



Southwest
New Brunswick
Service Commission

Non-traditional building

Straw bale, cordwood, slipform masonry, earthbag, Earthships and tiny homes: naturally, no building inspector in her or his right mind is going to approve any of these builds, right?

The National Building Code of Canada (NBC) doesn't necessarily say "no" to alternate builds, even though "cordwood" is not a word you will find in the hundreds of thousands of words in the NBC. What follows is an outline of alternate building techniques and how they mesh with the requirements of Code. This should be considered nothing more than a general guideline, and anyone considering a non-traditional build must consult with the authority having jurisdiction with specific questions, or for interpretations of the Code as it applies to their project and area.

New Brunswick Code-exempt structures

First off, New Brunswick has an interesting legal framework for building and construction. Under current provincial regulations (Regulation 2021-02, clause 8), those living in rural areas may be able to construct a small personal-use residential structure of up to 625 square feet of occupied space – a camp, essentially – without having to meet building codes, as long as it is not used for "public congregation." (Note this 625 square feet is not the footprint alone; so, for example, loft spaces are included in the calculation of area.) Any structure rented either on a long- or short-term basis is NOT exempt from the Code, and must meet all egress, structural and life-safety requirements.

What does this mean?

Residential dwellings of 625 square feet or less in many unincorporated areas of New Brunswick (ie: camps or tiny homes) can be constructed with nothing more than a development permit, and do not have to meet the standards of the National Building Code. The building will still have to conform to provincial or regional setback regulations, waterways or wetland setback regulations, and the requirement for on-site septic systems. There may also be rural "planning statements" that control placement.

The same development permit system also applies to larger accessory structures. They do not have to meet Code, meaning it can be constructed as the builder wishes.

That said, 625 square feet may be a little cramped for some people - and that means building to Code.

Non-traditional builds and building Code

The following overview of non-traditional building techniques is intended to provide an evaluation from the view of not only building code but building science. It is not intended to dismiss outright any technique, but is intended to give the potential non-traditional builder a cold look at some of the benefits – and flaws – that each approach may have.

A number of non-traditional building techniques originated in warmer, southern climates. A number face challenges in Canadian settings, due to the need for extra snow-load support, insulation, and (for the Maritimes) resistance to water and vapour penetration.

If used as residential structures, all the building systems below will require typical elements of a home, such as a heat-recovery ventilator, smoke alarms, water, heat and so on.

Non-seasonal buildings

The National Building Code allows an exemption from insulation and vapour barrier for “seasonally occupied dwellings,” which is a fancy way of saying that the Code-creators are smart enough to understand that some folks just want to build a summer camp that doesn't have to be heated through the winter. In reading any of the following, note that any seasonal dwelling made with an alternate construction technique will also fall into this category. In other words, if you want to build a summer camp out of cordwood, it doesn't have to be insulated or treated with a vapour barrier.

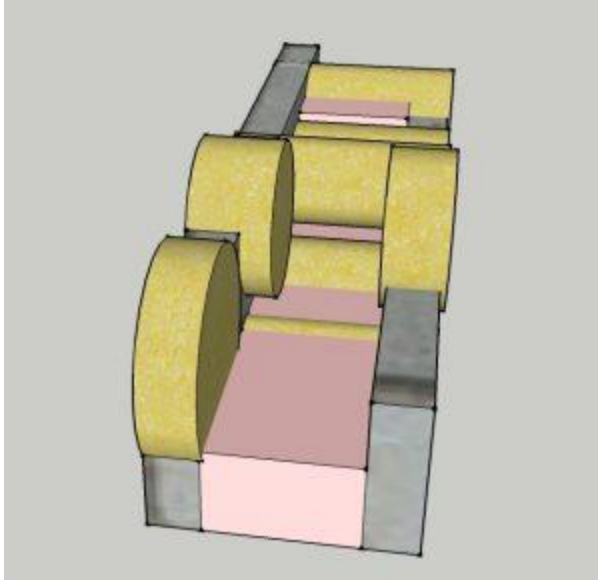
Cordwood



A cordwood wall. London Permaculture photo, published under the Creative Commons licence.

Cordwood construction involves setting lengths of softwood cut to specific lengths sideways in beds of mortar at both ends – but not in the middle. Leaving a gap in the middle allows for infill of insulation. Wood is a natural insulator to a modest extent (quick fact: the old “R” value is based on the insulative properties of one inch of softwood), and by leaving a small bed of mortar (3-4”) at each end, the resulting gap in the middle can be filled with an insulation product to increase the R-value of the wall.

This is relatively time-consuming, in that each row can only be added to by a small amount until the mortar sets, and a full year of drying is required for the source materials (which then have to be de-barked.) However, for those with ready access to wood may consider this an inexpensive build approach. The techniques are within the realm of an ambitious do-it-yourselfer.



A graphic showing the general principles of a cordwood design

In the illustration used here, a 14" section of log has been set in two runs of 3" mortar. This leaves 7" of space between the logs. Filling with, say, loose-fill cellulose will give on the order of R24 in the gaps, and the logs should give R14 – the two should average out to above the R17 value required.

Potential obstacle: infill required

The cordwood-and-mortar assembly cannot be a load-bearing wall, unless it is designed according to the plans and specifications laid down by a Professional Engineer qualified to work in the Province of New Brunswick. For most, this isn't an issue: the typical approach is to have the cordwood serve as "infill" around a post-and-beam skeleton. Since the load is borne by the posts, not the cordwood walls, as long as the post-and-beam construction meets Code, the cordwood infill is of no concern.

Obstacle: Water intrusion

The exposed ends of the wood on the exterior are naturally porous. There is a risk of wood – especially low to the ground where rainfall is more likely to strike the wall – absorbing moisture and transmitting this moisture into the central cavity.

Mortar is also porous. The kind of mortar used in cordwood construction is a very "soft" mix, in that it contains more lime than most brick mortars (more of a type N or O mortar) as well as either chemical retardants or wet sawdust to prevent the logs from absorbing moisture from the mortar before it can cure. That said, coatings (varnish) can be applied that may give the assembly a sufficiently water-resistant presentation.

If the wall is designed by an engineer to be load-bearing, then the wood will have to be "protected from exposure to precipitation" unless the design is not "conductive to moisture accumulation", which means – for example – very wide roof overhangs. [9.3.2.9(3)(b). In Southwestern New Brunswick, the Moisture Index is greater than the 1.00 mentioned in this section of code.] However, this code only applies to structural wood – in a standard cordwood infill, the cordwood is not structural, and does not have to be protected. It is possible that a building official will accept varnish as a suitable protectant – but such decisions rest with the authority having jurisdiction.

There is another Code hurdle to overcome. Clause 9.27.2.2(4) states that any exterior walls exposed to precipitation must have a "second plane of protection." In standard construction, this is achieved by housewrap. It is essentially impossible to incorporate housewrap into cordwood construction.

The only relief – other than cladding the exterior and thus hiding the cordwood – is to ensure overhangs are sufficient to protect the walls from driving rain.

Issue: cracking

If the wood is not entirely dry (and this especially applies to rounded portions) it is likely to crack, creating points of entry for water. Indeed, it is worth noting that most cordwood construction experts recognize this and outline a plan of sealing cracked ends with mortar or another substance. (Use of split wood virtually eliminates this issue, but some consider the result less attractive.)

Obstacle: vapour permeation

Both the mortar and wood absorb moisture from the air. Since both materials naturally wick moisture, there is reason to be concerned about the potential for moisture to permeate into the hollow cavity and contaminate insulation. (As proof, the traditional insulation method is to fill cavities with a lime-sawdust mixture: the lime was intended to absorb moisture as well as create an alkaline environment to stem decay.) Modern insulations, such as fibreglass, are particularly sensitive to moisture, and lose their capacity to insulate when moist.

Protecting the inner cavity from vapour intrusion from the exterior is a critical matter, and any applicant intending to build with cordwood must present a means to mitigate this intrusion. Possible solutions to consider include application of a waterproofing or damp-proofing agent, such as that used to damp-proof foundation walls, in the inside of the exterior layer of mortar. (Theoretically, site-applied spray foam would work, but given that cordwood must be built in multiple stages, this is almost certainly time- and cost-prohibitive.)

Issue: to seal or not

While the cordwood is not kiln-dried, and thus will retain some of the natural antifungal agents contained in the tree sap, all wood will decay over time if not protected. One of the perpetual discussions in cordwood building revolves around the wisdom of sealing the exterior ends of cordwood sections. Rob Roy, considered one of the experts in this field (see resources at end) [does not advocate for sealing in general](#), but does acknowledge the requirement in some situations. Cordwood construction experts advise use of softwood. Use of woods known to be decay resistant (cedar) can presumably be of benefit in resisting decay.

Possible sealants include organic products like linseed oil to lacquers.

Obstacle: vapour barrier

All buildings require a vapour barrier to separate the conditioned (heated) space from the exterior elements. This means all walls, floors and ceilings. [9.25.1.1(2)(ii).] As it stands, classic cordwood techniques do not address vapour barrier. If the homeowner intends on layering a vapour barrier on the inside, and covering the cordwood wall with another material, then there are no issues. However, this is rarely the case.

There are options, but they are problematic. The first is to incorporate the vapour barrier into the assembly during construction, and sealing it around the logs where they penetrate the interior mortar (which would be a stupendously time-consuming task). Another potential solution is to apply a waterproofing membrane to the inside of the interior mortar wall that meets the requirements of clause 9.25.4.2 of the Code. Alternatively, an application of site-applied closed-cell foam would also meet the requirement for vapour barrier. As with exterior protections, an application of varnish on the interior may satisfy the building official as an alternative solution - and it's the most feasible approach.

Obstacle: foundations

Like any other structure, a cordwood home is going to require a foundation. Given the weight of wood and mortar, this means that the stem walls will have to be either as thick as the intended walls (often 16"). This is double the amount of concrete normally used in a stem wall.

Links:

<https://cordwoodconstruction.org/>

<https://www.cordwoodmasonry.com/>

<https://accidentalhippies.com/2017/01/08/cordwood-rot/>

Cob/Earthbag construction



A cob wall under construction. (Mouse over for Creative Commons attribution.)

Earthbag construction involves packing sacks of some nature with earth, much like sandbags, then stacking these bags in offsetting layers. Typically, earthbag structures are rounded, with the walls slowly converging into a dome of some nature. The intent is to use the same general physics as gothic arches, so that forces at the top of the dome are spread evenly to the base. Earthbag structures build in more affluent areas have also relied on rebar penetrating layers to provide support. From a construction standpoint, the process is quick as well as inexpensive, and requires minimal specialized skill.

Cob is an ancient system where a blend of thick mud and straw is shaped into wall systems and left to dry. The end result is a monolithic wall system. It requires little special skill.

Obstacle: Engineered design required

These two techniques are sufficiently similar that they can be treated the same – and not with favour, at least from the view of building Code. Earthbag/Cob structures can only be constructed if they are designed in accordance to the directives of a Professional Engineer authorized to perform work in New Brunswick. That will only deal with the structural issues. Typically, earthbag or cob homes are built on ground without foundation: an engineer will have to address this as well. Likewise, window and door openings must be designed to handle the loads. Unless the building is seasonal in nature it will still have to have insulation, vapour barrier and other elements, or something that will perform the same function. Cob homes are particularly vulnerable to moisture and rain, but they have been built – successfully in rainy climates.

Earthships:



An Earthship. Wikimedia commons photo.

Earthships are usually built by ramming earth into stacked tires as load-bearing elements of a wall. In many cases, they are also partly set into earth. While fundamentally similar to cob or earthbag, it's best to treat them separately due to their cachet within the alternate building community. They are complex, environmentally questionable (due to the use of hundreds of tires) and labour-

intensive. The complexity makes the project one that requires some degree of specialized skill to tackle.

Critical obstacle: engineered design required

Any Earthship structure will have to be engineered, as it cannot be safely rated for load-bearing by prescriptive measures (ie: by meeting specific requirements of Code) unless there is some degree of post-and-beam superstructure where the rammed-earth tires are merely infill providing thermal mass.

A key ideological element of Earthships is that they provide thermal mass from earth as a temperature-mitigation measure. Earthships originated in the southern U.S., in particular, Arizona and New Mexico where they were intentionally designed to be built into earth mounds. In these climates, the earth – which naturally has a temperature of 10-15 degrees C – provides a cooling effect when compared to much higher temperatures outside. That's well and good for Arizona, perhaps, but the concept is not well-suited for Canada, because of the need to insulate the home from the surrounding earth – that includes the floor as well. Once insulation exists, the thermal mass effect is lost, essentially eliminating one of the primary reasons for the Earthship construction in the first place. There is a [very good article on this at a sustainable building website](#) that explains this.

Rammed earth

Rammed earth is a rare technique that involves a blend of clean, sandy soil with minimal clay and minimal organics mixed with Portland cement, and compacted between forms. The end result is a cementitious (rock-like) wall that is essentially monolithic (one piece), exceptionally strong, and quite attractive. Generally speaking, in order to achieve the density and load-bearing capacity required, specialized equipment is needed, meaning rammed earth is not likely a do-it-yourself project.

Obstacle: Engineer's approval required

A professional engineer must design plans for the building to ensure the structure can bear the required loads. As part of the design, the engineer will also have to provide assurance that the exterior wall will not be adversely affected by moisture or moisture intrusion and ensure moisture does not penetrate to the interior. The engineer will likely have to design the foundation system.

Minor obstacle: Insulation

The normal solution to required insulation is to sandwich closed-cell foam between two legs of rammed-earth wall. This generally means the walls are thicker (hence one of the reasons why foundations need to be more robust.) The foam serves as a

vapour barrier and moisture barrier. This will almost certainly be addressed in the engineered design.

More online:

<https://www.yourhome.gov.au/materials/rammed-earth>

<https://www.archdaily.com/933353/how-rammed-earth-walls-are-built>

Strawbale construction



Volunteers help construct a straw bale home in Craik, SK.

Strawbale houses use bales of straw as a fundamental insulation material and structural block for walls of a structure. The intent is that the air entrapped between straw provides insulation value. (The reported R-value of straw is between about 1

and as much as R2.75, depending on installation techniques, the straw used, and the like.) While these originated in the U.S. prairie states, they have been built in Canadian climates (especially Saskatchewan) with some success. In southwest New Brunswick, access to dry straw may be problematic. On the plus side, construction is relatively quick compared to other non-traditional methods: The straw of a fairly large house might well be set in place during a weekend, for example. The techniques are not out of the realm for a suitably informed do-it-yourselfer.

Obstacle: infill or engineer required

In most cases, the straw bales will be used as infill around an existing post-and-beam construction. Any intent to use the straw as a load-bearing member will require certification from an engineer permitted to perform work in the province.

Obstacle: Water intrusion

The typical approach to straw bale is to use natural plasters, or lime plasters, to seal interior and exterior sections of the straw. However, Code does not allow for direct application of plasters to the exterior of a structure without a second plane of protection (housewrap) and a drainage plane (a 1 cm air gap) behind the plaster. In other words, the ends of the straw can be sealed using a traditional plaster, but the exterior will still require a traditional cladding system of some nature – even if that system is a second plaster wall constructed with the required housewrap and capillary break. Given the requirements for exterior and interior finish, a straw-bale home is essentially a post-and-beam construction with a natural rather than synthetic insulation. There are contractors who disagree with this approach, and there is some evidence that suggests sealing the straw in this manner is actually harmful. The reader is advised to research this challenge and be prepared to present evidence that any deviation from Code-required practices in similar climactic conditions has met the intent of code (alternate solutions submittal.)

Obstacle: vapour barrier

All buildings require a vapour barrier to separate the conditioned (heated) space from the exterior elements. This means all walls, floors and ceilings. [9.25.1.1(2)(ii).] A plaster – even a traditional (earth plaster or other) plaster – can be applied on the exterior of a straw bale home, but unless an alternate solutions request is filed, it must be separated from the straw by a Code-compliant vapour barrier (plastic.) However, this would require something like a metal or plastic lath to be attached over top of the straw – which negates one of the reasons for applying plaster to the straw itself: sealing the open ends of the straw while also making use of a viable bonding surface. As with the exterior, a client wishing to forego interior vapour barrier must present an alternate solutions proposal showing how the intent of the Code will otherwise be met.

Online resources:

<https://buildersontario.com/straw-bale-home-construction>

<https://www.buildingwithawareness.com/the-pros-and-cons-of-straw-bale-wall-construction-in-green-building/>

Slipform masonry



A slipform masonry structure in mid-construction. (mouse-over for Creative Commons attribution.)

This technique, popularized by Scott and Helen Nearing, involves setting rocks into concrete in layers to form an exterior load-bearing wall. Forms on both sides hold the rocks and concrete in place; the exterior form is removed the day after setting to allow the builder to chisel out fresh (green) concrete, and then the forms are "lifted" atop the existing wall to allow creation of the next layer. The gaps are later "pointed" with mortar. Slipform homes are fairly labour-intensive, and somewhat slow to build, but apart from some planning do not require extensive specialized skill. The interior will need insulation and walls for finish, which is more traditional, but nonetheless simpler than other non-traditional building systems. The foundations for a slipform masonry wall must be designed with the extra loads in mind. However, these can be specified under Part 9 of the Code, as the loads are essentially identical to brick or ICF (insulated Concrete Form) construction (depending on wall thickness)

Challenge: Window/door openings

The openings in slipform masonry walls must be built to handle the loads above them. There are ways to do this, such as extra rebar, metal lintels, or other mechanisms. While most of the openings can be handled with angle-iron lintels, wide openings may require engineer's approval or evidence that a construction technique meets the intent of Code (what's called an "alternate solutions" submittal.)

Potential obstacle: Water intrusion

Unless the roof overhangs are designed to significantly reduce rain, the stone/concrete alone will not completely block all water penetrating to the other side of the wall: mortar and concrete will allow water permeation. The simplest way to address this is the application of a waterproofing or damp-proofing agent, such as that used to damp-proof foundation walls, on the interior. Alternately, the application of site-applied closed-cell foam as part of the interior insulation system would create a monolithic element to block moisture penetration. Another concept is the creation of a capillary break – that is, an air gap – between the exterior wall and any interior structures.

Links:

<https://www.motherearthnews.com/diy/stone-masonry-primer-zmaz96djzgoe>

http://www.hollowtop.com/cls_html/Good_Life_Center.htm

Modified slipform masonry



The critical difference between slipform and modified slipform masonry is that the stones are set by hand using traditional masonry techniques.

SNBSC staff photo

Modified slipform masonry is like slipform masonry, except only the interior side of the wall is framed with forms. The front is created using traditional stonemasonry techniques, and only once a layer of stone is set in standard type S mortar is concrete used to fill the remaining gap behind the stone. As a result, the general

load-bearing and compressive strength of the wall is increased. (Mortar is 2000 psi, cement is 3000 psi.) However, because the primary face of the wall is stone set in Type S mortar, modified slipform is quite close to a traditional masonry build, and in many ways, can be treated as such. For example, the NBC outlines measures for masonry (brick) and stonemasonry construction. Given that, a modified slipform home can meet requirements for framing/supporting loads over openings like doors and windows by following code-established principles (a precast lintel, a metal L-plate, or an arch).

In all other regards, the considerations are the same as for slipform masonry construction, with a particular emphasis on preventing moisture penetration, as the use of mortar will make the wall more water-permeable. It is, however, an exceptionally slow, labour-intensive technique. It requires some degree of specialized skill

Shipping containers



A shipping container building. Published under the Creative Commons licence for non-commercial use.

When delivered, shipping containers are incredibly strong, pre-built metal boxes. They have been repurposed successfully, as residential and commercial structures in a number of jurisdictions. Indeed, in some urban settings, shipping container structures have helped define a certain urban architectural feeling. Usually, shipping containers are combined with others to create a final product. The exterior is essentially a waterproof single-layer cladding, so there is no need for exterior cladding or housewrap. Construction can be relatively rapid, even when compared to traditional building techniques. Some elements of interior work can be done by a hobbyist, but there will be steel-work and welding that is best left to a professional or a suitably skilled do-it-yourselfer.

Obstacle: Engineer required

Like many non-standard techniques, an engineer has to design and approve a set of plans for the final building. This is because containers are invariably modified by cutting holes for windows and doors, which alters the structural integrity of the container, and an engineer must certify the modified design meets all local requirements for load-bearing capacity.

Decision: insulate in or out?

When considering shipping container construction, a key issue must be addressed almost at the outset: will the metal of the container be the interior wall/floor/ceiling or the exterior?

If the metal is to be the exterior wall, then the interior will require infill framing, insulation and vapour barrier. This can present a problem of thermal bridging. Consider a building constructed of two containers laid side-by-side and joined, with the ends of each forming opposing walls. These walls need to be insulated, but if the walls adjoining the two units are left uninsulated, then the metal walls will provide an uninhibited conduit to the outside. This has to be addressed, but the challenge isn't prohibitive.

If the metal is to be the interior wall, then the containers must be isolated from the environment by insulation, cladding and – depending on the cladding – a housewrap.

Link:

<https://www.discovercontainers.com/what-i-wish-id-known-before-building-my-shipping-container-home/>

Yurts/Glamping Domes



A yurt on Vancouver Island. Phil Whitehouse photo, used under the Creative Commons licence.

Yurts – which are essentially robust, large tent-like structures with (usually) round footprints – also have a certain cachet in the alternate build community, in large part because they are often sold as complete assemble-yourself kits. They can be quite spacious and efficient structures, but unless they are less than 625 square feet, they fall into the realm of building Code.

Glamping domes have become quite popular of late, but these are mostly being considered in a commercial camping setting. As such, regardless of size, a glamping dome is NOT exempt from the Code (because it is being used for public congregation). If being used for personal use, the issues for these are the same as a yurt.

If considering a yurt/dome, it is vital to obtain certification from the manufacturer that the yurt will meet the snow load and insulation requirements of the area it is to be set. Another issue is flammability: the fabric must meet Canadian flame-spread limits.

It should also be noted that the yurt/dome will still require some kind of foundation, although the nature of the structures are such that they are commonly placed on a platform supported by piers. A reasonably informed do-it-yourselfer can assemble a yurt. Domes may require more specialized skill.

Hempcrete (blocks)

In the latter part of 2021, our office became aware of a company out of Alberta that has invested considerable time and energy into a hempcrete block system. It is notable that unlike many U.S. based hemp-block firms, the Alberta manufacturer has invested the time and money to have its product subjected to some certified testing, including testing that verifies the blocks (as finished) meet minimum standards for vapour permeance. At this time, it seems this product can be used in Canadian situations. We will update this section as more information becomes available - unfortunately, the company has not provided us any information, despite several requests.

Tiny homes (on wheels)

Tiny homes have been popular for some time. They are compact residential dwellings, and usually built on wheels. There's a reason for that: things on wheels aren't usually considered buildings or structures from the eyes of Code – they're trailers. Throughout North America, tiny homes on wheels have been used as a way to circumvent building Codes and pesky inspectors. The same holds true in this region: any mobile structure is exempt from building codes (although not exempt from zoning regulations.) From that point of view, there are no restrictions on tiny homes (on wheels) as long as they remain mobile. Any activity that prevents the tiny home from being mobile, like connecting it permanently to a sewage system, water supply system or electrical system may cause it to be considered a structure. (A garden hose is not a permanent water supply, nor is a plug a permanent power connection.)

A number of municipalities have zoning regulations that prohibit use of tiny homes on wheels.