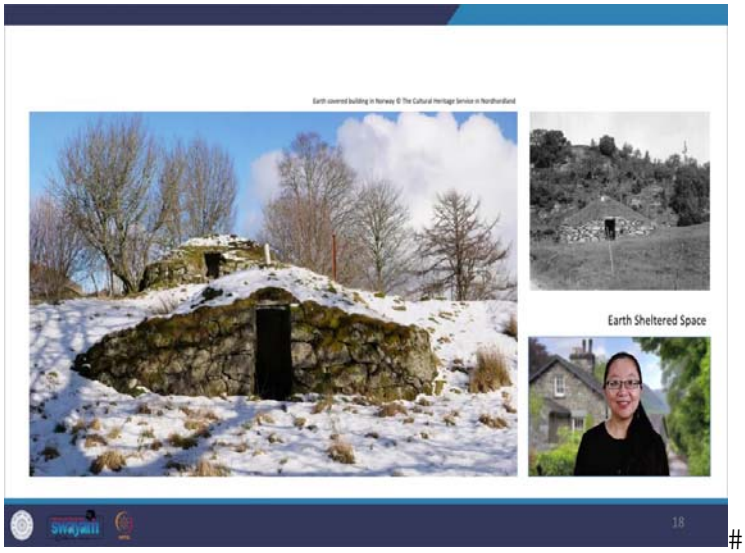

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Earth shelter are also naturally soundproof, which can be beneficial in noisy urban areas, and provide greater privacy from the neighbor. Earth shelter with seats which sit below the surface also make efficient use of land with a possibility for lawns or gardens above. In regions prone to natural disasters, such as tornadoes and hurricanes earth shelters may also cost less to insure as they are less susceptible to catastrophic damage.

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This earth shelter space or green roof has been applied to many contemporary building design, such as this California Academy of Science by Renzo Piano. The architect called this green roof, a living roof, covered with more than 1 billion plants planted especially conceived biodegradable coconut fiber containers.

The roof is flat at its perimeter, and like a natural landscape becomes increasingly undulating as it moves away from the edge to form a series of domes of various sizes. The two main domes cover the planetarium and rainforest exhibitions. The domes are speckled with a pattern of skylights automated to open or close for ventilation.

The soil moisture and roof openings cool the inside of the museum significantly, thus avoiding the need for air conditioning in the ground floor public areas and the research offices along the fossa. The choice of materials recycling dispositioning of the space with respect of natural lighting, natural ventilation, water usage, rainwater recovery and energy production has made the museum obtain green building LEED Platinum certification.

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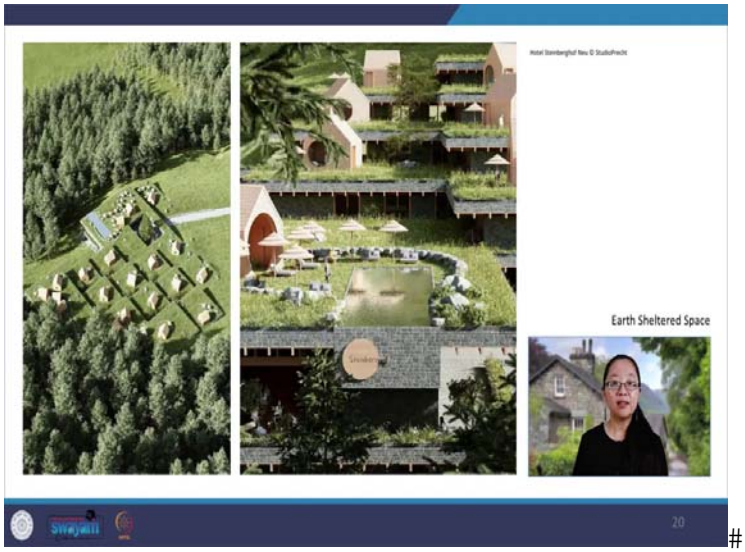

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Another example of contemporary design of these Earth sheltered spaces is a hotel design proposal in mountainous area in Austria. Chris Precht, the architect stated that they envisioned a terrain building that almost heights in its natural surroundings. The levels of the hotel are terracing down with the natural slope, built with stone wood and lots of grass.

It takes on the materiality and color of the surrounding. And intensive greening of the roof gives back space to nature and wraps the building and healthy and flow. Many more green roofs have been applied in many contemporary architecture designed by architects both to reduce the heat, but also to create a more sustainable built environment.

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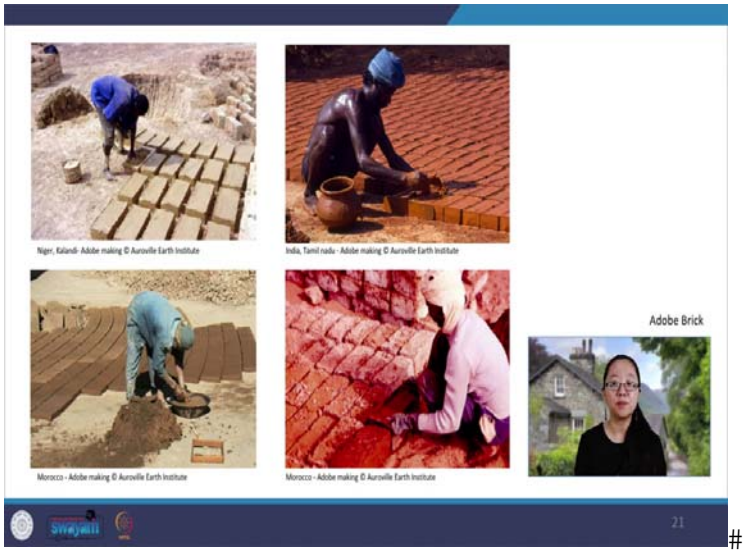

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The fourth Earth construction technique discussed here is the sun-dried rectangular clay brick, also known as adobe. These adobe bricks are made of thick malleable mud often with straw added to increase compressive and tensile strength. After being cast, either in a mold or shape by hand they are left to dry under the sun in the open air.

Normal bricklaying technique are used using Earth or lime mortar. Earth bricks have load bearing structure of properties but provide poorer insulation compared to the dugout rammed earth or earth sheltered spaces mentioned before.

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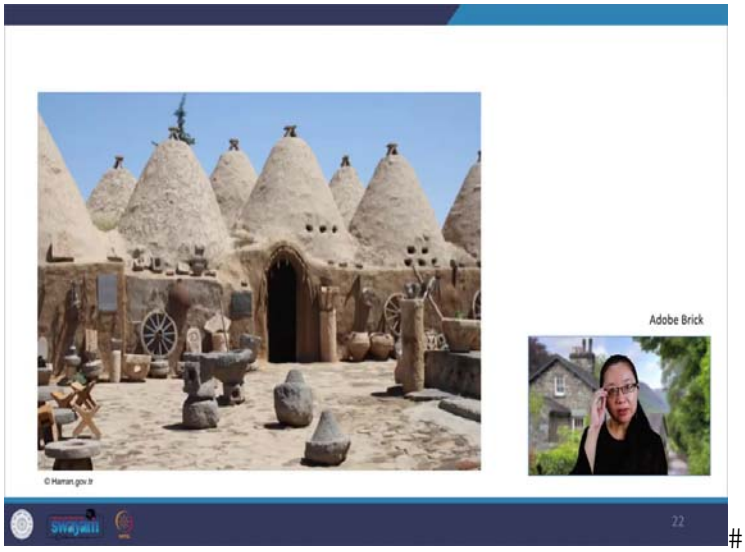

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There is a huge variety of vernacular buildings worldwide using this adobe brick form. One of the most notable ones are the beehive vernacular houses in Heron Turkey, which they did back in 1750. These houses stay cool in the desert here, and their thick mud brick Adobe walls trapped the cool and keep the sun out.

The high domes collect the hot air move it away from the ground floor keeping the interior around 24 degrees Celsius, while the outside extreme ranges from 35 to 0 degrees Celsius, the roof slopes steeply to shed the occasional but heavy rainfall.

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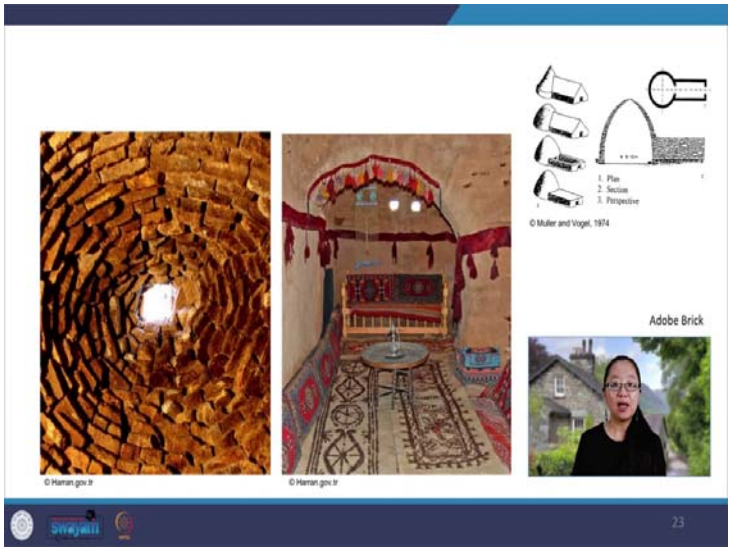

These houses resist the stresses of strong winds and minor shocks from frequent earthquakes since the mid-18th century. The doors and windows are few and small to minimize the Sun's glare and the movement of hot and cold air during the day and night. Its floor slightly raised above the soil outside spotlessly clean with a recess for cooking and attractive decorations in bright tensile paper on the walls.

Though only a few yards in diameter is high conical roof gave it a sense of space. Each dome is built with about 1400 adobe bricks. The pictures show the construction of the dome using brick layered in circles smaller in diameter towards the top. Naturally built home like this have been lived in comfortably for 1000s of years.

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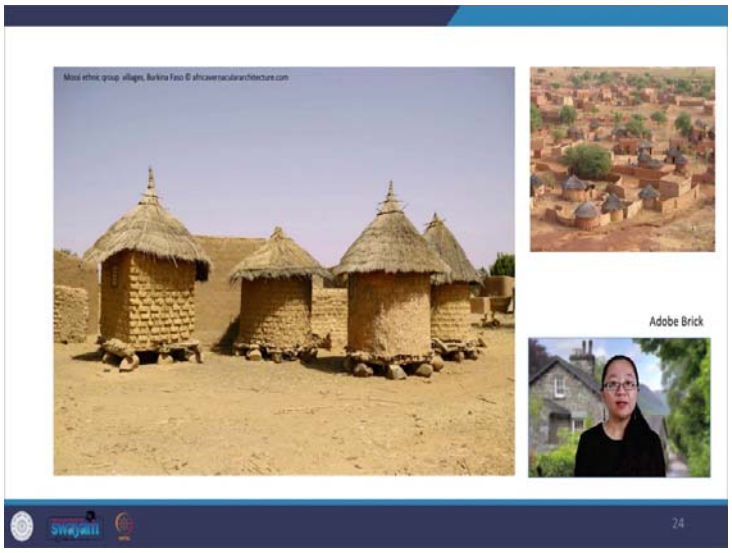

Another example of Adobe architecture is the vernacular architecture of Mossi ethnic group in Burkina Faso. The Mossi live in villages of extended families, parents, and children plus other relatives. The boundary of the village may be a stream or a natural feature, but in general, the village is a more social unit than a geographical one.

A traditional Mossi village consists of a number of round Adobe huts with cone shaped roof made of touch. They are surrounded by adobe walls. Each member of the extended family has a hut. Each house of the Mossi people also includes a patio like area of bounded swept Earth with an awning. People rest there during the day and welcome guests.

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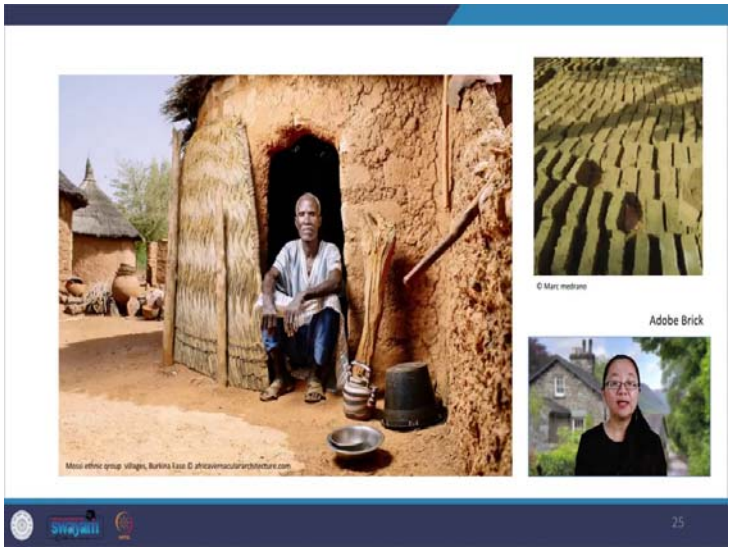

In their development more houses built in rectangular shapes. The load bearing walls are built with a 15 centimeters thick adobe brick with an interior clay coating an exterior lime coating. The adobe bricks are manually built on site. Bricks are produced in wooden molds mixing earth material and water and sometimes straw is added to limit cracks.

The Earth mixture is placed in molds and dry in the sun. Nowadays, the traditional touch roof are replaced with corrugated iron roofs. The ones use this iron roofs represent higher status in economy, although they make interior of the house hotter and noisier during the rainstorm.

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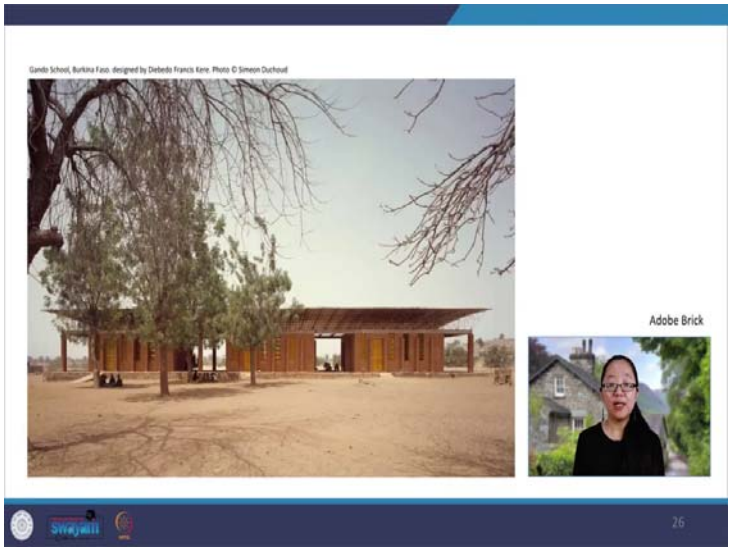

In Burkina Faso, a native architect called Diebedo Francis Kere design and build an extraordinary contemporary architecture project using adobe brick. The project is the Gando Primary School in the province of Burgo in the east of Burkina Faso. The school was built as a solution to poor lighting and poor ventilation a problem found in many educational building in the area.

Francis Kere created a design that resolve these issues directly within the parameters set by cost climate, resource availability and construction visibility. Clay is abundantly available in the region and traditional use in house building. So, clay and cement hybrid was used to create structurally robust brick.

These are not only easy to produce, but also to provide thermal protection against the climate. Despite their durability, however, the walls must be protected from damaging rains by an overhanging roofs.

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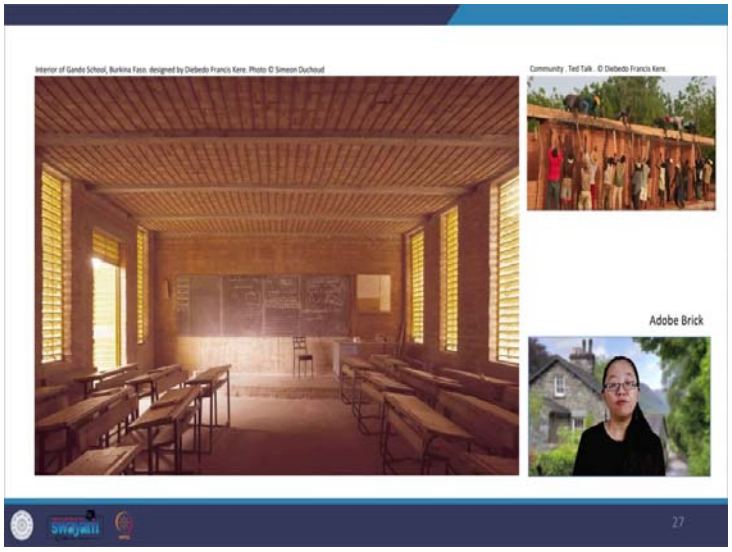

To avoid the overheated classroom because of corrugated metal roofs the architect introduces a dry stack brick ceiling in between allowing for maximum ventilation. Cold air is pulled from the interior windows while hot air is released out through perforation in the clay roofs. This also significantly reduces the ecological footprint of the school by alleviating the needs of air conditioning.

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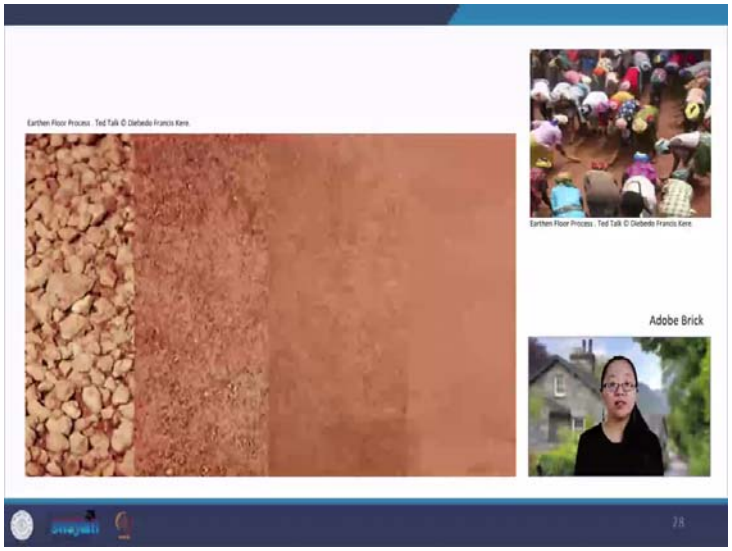

Other than the walls and roof ceilings, the floor is also made from clay using traditional technique. For the floor, the community come together, men and women beating the floor for hours, then they start polishing it with a stone also for hours. And then the result is this very fine floor texture.

The whole building including this clay earth floor is built by the whole community together. From the Gando School Project, we learn how to build combining new technology with traditional technique. And from this project, we also learn how contemporary architecture can add value to vernacular society.

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Now, we have arrived at the end of the lecture. Throughout the lecture, we have discussed some earth construction technique and their application to vernacular architecture across the world. We have also learned how Earth as building material evolve and used in contemporary world of architecture today.

The examples have shown that Earth is a 100 percent ecofriendly building material, it is neither manufactured or transported, it is low technology easily work with simple tools, and yet can be used by anyone to construct walls, floors and roof of advanced architectural design.

A wall or roof made of earth also serve as thermal mass as well as natural air conditioner being warm in the winter and cool in the summer. Earth building are highly durable, have good humidity regulation and sound insulation and are nontoxic, non-allergenic and fireproof. And when the building is demolished, the earth returns to the soil and can be recycled indefinitely.

Earth buildings have very low embodied energy and low environmental impact, especially when the material is sourced on site. So, in this sense, Earth as a building material and construction is the ultimate sustainable solution not only environmentally but also culturally.

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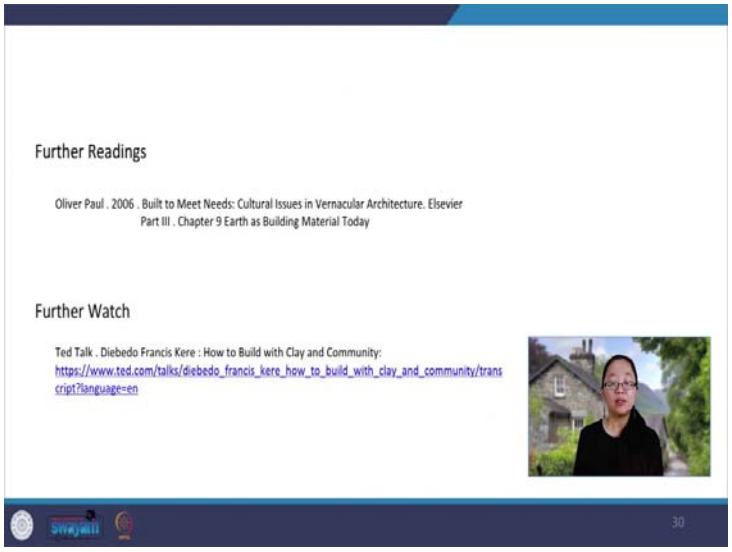

Here are some references that you might be interested to look further including this Gando School Project presentation by the architect itself at Ted Talk, the link is provided below. Thank you. See you in the next lecture.