

How to Build an Insulated Earthbag House

by **Owen Geiger** on February 17, 2011

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Intro: How to Build an Insulated Earthbag House

For those new to earthbag building, please read my [Step-by-Step Earthbag Building Instructable](#) .

Energy performance on most buildings can be improved with insulation, including those made of earth such as adobe and earthbag structures. Although most earthen structures are located in hot, dry climates, there is increasing demand for low-cost, eco-friendly earth building techniques in cold climates. This article explores four innovative methods for insulating earthbag buildings, which extends their building range to cold regions.

Most earthbag buildings use polypropylene grain bags or mesh bags filled with soil. Bags or tubes can be used. We demonstrate bags, because they're often available recycled for very low cost. The bags or tubes are filled in level courses and then tamped solid. There are typically two strands of barbed wire between courses to bond the bags to each other and add tensile strength. The building process for insulated earthbag houses is nearly the same, although the materials would weigh significantly less and speed construction considerably.

Unlike other earth building methods, earthbag building has the unique advantage of providing either thermal mass or insulation, and therefore can be adapted for cold climates with an insulated fill material. Scoria, pumice, perlite, vermiculite or rice hulls are all suitable insulating materials. These materials are natural, lightweight, easy to work with and non-toxic. Most (all but rice hulls) will not burn or rot and do not attract insects or vermin. In addition, all but rice hulls are not adversely affected by moisture and can be used as part of earth-bermed or earth-sheltered structures. Recycled polystyrene (Styrofoam) is another good possibility. Another possibility is adding foam board or foam insulation on the exterior of earthbag walls, as explained in the 4th option.

The table below compares the approximate R-values of five low cost insulating materials that could be used in earthbags. (The first column in the table is the insulative value per inch; the second column shows the R-value for a typical 15" thick earthbag wall.)

Material -- R-value/inch -- R-value/15"

Rice hulls -- R-3 -- R-45

Perlite -- R-2.7 -- R-40

Vermiculite -- R-2.13 -- R-32 to 36

Extruded polystyrene -- R-3.6 to R-4.7 -- R-54 to R-70

Molded polystyrene (low density) -- R-3.85 -- R-58

(Source: Wikipedia Encyclopedia.) [http://en.wikipedia.org/wiki/R-value_\(insulation\)](http://en.wikipedia.org/wiki/R-value_(insulation))

Tools and supplies:

Shovel, bucket, garden hose, tamper, slider, gravel, soil and/or insulation, earthbags (poly sand bags), barbed wire, wire cutters, level

The following pages discuss four low cost methods of building insulated earthbag houses.

For more information, my [You Tube Channel](#) has dozens of short videos showing every step of earthbag building. And our [Earthbag Building Blog](#) , the number one blog on the subject, covers every aspect of building with bags in detail.



Image Notes

1. Half Moon Earthbag Earthship

step 1: Bags or tubes filled entirely with insulation

The first and simplest method for insulating earthbag buildings uses bags or tubes filled entirely with insulation. The main advantage of this method over the other methods described below is ease of construction. Walls are one bag wide and filled entirely with insulation. Thick earth or lime plaster on the interior provides thermal mass to help stabilize indoor temperatures.

A demonstration home using this method was built in Crestone, Colorado with scoria-filled earthbags. Scoria is also known as volcanic rock or lava rock. It's widely used in landscaping. Due to its volcanic origin, scoria is filled with tiny air spaces, making it a good insulator. Although the R-value of scoria is debatable, the owner claims these earthbag walls are comparable to straw bale walls of around R-26 to R-30. This estimate includes 5" of papercrete at approximately R-2/inch.

Building a load bearing structure with bags of insulation in this way is still experimental. We're confident in the working properties of scoria and pumice, but using other types of insulation needs more research. For instance, some types of insulation may compress excessively under loads. Lightweight walls of insulation are not as sturdy as bags or tubes filled with soil and may require some temporary braces. Tubes tend to roll. Round or curved building shapes are more stable than rectangular. Adding vertical bamboo or rebar pins tied together through the wall may be needed. You might also need to use a post and beam system to provide additional support and to meet code. Start out with a small test structure to improve your techniques. It would be great if someone would build some small test structures and document the results. You can join the discussion about [Perlite Roundhouses](#) on our blog.

The photo below is of [Kelly and Rosana Hart's Dome Home](#) . Their home has been published in at least 10 books and magazines. Kelly is the owner/author of the number one most popular sustainable building website [GreenHomeBuilding.com](#) . His site covers every green building method.



step 2: Tube sandbags filled with insulation on the exterior of earthbag walls

Another method for insulating earthbag buildings uses tube sandbags, also called traction tube sand bags, typically used to improve automobile traction on snowy/icy roads. (The bags are sold to add weight for vehicle traction.) This method involves stacking tube sandbags filled with insulation on the exterior of earthbag walls, thereby creating a double wythe wall joined together with poly baling twine or with barbed wire.

Tube sandbags provide about 10" of insulation, which is perfect for many climates - not too much, not too little. Again, scoria, pumice, perlite, vermiculite, polystyrene or rice hulls could all be used for insulation. Perlite and recycled polystyrene would be my first choices due to their high R-value and resistance to moisture damage, although the final decision needs to be weighed against other locally available and inexpensive natural materials.

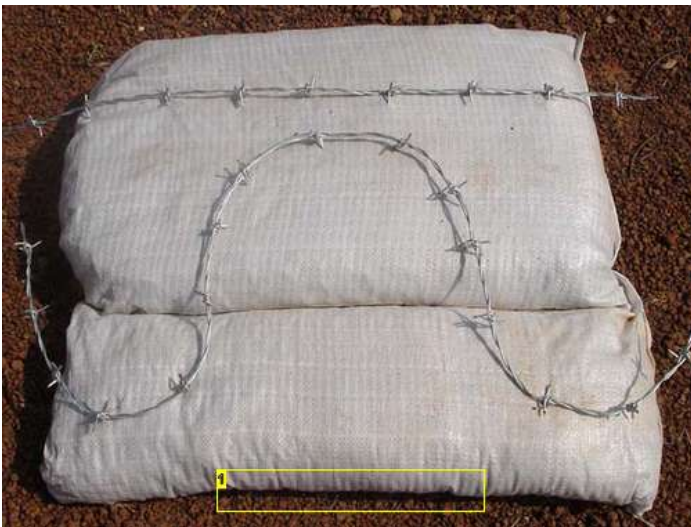


Image Notes

1. Earthbag (top) adjoined to tube sand bag (bottom) with barbed wire

step 3: Make a seam lengthwise down earthbags to create two compartments

A third possibility is to add a seam lengthwise down earthbags – either 18" or 24" wide bags – to divide them into two compartments. The outer part could be filled with insulation; the inner part with soil. Like the other systems described here, this would create an insulated wall with thermal mass on the interior. For many situations, especially structures in moderately cold regions, this is an ideal wall system, although the bags would be somewhat awkward to fill.

The placement of the seam could vary, depending on the climate. In a mild climate like New Mexico, about 4"-5" of insulation on the outside would suffice. This would provide about R-10 insulation. In a slightly colder climate the seam could go down the middle (50% insulation / 50% soil). In extremely cold or extremely hot climates I would fill the bags with 100% insulation (or all earth in a hot climate if insulation is not available).

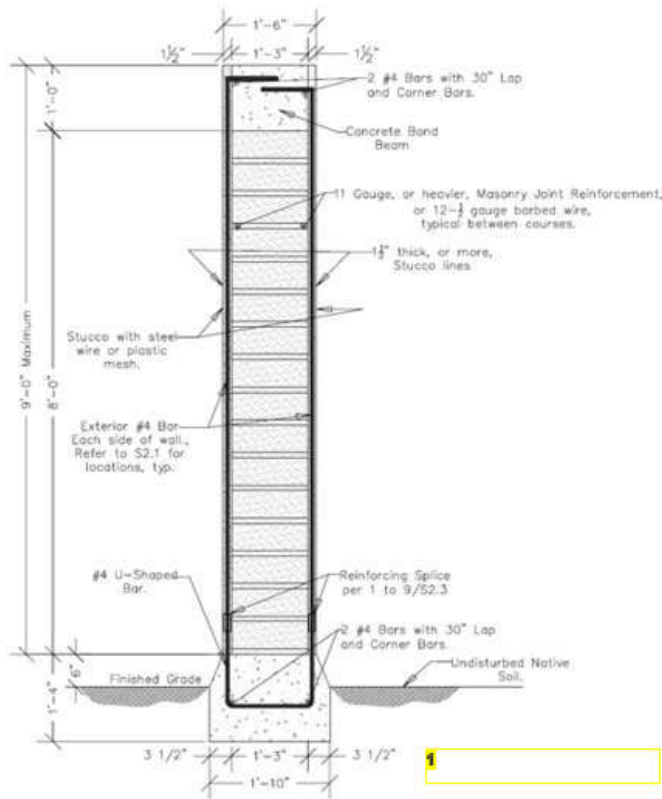


Image Notes

- 1. Seam sewn down center of earthbags

step 4: Reinforced earthbag system

A fourth option utilizes the reinforced earthbag system developed by Precision Structural Engineering, Inc. (PSE). Simply add foam board insulation or spray foam insulation on the exterior of earthbag walls. This is probably the most practical approach if you need a building permit. PSE is licensed in 27 states, and they also have reciprocal relationships with engineers around the world that would enable you to get engineer approved plans and building permits almost anywhere. Their fees are quite reasonable. This building system has been covered in detail on our Earthbag Building Blog. Here's the link to their [Reinforced Earthbag Specifications](#).



① TYPICAL EARTH BAG WALL SECTION
Scale: NTS

Image Notes

- 1. This design by Precision Structural Engineering, Inc. has revolutionized earthbag building now that virtually any design can be engineered to meet building codes.

Related Instructables



How to Build an Earthbag Dome

by Owen Geiger



Step-by-Step Earthbag Building

by Owen Geiger



How to Build an Earthbag Roundhouse

by Owen Geiger



How to Build Dirt Cheap Houses

by Owen Geiger



How to convert a closet into a mini wine cellar by dedub01



Resurrecting the California Cooler by dlginstructables

Comments

2 comments [Add Comment](#)



armynavy17 says:

Feb 18, 2011. 2:36 PM [REPLY](#)

Good instructable. I'm curious though, on your website you have plans for multistory homes, yet you don't explain how one would do the floor of one of these. That's my question, how would one build the floor of the second level?



Owen Geiger says:

Feb 18, 2011. 4:43 PM [REPLY](#)

There are numerous possibilities for building second stories. You could use the Precision Structural Engineering, Inc. method. You could use post and beam or confined earthbag. You could build a lightweight second story. Use the search engine on our blog. Every topic is covered.
<http://earthbagbuilding.wordpress.com/>