advantages and challenges

commonalities

Building with cob, rammed earth and adobe all present similar benefits, considerations and challenges. Earthen homes are generally best suited to hot and dry climates, since earth is a thermal mass and responds well to daily and seasonal changes in temperature. Structurally, earth has good load-bearing and compressive strength, but is much weaker when it performs in tension. Additive materials like straw (used to make cob) will enhance tensile capacities while structural frames made from wood or bamboo (used for rammed earth and adobe) can absorb perpendicular forces. Tensile and structural reinforcement also improves resistance to certain climatic challenges such as strong winds and earthquakes though generally earth may not be the best choice in disaster prone areas.

A vaulted house being constructed in Burkina Faso. Earth bricks make the structure, which is then finished with water repellent mud mortar. © AVN

Different types of earth constructions have varying abilities to tolerate humidity and water. Long roof overhangs, finishing materials such as cement or plaster and high foundations will all help to protect earth structures from water. For all kinds of earth construction is it important that the quality of the soil be assessed before using it . Mineralogical composition, grain shape and size, and particle distribution all affect soil quality and the overall durability of the finished structure. Responsible sourcing of soil, sand and clay should be considered since extracting from certain sites such as riverbeds can have negative environmental impacts like increasing erosion.

Green Materials Technical Notes Series

UN-Habitat promotes the use of green building materials within the context of slum upgrading, large scale affordable housing, social housing, and reconstruction in developing countries and emerging economies. UN-Habitat supports the adoption of green materials in mainstream building based on affordability and capacity to uphold the 4 dimensions of sustainability. UN-Habitat also encourages governmental support for alternative building materials, which may include adaptations to building codes and providing subsidies.

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Information adapted from "Going Green: A Handbook of Sustainable Housing Practices in Developing Countries". 2012 UN-Habitat: Nairobi

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Green Materials

EARTH MATERIALS

Adobe and rammed earth constructions house approximately one fifth of the world's population. As a building material, earth is natural, recyclable, generally abundant and requires little energy to extract and prepare for use in construction. Earthen structures can be erected quickly, are inexpensive, and have natural resistance to fire and insects. Compared to concrete, earth materials also have low-environmental impact, very low-embodied energy and good insulation for heat and sound. Since many regions have a tradition of earthen architecture, promoting and preserving earth structures has great potential to sustain cultural heritage.

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SUSTAINABILITY avdantages of earth across the four dimensions of sustainability

environmental

As a natural resource, earth materials have relatively low environmental impact since earth is locally available, readily abundant, and easily extracted, although the specific site of sourcing should be taken into consideration since certain areas may result in environmental damage such as erosion while others will have little to no environmental impact. Earth construction typically requires few additional materials, and the majority of those used are also natural and sustainable resources. At the end of their lifespan, earth structures are easily disassembled and recycled. What is not recycled can be safely discarded since earth construction rarely uses toxic or otherwise harmful substances. Since earth is a thermal mass, it regulates temperature and can reduce energy needed for heating and cooling.

cultural

Earth construction has been incorporated into the vernacular architecture of many cultures around the world and their preservation is an aspect of cultural heritage conservation since promoting earth construction sustains building traditions.

social

Although earth construction is a common building material, many communities associate traditional earthen homes with poverty, and prefer more modern materials. Changing the perception of earth construction through educational programs is often necessary to convince communities of the advantages of building with earth. Removing stigma related to earthen homes may also help to equalize the community and contribute to greater social inclusion.

economic

Promoting earth materials where there is a tradition of earth construction helps to develop skills and expertise that may be advantageous for securing work in the future as well as providing jobs in the immediate context.
Since earthen buildings have also been associated with cultural heritage, activities related to tourism can be developed to generate economic assistance in certain communities. Earthen homes may also cut down in energy usage due to its high insulative properties, which reduces costs related to both energy and extraneous materials though. The cost to prepare earth for construction may depend on the method. If well constructed, earth homes are durable and have relatively long-lifespans, which results in longterm savings by reducing the frequency of repairs and reconstruction.

stabilized soil blocks & interlocking bricks

CEBs are made with moist soil that is poured into a steel mold, compressed and cured for approximately four weeks. A single press can produce between 250-350 bricks a day. Compared to adobe bricks, CEBs can build taller and thinner walls with better compressive strength. The production of CEBs is both more cost and energy-efficient than adobe, and is adaptable to a wider range of climate types.

Interlocking bricks are made from stone dust/soil and a stabilizer that gives it strength and waterproofing and are fabricated in a manual press. The bricks can be produced with holes to allow for steel rod reinforcement, which gives the structure flexibility and earthquake/hurricane resilience. Building with ISSBs is advantageous since they need less cement than conventional bricks.

Women use press to make unstabilized soil blocks in DRC © UN-Habitat

TECHNICAL ASPECTS the three most common methods of building with earth

rammed earth

Rammed earth is structural wall system that is made from damp sand, gravel and clay with the sand and gravel acting as aggregates and silt and clay as binders. For increased strength cement may be added as a stabilizer, which improves durability and eliminates the need for plastering. Once formed, the material is compacted and dried and another layer is added and the process is continued until the wall is com-

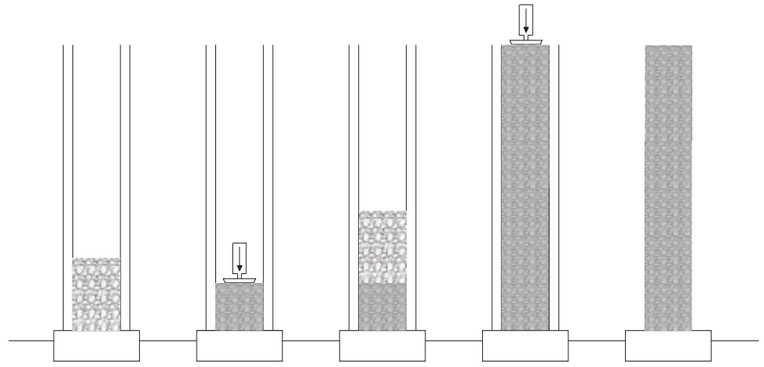

Diagram showing the construction process of a rammed earth wall: The wall is formed between two panels, which are removed once the wall has dried. @ UN-Habitat

cob

Cob is made from a mixture of sand, soil, straw and water. Clay particles are first suspended in water or separated mechanically in order to break them down, and then mixed with sand to make a homogenous substance. Next straw is added, and the mixture is made more resilient by walking and jumping on it. The mix is formed into masses and placed on a foundation. Walls are built up by contours, which are then smoothed to make layers. The process is repeated, though it is necessary that the layer underneath has dried before adding the next one.

The layers average 60cm high and 60-90cm in depth, and take several days to dry. Once a cob structure is complete, it takes between 6 and 9 weeks for a wall to dry completely. Since the structure will also shrink in the process, only after drying may doors and windows be installed.

A worker forms traditional craftmanship adobe bricks and sets them to dry in a construction site in Madagascar @ UN-Habitat

Adobe has been used for thousands of years as a building material in almost every region of the world. The largest adobe structure, the Citadel of Bam in Iran, dates back to 500 BCE.

adobe

Adobe is made from a mixture of sand (the aggregate, comprising 75 per cent of the volume), clay (the binder, making 25 per cent of the volume), water and sometimes a fibrous material such as straw. It is important that the mixture be smooth, so rocks and gravel are not suitable. Once mixed, the substance is then shaped into bricks using molds and then dried in the sun. Adobe bricks can either be structural or used as infill in skeletal frames made from wood or bamboo. Once constructed the bricks can be finished with earth/lime plaster.