

# Step-by-Step Earthbag Building

by **Owen Geiger** on November 24, 2010

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## Intro: Step-by-Step Earthbag Building

This Instructable explains each main step of construction for building vertical earthbag walls. Videos on my [Earthbag Natural Building YouTube channel](#) demonstrate the process.

For those who don't know, earthbag building uses polypropylene rice bags or feed bags filled with soil or insulation that are stacked like masonry and tamped flat. Barbed wire between courses keeps bags from slipping and adds tensile strength. The final plastered walls look just like adobe structures. Thousands of people are now building with bags to create their dream homes, home offices, shops, resorts, rootcellars, storm cellars and survival shelters. Non-profit organizations are building schools, orphanages, emergency shelters and other structures.

I got involved with earthbag building when the Indian Ocean tsunami hit Southeast Asia in December, 2004. As the director of Builders Without Borders at that time, I searched all available affordable, sustainable building methods and decided building with bags was the most practical. They're flood resistant (used for flood control), earthquake resistant (passed an ICBO shake table test), bullet and blast resistant (used for military bunkers), and now engineer and code approved plans are available. Just search for earthbag house plans on the Internet.

Our websites at [EarthbagBuilding.com](#) and [Earthbag Building Blog](#) explain just about everything you need to know for free. And if you're looking for house plans, my [Earthbag House Plans](#) site features over 110 sustainable plans that can be purchased through [Dream Green Homes](#).

The following instructions assume you have cleared and leveled the site, removed topsoil, positioned fill soil around the building site to minimize work, dug a trench to stable subsoil, put about 12" of gravel in the trench, and added corner guides and stringlines.



### Image Notes

1. Vertical earthbag wall

## step 1: Tools and materials

Step 1. Tools and materials (listed left to right): woven polypropylene bags (about 18" x 30"), bucket chute (4-gallon bucket with bottom cut off), 4 or 5 heavy duty 2-gallon cement buckets, stringline, metal chisel and scrap steel for cutting barbed wire (or bolt cutters), hammer, sheetmetal slider (about 13" x 16"), 15 gauge galvanized wire, knife, wire cutters, tape measure, 4-point barbed wire, corner guide, grub hoe or grape hoe, level, tampers, bundle 500 bags, shovel.



### Image Notes

1. Earthbag tools and materials

## step 2: Fill the bags

Step 2. Fill the bags: Use the same number of buckets for each bag. Fill bags approximately 90% full, leaving just enough to sew the bags closed. This technique ensures each bag is filled to capacity to save bags, and each bag is the same size, which helps keep walls level.

First Foundation Bag



### Image Notes

1. Filling earthbags

## step 3: Sew or stitch the bags closed

Step 3. Sew or stitch the bags closed: fold the bag end over; use 15 gauge wire about 9" long with one end cut at a sharp angle; make one stitch on one side and bend the end over; make a stitch in the center and pull the corner over; make a stitch in the other corner and pull the corner over; poke the remaining wire into the earthbag. This technique facilitates handling, prevents spills and enables bags to be filled to capacity.

Stitching Bags Closed



### Image Notes

1. Stitch earthbags closed

#### step 4: Gravel bags on lower courses

Step 4. Lower courses: place gravel-filled bags (double-bagged for strength) working from the corners and openings to the center. Align bags to stringline; tamp the bags solid and level after the course is complete. Always put tops of bags (the ends you've sewn closed) butted against other bags to prevent spillage. Maintain a running bond as in masonry.

Second Foundation Bag



#### Image Notes

1. Gravel bags on lower courses

#### step 5: Add barbed wire

Step 5. Add barbed wire: use two strands of 4-point barbed wire in-between each course of bags; bricks or stones temporarily hold the barbed wire in place.

Barbed Wire



#### Image Notes

1. Barbed wire between courses of bags

### step 6: Place additional courses with sheetmetal slider

Step 6. Use a sheetmetal slider to place additional courses so bags do not snag on the barbed wire: fill the bags on the slider; sew the end closed; tilt the bag into position and push it against the previous bag. After the bag is aligned, hold the end of the bag and jerk the slider out. Continue with gravel-filled bags until you are safely above the height where moisture can cause damage.

First Bag Second Course



#### Image Notes

1. Place bags using sheetmetal slider

### step 7: Repeat the process using earth-filled bags

Step 7. Repeat the process using earth-filled bags for upper courses, but with a few minor changes: turn bags inside out to avoid protruding corners; use lightly moistened soil; lightly tamp the contents after each bucket of soil is added; pre-tamp each bag after it is aligned in position. This last step lengthens each bag to ensure good overlap.

First Earth Filled Bag

Tamping First Earth Filled Bag



#### Image Notes

1. Earth-filled earthbags

## step 8: Make custom-sized bags

Step 8. Make custom-sized bags to fill odd-sized spaces: measure the opening; fill the bag to the approximate level; cut off excess bag material; fold each side of the end toward the center and tuck under the bag; place the bag in the wall.



## step 9: Tamping

Step 9. Tamping: Tamp earthbags solid and level after each course is complete. Tamp the high points first. Once the wall is approximately level, evenly tamp the entire wall several times as you continually move the tamper so as not to create low spots.

Tamping First Course of Earth Filled Bags

Repeat the process for the remainder of the walls, adding doors and windows as you go. Check often to keep walls plumb and level.

If you like this Instructable, please check out my other one that covers almost every detail for building a roundhouse: [How to Build an Earthbag Roundhouse](#)

Owen Geiger is the former director of Builders Without Borders, a Mother Earth News Green Home Adviser, The Last Straw Journal Correspondent and the director of the Geiger Research Institute of Sustainable Building .

Photos and videos by Got Chankamol



### Image Notes

1. Tamping Earthbags

## Related Instructables



[How to Build an Earthbag Dome](#)  
by Owen Geiger



[How to Build an Earthbag Roundhouse](#)  
by Owen Geiger



[Durable Raised Garden Beds](#)  
by Owen Geiger



[Make acoustic panels for your recording studio or home theater](#)  
by TheHighwayBeauti



[How to convert a closet into a mini wine cellar](#)  
by dedub01



[Build a Concrete Block Wall \(video\)](#)  
by Sakrete

# Comments

50 comments [Add Comment](#)

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**thomas\_hemme8188** says:

Jan 31, 2011. 11:39 PM [REPLY](#)

isn't there some sort of permit needed to build that sort of structure? always nice if there isnt.....



**Owen Geiger** says:

Feb 1, 2011. 12:14 AM [REPLY](#)

Building codes vary from country to country, state to state, even city to city. You'll have to talk to your local building officials.

This is a huge subject of interest, because it has a major bearing on the cost of construction. You might want to join the discussion on our blog: <http://earthbagbuilding.wordpress.com/2010/01/24/counties-with-few-or-no-building-codes/>



**hogey74** says:

Jan 30, 2011. 5:12 PM [REPLY](#)

Just a quick thankyou for this instructable! I love the super low embodied energy and simple construction techniques. Clearly optimized for people in low SES circumstances but I can also see myself doing something like this on a secluded block of land one day as a holiday house... a great use of your experience for the benefit of others. Very admirable mate.



**Owen Geiger** says:

Jan 30, 2011. 8:34 PM [REPLY](#)

Thanks a lot. This really does help a lot of low income people. But there's also quite a few schools, resorts, orphanages and other structures being built, as well as luxury homes and vacation homes.



**rmgb** says:

Jan 30, 2011. 6:25 PM [REPLY](#)

Does anyone know if these are hurricane-resistant? I know they're bullet- and earthquake-resistant, but unfortunately that doesn't always make them able to withstand hurricanes.



**Owen Geiger** says:

Jan 30, 2011. 8:26 PM [REPLY](#)

Yes, we believe they are. However, we're lacking complete testing to validate this. There was a wind tunnel test scheduled for December, but I haven't heard what happened. I imagine we'll hear from the engineers doing the study shortly. All the news like this is updated daily on our Earthbag Building Blog. <http://earthbagbuilding.wordpress.com>

The next best thing is using the design developed by Precision Structural Engineering at [Structure1.com](http://Structure1.com). Any engineer can quickly see this is a very strong design that would be hurricane resistant with a good roof design. It would also meet code. So if you're serious, please email them.



**neddup98** says:

Jan 28, 2011. 10:14 AM [REPLY](#)

Looks good - economical, fast, and I guess a decent insulation value when the soil has dried out. However, the integrity of the wall depends on the plastic bags holding up. While you note the need to protect the empty bags from sunlight in your comments, I couldn't see anything in the instructions to indicate that ultraviolet protection like the parging like you did in your Round House or sheathing is essential if the wall is going to last. I filled some feed bags with firewood offcuts two years ago and forgot about them outside. When I tried to pick them up last fall, the bags completely disintegrated. I know most builders will want to cover the wall anyway for aesthetic reasons but it wouldn't hurt to make it clear that this is not merely an option. Otherwise, a good idea clearly described. I think I have accumulated enough feed bags that I couldn't bear to throw away to build at least half a shed.



**Owen Geiger** says:

Jan 28, 2011. 5:22 PM [REPLY](#)

Yes, this is an important point that must be emphasized. But I didn't want to repeat too much stuff from the first Instructable.

Soil actually has very low insulation value. It's effective in moderate and hot climates because the walls are thick and high mass. It's called the thermal flywheel effect.

In cold climates you can build insulated earthbag houses. That's a future Instructable.



**drewgrey** says:

Jan 28, 2011. 4:56 PM [REPLY](#)

Interesting, Reminds me of a history teacher I had in high school who grew up in a sod house .



**seabeepirate** says:

Jan 27, 2011. 11:36 PM [REPLY](#)

This is awesome! I was really into the straw bale buildings for a while but this seems like it will stand up to a lot more.



**Owen Geiger** says:

Jan 28, 2011. 12:10 AM [REPLY](#)

No building system is perfect for all situations. You have to consider many variables to determine what is best for you. Strawbale has lots of advantages. It's super fast. We stacked the bales for a 1,000 sq. ft. Habitat for Humanity home in less than one day. First we built a wood frame. Then we stacked the bales on edge against the wall. But bales are more susceptible to moisture damage than tamped earthbags. Again, use what makes most sense for your situation.



**rimar2000** says:

Nov 24, 2010. 6:15 PM [REPLY](#)

Awesome! I like this eco-friendly way of building. I subscribed your Youtube channel, there are interesting things. I never had the opportunity to build a house, but I would like to experience one of these non-traditional techniques. I really like the domes too, whether or not Buckminster Fuller's.



**Owen Geiger** says:

Nov 24, 2010. 7:10 PM [REPLY](#)

The YouTube videos turned out to be very popular. 1-3 people sign up almost every day. I have 8 more videos planned on CEBs, earthbag benches, etc.

If this site becomes popular, I'll add more Instructables.



**Jayefuu** says:

Jan 23, 2011. 11:02 AM [REPLY](#)

Please do! You might find this instructable useful to help you fill your bags quicker!

<http://www.instructables.com/id/Filling-Sandbags-the-Easy-way-with-Sandbag-Tubes/>



**Owen Geiger** says:

Jan 23, 2011. 4:18 PM [REPLY](#)

It's easier filling bags in place on the wall. That way you're only handling one small bucket of soil at a time. Full bags weigh around 100 pounds, so would be too difficult to carry around.



**nerys** says:

Jan 27, 2011. 8:19 PM [REPLY](#)

by yourself? yes. but if you have help thats what a lawntractor and a small trailer are for :-)



**Owen Geiger** says:

Jan 27, 2011. 9:09 PM [REPLY](#)

That's great if you can afford it. Most people doing this do everything by hand. I like three person crews: one person filling buckets, one carrying buckets, one filling and placing bags.



**nerys** says:

Jan 27, 2011. 10:38 PM [REPLY](#)

ahh its not hard to get a good running lawn tractor for \$50 to \$75 and REALLY NICE ones for \$100 to \$150.

I just buy them in the fall when no one wants them and just want them gone (don't even THINK of buying them in the spring \$250 is the lowest which is why I have 4 extra's :-)

the trailer I got for \$12. well free then I bent the rim straight and bought the \$12 inner tube it needed from home depot.



**Owen Geiger** says:

Jan 27, 2011. 11:35 PM [REPLY](#)

Your idea makes sense at that price. Construction is hard work and having the right tools can make things so much easier.



**rimar2000** says:

Nov 25, 2010. 3:26 AM [REPLY](#)

Owen, Instructables is VERY POPULAR. People around the world has it as daily read. In example, I live in Argentina and use Google Translator to read and write English. You will meet here many followers, they will profit your teachings.



**Owen Geiger** says:

Nov 25, 2010. 5:25 AM [REPLY](#)

Oh, I agree. I've been reading Instructables for a couple years or so. They're a great resource and I'm glad to be published here.

When I said "If this site becomes popular..." I meant this particular Instructable on earthbag building.



**twighahn** says:

Jan 27, 2011. 3:38 PM [REPLY](#)

i wonder how well this would work for an underground home



**Owen Geiger** says:

Jan 27, 2011. 4:56 PM [REPLY](#)

We just talked about this. Read the other comments and search our blog. It works great, that's why I have quite a few earth bermed, earth sheltered and underground earthbag designs. See Earthbag House Plans.



**twighahn** says:

Jan 27, 2011. 5:56 PM [REPLY](#)

where is your blog?



**Owen Geiger** says:

Jan 27, 2011. 8:57 PM [REPLY](#)

Earthbag Building Blog: <http://earthbagbuilding.wordpress.com/>

Currently 433 posts on every aspect of building with bags, and 1,377 comments. This is where we put all the breaking news, new projects, etc.



**twighahn** says:

something to add to my plans im a drafter but retired the only house i plan to draw is my dream house which is underground

Jan 27, 2011. 5:47 PM [REPLY](#)



**DAMO\_NZ** says:

Any chance of posting a pic of finished project? or is this as far as you got?

Jan 27, 2011. 5:02 PM [REPLY](#)



**Owen Geiger** says:

This is a demonstration wall used for training purposes. There are thousands of earthbag houses, schools, resorts, etc. around the world. Our earthbag websites document the best projects. Here's just one link: <http://www.earthbagbuilding.com/projects/projects.htm>. Many more are on our blog.

Jan 27, 2011. 5:28 PM [REPLY](#)

I plan to publish our roundhouse as an Instructable soon, since most people don't document the entire process.



**extraordinary1** says:

Great instructable. I worked construction 16 years before my heart gave out.

I never got to build my dream earth contact home, and I was considering something like this, using recycled materials as much as possible to keep the cost minimal.

Jan 27, 2011. 1:12 PM [REPLY](#)

I never got to buy any land to build on, and now, I know my heart can not withstand a project like this. I'm due to return for more heart surgery within the next three months to replace my defibrillator/pacemaker battery, and do an ablation to stop what they call PVC's which I experience daily.

Funny your last name is Geiger, I have a Geiger ready mix concrete license plate on my car. I strongly considered using the huge blocks they make with wash-out concrete to build a home with. On top of a strong concrete slab with very strong footings, and add underground braces to prevent quake damage from causing the walls to cave in.

You have done a great job with this instructable. After my heart went bad, I went into electronic engineering school, but was forced to quit half way through, as my heart couldn't take the stresses involved. I turned to designing alternative energy projects, especially wind power, that will produce far more power outputs than normal wind generators with counter rotation.

It is also nice to see you are a builder without borders. I greatly respect and admire those who do such things. I tried very hard to get all those people who claim they are feeding the 3rd world countries kids... building schools... only to be rejected time and time again, even from so called evangelical people doing the same. I found one local source, they have a massive property to maintain, massive building, many employee's driving cars that are very expensive. The money isn't reaching the cause.

I also researched many other things, such as stripping humidity to keep our well full, distill it, use a solar furnace when possible to assist in the distillation of water. Keep up the great work, and God bless you for it.



**Owen Geiger** says:

You should post your ideas on Instructables. Sounds like some really projects. Take care of yourself.

Jan 27, 2011. 4:55 PM [REPLY](#)



**raygris** says:

When I was last at Cal Earth (Late 90s) They had roles of the uncut fabric tubes that are cut and sewn to make the bags. The end where just folded under instead of sewn shut after filling. Is there an advantage to using cut and sewn bags instead of the tubes?

They also had made hoppers on adjustable stilts and rollers that stratled the wall. A skip loader filled the hopper that rolled along filling the tube. Is there a faster process now?

Jan 27, 2011. 12:11 PM [REPLY](#)



**Owen Geiger** says:

Most people don't have tractors or skip loaders, so we usually focus on simple, low cost techniques. For instance, most people can get bags or recycled bags easier than tubes. Filling bags to maximum capacity and sewing them closed creates larger bags with greater overlap between courses, which creates stronger walls and saves bags. So sewing is extra work, but its practical for certain situations.

Jan 27, 2011. 4:52 PM [REPLY](#)

Here's a discussion about mass production earthbag: <http://earthbagbuilding.wordpress.com/2011/01/13/mass-production-earthbag-101/>

There are industrial machines now that fill tubes incredibly fast. They're used to fill tubes for erosion control barriers, etc., but they're not practical for building houses.



**rclane48** says:

Another source of bags is from folks that use wood pellets to heat their home or business. A ton of 40 pound bags yields 50 bags. Depending on the size of the house, the length if the heating season, or how the stove is used, one house may use anywhere from 1 to 10 tons per season.

Jan 27, 2011. 11:20 AM [REPLY](#)



**Owen Geiger** says:

That's a new idea I hadn't heard, thanks. Poly bags are so common in some areas that you can find recycled bags bundled for sale real cheap at feed stores, etc.

Jan 27, 2011. 4:46 PM [REPLY](#)



**raygris** says:

Nice to see someone is 'building' on the work of Nader Khalili, the late Persian architect. Having been in several serious earthquakes, I was most impressed with this building systems ability to exceed California's most extreme earthquake zone standards.

I saw a 1996 video interview with the head of the Hisperia building dept. (Tom Harp?) When National Geographic asked him if the system had been tested, he answered, "Kind of." When it had exceeded 200% of the zone 4 standard, they quit the test because the test fixture was breaking.

Jan 27, 2011. 9:51 AM [REPLY](#)



**Owen Geiger** says:

Jan 27, 2011. 4:43 PM [REPLY](#)

Yes, and a more recent shake table test at the University of Nevada showed earthbags passed the levels experienced by the Northridge, CA quake. Just search our blog for details. This is a huge concern in earthquake regions. Now there's about a dozen earthbag projects under development in Haiti. Precision Structural Engineering will stamp plans for seismic and non-seismic areas so anyone can get a building permit. So slowly this building method is moving into mainstream.



**incorrigible packrat** says:

Jan 27, 2011. 8:57 AM [REPLY](#)

Wow, a decent use for barbed wire (unlike using it for animal containment). Nice corner there.

Anyone looking for bags should contact a farmer (if there's any left in the area). Most farms will have plenty of empty poly feed bags lying around. (I kinda miss the old burlap sacks, they were so jute!)



**Owen Geiger** says:

Jan 27, 2011. 4:27 PM [REPLY](#)

We encourage the use of recycled bags since so many farmers have them in abundance. Just make sure they've been stored out of sunlight and are the same size. Make a test earthbag to make sure the bags are strong.



**kevinpatrick** says:

Jan 27, 2011. 1:59 PM [REPLY](#)

"they were so jute!"

Hey-O! :)



**Suarve** says:

Jan 27, 2011. 7:10 AM [REPLY](#)

Hi Owen, I'm considering building a garage sized workshop on piece of land outside my house in the UK, I was looking for a solution which is well insulated and build-wise as close to carbon neutral as I can get it, and your designs look perfect.

I had a quick look at your blog site but most of the guidance seems to be for hotter climes (or at least places which spend a substantial part of the year very hot). Do you have any information on how the design stands up in more temperate regions such as Western Europe? I'm thinking specifically of the barbed wire rusting and losing integrity as happens with roofing nails in the UK, which typically last 70-80 years but which are not hammered into a damp material to start with...

I'm also curious as to any advice you have on how best to let the bags dry out (which I assume is a requirement) in such an environment.

Could you please point me to any areas on your blogsite which could be useful?

Thank loads - your system looks excellent.



**Owen Geiger** says:

Jan 27, 2011. 4:18 PM [REPLY](#)

This topic is discussed in some detail. The search features on our sites are very good (Wordpress on the blog, Google at EarthbagBuilding.com). Search for cold climate and insulated earthbag.

No worries about the barbed wire inside a protected wall. Even out in the elements, barbed wire can last over 100 years. (Again, we have a blog post on this. Search barbed wire on the blog.)

Mesh bags dry out faster than poly bags. Some call this hyperadobe. So search for hyperadobe or mesh bags on our blog.



**pdc4770** says:

Jan 27, 2011. 8:54 AM [REPLY](#)

For the UK, try the traditional Welsh building technique 'clom'

It's a mixture of earth, straw and aggregate. It's cheap, lasts up to a couple of hundred years and has fabulous insulating qualities. The challenge you'll have is getting the right consistency.

Have a look at,

<http://www.rcahmw.gov.uk/HI/ENG/Publications/Bookshop/?book=23>

and

<http://www.coflein.gov.uk/en/site/35396/details/WIG-WEN-FACH%2C+LLANERCHAERON/>



**Owen Geiger** says:

Jan 27, 2011. 4:39 PM [REPLY](#)

Sounds good. I'll look into it. There are lots of similar mixtures. Straw usually isn't needed because the bags and barbed wire hold the walls together. That eliminates one step of building -- no need for straw, no cutting and mixing. Although it might contribute slightly to the R-value.



**Suarve** says:

Jan 27, 2011. 10:14 AM [REPLY](#)

Thanks - I'll check this out



**willrandship** says:

Jan 27, 2011. 3:47 PM [REPLY](#)

Reminds me of minecraft :P

Great idea.



**TALLJ29** says:

Jan 23, 2011. 4:28 PM [REPLY](#)

Its a great project, but my concern is that these polypropylene bags are affected by sunlight (1600 hours or so). They will weaken over time That can be fixed by either

- a. Building your structure underground
- b. Covering the bags with sheeting or other material

On another note where would you recommend getting the bags from. Also, i'm curious about how you would do the roof.

This is pretty cool.



**Owen Geiger** says:

Jan 26, 2011. 5:46 AM [REPLY](#)

Where to buy bags: Your best bet is to use Google to search for a supplier near you. That should reduce shipping costs. We also list a few companies on our Resources page (scroll down): [www.earthbagbuilding.com/resources.htm](http://www.earthbagbuilding.com/resources.htm)



**Owen Geiger** says:

Jan 23, 2011. 5:35 PM [REPLY](#)

Bags need UV protection for projects that take more than a few weeks. You can pay extra for UV protected bags with a special coating. Or you can spray cheap or recycled latex paint on the earthbag walls if necessary (or even brush it on).

You can build almost any roof imaginable -- trusses, pole roof, TJs, etc.



**Broom** says:

Jan 24, 2011. 12:24 PM [REPLY](#)

Brilliant! And simple! Like the rest of this instructable.



**Ryonin** says:

Jan 23, 2011. 9:55 PM [REPLY](#)

And of course, as is stated in the instructable, the finished walls would be plastered. A coat can go on as soon as the contents of the bags have dried; long before significant damage is done. This would probably be faster with a stucco sprayer.

[view all 62 comments](#)