

Earth Brick Building for Canada

Adobe-style homes have always been popular in the Southwest U.S., but a new form of earth based construction has recently been gaining popularity in Northern parts of the continent including Ontario, Wisconsin, Iowa and Minnesota or in areas with cold climates such as Colorado. Long-term benefits make earth blocks a better deal. Johnson of Midwest Earth Builders has been building with earth bricks for 14 years.

"Earth block buildings are produced on site with local soils so less energy is used to produce, process and transport the materials," says Johnson. "That's important to a lot of my customers. Others just like the benefits of the solid buildings they provide. The earth bricks store and release heat when used in a passive solar design or with wood stoves. Plus they are fireproof."

Johnson adds that people also like them for the design capabilities. It's easy to build arches and curves, and they can be left exposed like a fired-brick wall or plastered with a wide variety of colors and looks. "Earth bricks can be set in mortar like regular bricks, dry stacked in place like adobe, or stacked with the use of a clay slurry to seal them together," says Johnson. "All that's needed is the right soil consistency."

Too much sand causes the bricks to crumble, while too much clay will produce a brick that cracks as it dries. Johnson's ideal soil for earth bricks is 30 percent clay and 70 percent sand with no organic matter. Sand can be added if the available soil has a higher ratio of clay. If producing bricks for an exterior wall, he also adds either Portland cement or lime.



"There's no perfect soil as you always have some silt in it," he says. "If we don't have acceptable soil on site, we can usually find it nearby and haul it to the site."

Johnson uses a double action hydraulic press from EarthTek, Inc. to make uniform size and density bricks with square corners. The company recommends compressing the earth blocks at 2,300 psi, though that can vary depending on the raw materials.

Johnson has the second largest EarthTek block maker, which cost him \$60,000. It can be operated by a single person, but is most efficient with two or three people. The machine can produce up to 360, 4" high by 14" long by 2 to 10" wide blocks per hour.

EarthTek makes powered blenders for mixing sand and clay soils to get the right consistency and base for optimum bricks. Johnson uses a tractor with a rototiller to prepare the soil being used and to mix in additional sand, clay, lime or Portland cement as needed.

Earth blocks are producing is an unfired brick. While it is not necessary from a structural perspective, Johnson always puts a protective coating on the exterior whether stucco or even siding.

In southern climates, one can just make the bricks and use them. In colder months, bricks are made and left to cure for about two weeks before being used.

Earth brick construction can use the same foundations as other construction techniques. Johnson has used earth bricks for interior and exterior walls and interior only with stick-built exteriors. He has



Midwest Earth Builders: midwestearthbuilders.com
EarthTek Inc: adobemachine.com



also used them for partial interior walls to absorb sunlight or heat from a wood stove.

Johnson notes that the only difference between earth brick construction and other styles is in the cost of the walls. Windows, roof, foundation and other costs remain the same. For Johnsons clients, using Earth Bricks has typically added 3 to 4 % to the total cost of a house, while for others, using earth blocks has reduced the cost since it is possible with economies of scale to reduce the brick cost by 60% on multi-home developments.



One Hydraform machine (hydraform.com/agri/) can produce up to 2,200 blocks per day or over 600 m² of double walling per month, which over 1 double storey house of approximately 100 m² of footprint per month.

Double Wall System-Thermal Mass and Insulation

For Canada's climate builders are advised to go with a double wall/cavity wall system for exterior walls. This wall is built with two courses of block running parallel to one another with a space/cavity in between for insulation. Several insulating options are available with this wall system including vegetable based foam, perlite, and sawdust (cellulose)/lime. In this configuration the interior blocks provides thermal mass for heat storage and conservation and the insulated cavity prevents thermal bridging and heat loss to the outside. The exterior course of blocks provides a moderating effect against cold and, even more, against heat gain in the summer.

Mortar?

Earth block builders have dry stacked walls, stuck them together with a thin slurry made from the same material as the blocks, and laid them in mortars. We have found that the slurry method works well for unstabilized blocks because it penetrates the surface of the blocks and sticks them together. However, our stabilized blocks are water resistant and stick better with a standard mortar. This mix is made with 2 parts lime to approximately 5 parts 1/8" screened mason's sand or a combination of 1 part lime/1part portland cement to 5 parts sharp sand.



Figure 1 Double wall prior to insulation

Dur-O-Wal lattice tying the two walls together

Windows and Doors

Window and door rough openings are built similar to conventional frame construction and placed in the wall according to plans. They can be secured in place with screws through the framing into the blocks, or expanded metal lathe nailed to the outside of the frame and laid between block courses. Lintels, similar to headers in frame construction, are placed over openings to carry wall and roof loads. Lintels can be made of wood, stone, steel, or concrete.



Figure 2 Wood lintel over framed rough opening for window in an unfinished wall

Electrical and Plumbing

Electric wires can be run in the cavity for a double wall system; woven between courses when using a solid wall system; notched into the walls after the walls are built, and then plastered over; or run through conduit in either double wall or solid wall systems. Electric boxes for switches and outlets are placed in the wall and built around.

Plumbing, which is typically run in interior walls, can be plumbed in first and then built around, or run through an interior framed wall or chase.

Bond Beam

A reinforced concrete or wood bond beam is built at the top of a CEB wall to tie all of the walls together, level the walls, and provide an anchor point for the roof or the next story.

Interior Finishing

Interior walls are typically plastered or left exposed with the blocks visible. Plasters with a base of clay, gypsum, or lime are all appropriate for earth blocks. Earth blocks do not generally take as much time to prep and plaster as other natural building materials. Two coats, a base and then a finish is often enough, although a third coat or color wash is also common. Color is added in the finish coat of plaster, in a wash like an alise (clay paint or lime wash), or breathable natural paints like milk paints.



Once many homeowners see the earth blocks walls, they often ask if they can leave the blocks exposed. This is not a problem, although a sealer or wash is suggested to eliminate dusting and lighten the color of the blocks.

Dry wall has been put up over earth blocks although this is unnecessary and an added expense. Walls can also be covered with a wainscot, crown molding, or other trim details.

A finished earth block wall can look as smooth as conventional drywall, organic and flowing with ridges and undulations like many naturally built homes, or something in between. The choice is up to the builder or client.

Exterior Finishing

Exterior walls are left exposed or finished with a stucco or lime plaster/render. Two or three coats of plaster are the typical application systems. There are earth block houses that have been sided with cedar, vinyl, and cultured stone although these are extras and are done so for appearances. Many homeowners like the exposed block look, but then a sealer that stands up to the test of time needs to be used. New geopolymer sealants used in foundations repairs can be used for that.

Costs

There are a number of variables that influence the cost of a CEB home such as site location, soil availability and composition, and architectural design. Bulk discounts are available on blocks, and cost reduction possible based on cost of local labor, machinery, stabilizer, etc. With volatility of fuel and lumber costs, CEB offer a reduced risk in construction cost.

Because CEBs are used entirely as a wall system, the remaining costs, which can represent 80-90% of the total cost of the home, will be the same as conventional building. For example, the cost of the roof, windows, cabinets, etc. are the same for a framed and CEB home.

Building the wall of a home typically represents 10-20% of the total cost of a home. In other words the wall of a conventional home may cost \$40,000 to 60,000 for a \$400,000 home.

For small projects, cost on a per block basis average approximately \$1.20 per (7" X 14" X 4") stabilized block and \$ 1.00 per unstabilized. A 1,000 square foot home with double exterior walls may need approximately 10,000 blocks. So, \$11,000 to 12,000 would be the block costs considering the fact that not all blocks need to be stabilized. This difference between the \$40,000 to 60,000 and \$11,000 to \$12,000 give a lot of breathing room for finishing the CEB walls.

Even in the case of single projects, the cost can be brought down to \$0.50 to \$0.60/block if working with volunteers (students), home owners putting in some of their own time or low cost labor to build the blocks. Multi-home developments can allow economies of scale and to significantly decrease of fixed costs and improved efficiencies translating in less expensive wall.

Over the lifetime of the home, this is a small cost when one considers the energy savings, environmental benefits, and aesthetic beauty of an Earth Block home.

Earth Block Building Advantage

- Wall systems combine thermal mass and insulation.
- Easily incorporated into other building systems.
- Ecologically sustainable
- Waste product is dirt.
- Architectural & Creative Freedom