EMERGENT PERMITTING STRATEGIES FOR NATURAL BUILDING SYSTEMS IN ONTARIO

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INTRODUCTION

Lowering the carbon intensity of the built environment is one of many tasks that must be undertaken in order to address climate change and to encourage sustainability. The siting, design, construction, occupancy, renovation, and disposal of single-family homes are all factors that contribute to the large carbon emissions generated by the sector. There are numerous strategies that seek to minimize the amount of emissions generated by a house during its lifecycle. This paper explores the use of so-called natural building systems in building envelope construction.

Though not the silver bullet for the home industry, natural building systems are an underexplored—and underexploited—approach to home construction in Ontario. This paper will explore the barriers that this building typology faces in Ontario as well as emergent strategies for overcoming these barriers. It will be shown that within the Ontario Building Code there are numerous opportunities to make the permitting process less costly and more predictable (e.g., fewer delays). These barriers need to be eliminated if natural building systems are to emerge as a relevant strategy for lowering the carbon emissions of the residential sector.

KEYWORDS

Ontario Building Code, alternative solutions, natural building systems, home construction, permit

NATURAL BUILDING SYSTEMS

A 2002 Canada Mortgage and Housing Corporation (CMHC) report defines natural buildings systems as the use of "indigenous, recyclable, low cost materials that are less damaging to the environment" (CMHC, 2002). For the purposes of this paper, natural building systems include these four building envelope assemblies: load bearing rammed earth tires; non-load-bearing straw bales; structural lightweight insulated cob; and straw light clay.

Rammed earth tires (Figure 1) are repurposed automobile tires that are rammed with earth and stacked like bricks in order to produce thermally massive, load bearing exterior walls. The tires are filled by hand using sledgehammers or a pneumatic ram and often use earth found on the building site. Concrete buttresses, steel reinforcement, and a concrete top plate add stability to the assembly.

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Non-load-bearing straw bale walls (also known as straw-bale infill) use timber-framed 'Larsen trusses' to hold stacked and cable-tensioned straw bales. These bales are often available locally and provide insulation values suitable to Ontario's cold climate. Lime plaster or cement stucco is used to weatherproof the exterior face of the wall, while a variety of finishing methods can be used on the interior.

Structural lightweight insulated cob is a load-bearing mix of 30% clay, 30% sand, 30% pumice, and 10% straw, that is mixed with water and dries like concrete (Eco-sense, 2011). Victoria, B.C., natural builders Eco-sense tested their mix and found a compressive strength of 1.25 MPa and an R-value of 1.0 per inch (Eco-sense, 2011). Figure 2 shows an un-plastered cob wall with fieldstone used to cover an on-grade 'earthbag' foundation.

Straw light clay (also known as slip-straw) is a mixture of clay slurry with straw that is packed into building cavities and used as insulation. Applied wet with the use of forms, straw light clay dries to a hard consistency with realistic R values of 1.6 per inch (CMHC, 2005). Figure 3 shows un-plastered straw light clay above a lintel. Depending on conditions, straw light clay can dry within 24 hours and can be finished traditionally or covered with a variety of natural plasters. The forms are removed immediately.

A predominate feature of these natural building systems is that they strive to reduce the amount of embodied energy in the materials without sacrificing structural or thermal performance. Eisenberg (2005) writes that natural builders try to reverse the trend whereby "industrial building replaces labour intensity with resource intensity" (Eisenberg, 2005, p. 23). Reducing the use of concrete and foam are major preoccupations of proponents of these systems; as is the reduction of structural timber, though this is widely debated. Whatever the motivation, these alternative envelope strategies must be explored as humanity veers ever closer to runaway climate change and resource depletion.

FIGURE 1. Rammed earth tires. The pop-can wall comes from Michael Reynold's 'Earthship' design.

FIGURE 2. Un-plastered cob wall with fieldstone used to cover an on-grade 'earthbag' foundation.

FIGURE 3. Un-plastered straw light clay above a lintel.

THE OPPORTUNITY

Objective-based codes (described in detail in the next section) have created more room for natural buildings systems. The National Research Council of Canada (NRCC) points out that because of these codes "building officials have a clearer picture of what must be assessed and proponents have a better understanding of what is expected of the alternative solution earlier in the design process" (National Research Council Canada, 2010). However, the NRCC also points out that "experience in other countries has indicated that there is not likely to be a dramatic increase in the number of alternative solutions submitted; most people continue to follow the prescriptive solutions" (National Research Council Canada, 2010).

What this means is that the code itself is not going to lead to more mainstream use of natural building systems. This paper will show that in order for this to happen, numerous action items need to be executed. These action items are diverse, expensive, and are generally poorly understood. They arise from the opportunities presented by the objective-based code and need to be addressed if this lucrative sustainability tool is to realize its potential.

THE 2006 ONTARIO BUILDING CODE

The Ontario Building Code (OBC) governs the construction of all buildings in Ontario over 108 square feet (Ministry of Municipal Housing and Affairs [MMHA], 2006). Prior to 2006 it contained only prescriptive codes; namely, the building code prescribed the use of specific acceptable systems, assemblies, and/or materials. These prescriptions are now called *acceptable solutions.* In 2006 the OBC was released in an 'objective based format.' Though there are still thousands of pages of prescriptions (e.g., the thickness of exterior stucco), the code also contains *objectives* and *functional statements* which "identify the areas of performance where equivalence must be demonstrated" (Canadian Commission on Building and Fire Codes [CCBFC], 2005, p. x). The use of nails to secure sheathing, for example, would have at least one objective and one functional statement associated with it which qualitatively mandates the performance level that anything seeking to replace it (e.g., glue) must demonstrate.[1]

The introduction to the National Building Code of Canada (NBC) justifies this: "to do something different from the acceptable solutions . . . a builder, designer, or building owner must show that their proposed alternative solution will perform at least as well as the acceptable solution(s) that it is replacing" (CCBFC, 2005, p. x). This shows both that the OBC is systemically capable of permitting merited alternatives and also suggests the procedure by which alternatives become accepted.[2]

ALTERNATIVE SOLUTIONS

The purpose of this section is to explore the process by which natural building methods (i.e., alternative solutions) are permitted for use in new home construction. In doing so a number of strategies for streamlining the process will emerge.[3]

As is the case with all legal documents, definitions are very important in the OBC. Two important definitions are:

> *"Acceptable solution* means a requirement stated in Parts 3 to 12 of Division B"
> "*Alternative solution* means a substitute for an *acceptable solution*"
>
> (MMHA, 2006, p. A1-6)

In order for a natural building method (i.e., an alternative solution) to be permitted for use, it must prove that it is a safe and appropriate substitute for the accepted solution it seeks to replace. The process by which this proof is generated is outlined in Div C 2.1.1.1:

> *Div C 2.1.1.1. Documentation of Alternative Solutions*
> *(1) The person proposing the use of an alternative solution shall provide documentation to the chief building official or registered code agency that,*
> *(a) identifies applicable objectives, functional statements and acceptable solutions, and*
> *(b) establishes on the basis of past performance, tests described in Article 2.1.1.2. or other evaluation that the proposed alternative solution will achieve the level of performance required under Article 1.2.1.1. of Division A*
>
> (MMHA, 2006, p. C2-3)

So, the first step involves identifying the relevant acceptable solutions and their corresponding objectives and functional statements. Next, it must be proved that the performance of the alternative solution satisfies these requirements. This can be done using "past performance, tests described in Article 2.1.1.2, or other evaluation" (MMHA, 2006, p. C2-3). An important point to make here is that the methods by which performance can be proven vary. The inclusion of the word "or" means that the Chief Building Official (CBO) (or a Registered Code Agency) have some discretion as to the amount of data required for a successful permit application.[4]

Past performance, tests, and 'other evaluations' each call forth imminent action items that, if accomplished, will lead to a more effective permitting process for natural buildings. These action items will be explored in the following sections.

TESTS

As pointed out in Div C 2.1.1.1 (1) (b), tests are one way that a proposed alternative solution (e.g., straw-bale infill) can substitute for an accepted solution. These tests are carried out in numerous venues, including universities and government agencies. The Canadian Mortgage and Housing Corporation (CMHC) is a major source of literature investigating alternative solutions. For example, a 2005 report entitled *Initial Material Characterization of Straw Light Clay* strives to satisfy Div C 2.1.1.1. (b) and thus enable the use of straw light clay (CMHC, 2005).

Research of this nature is important because it helps to establish a literature base for alternatives that is rooted in science, and also because it creates precedents which can (ideally) be used by officials, designers, and/or builders in future projects.[5] But it is also costly, especially

when carried out by owner-builders or by small to medium natural building businesses. These costs become especially burdensome if they are redundant due to the fact that similar tests have been carried out in other jurisdictions with the same materials.

Other sources of information at a CBO's disposal include the Canadian Construction Materials Centre (CCMC), Building Materials Evaluation Commission (BMEC), and Ontario Building Code Commission (BCC) rulings (see Appendix for definitions of each of these agencies). These agencies are authorized to prove performance equivalence of alternative solutions. However, as a 2002 CMHC report points out: "many municipalities may require the involvement of a design professional (architect or engineer) to approve the building even if the CCMC evaluation numbers are available" (Sun Ridge Group, 2002, p. 12). It becomes easy to agree with Eisenberg (2005) that "performance codes . . . increase the burden on the designer, building official, and, frequently, the owner" (Eisenberg, 2005, p. 22).

Again, it is important to note that the author supports the involvement of design professionals, as long as their involvement is crucial. The case is made in natural building circles that CBO's require participation of engineers and architects by default, despite compelling evidence of performance in other jurisdictions. Eisenberg (2005) offers a possible explanation for this: "despite their best efforts, code authorities remain responsive to and strongly influenced by the building industry" (Eisenberg, 2005, p. 26). Other explanations include that the nature of the OBC bureaucracy prevents proof from one jurisdiction from being used in another; or that the liability issues impinging on CBOs make it risky for them to take a chance on natural materials.[6]

Whatever the explanation, an important goal of this work is the elimination of the redundant involvement of engineers and architects as well as the elimination of redundant tests. Both of these precipitate serious financial (project costs) and logistical (project timeline) barriers that need to be eliminated if natural building is to capture its due market share.

The CMHC points out that the target market for natural buildings are "owner/builders who want the satisfaction of building a home using indigenous, recyclable, low cost materials that are less damaging to the environment" (CMHC, 2002). This group is especially vulnerable to excessive project costs and all the more in need of a streamlined and standardized permitting system for their important projects. An example of this is found in the case of the Seigel/Cochrane residence; a load bearing straw bale structure with exterior lime plaster.

During an appeal for a denied permit application, the Building Code Commission made a 'request for more information' before it would approve the alternative. This request resulted in a 12 page report authored by engineering firm *Building Alternatives Inc.* which addressed the two solicited issues of moisture/air management and the "load-carrying capacity of load-bearing strawbale walls" (Building Alternatives Inc., 2002, p. 1). The report was paid for by the owner, and though laborious and expensive, did result in a building permit for a load-bearing bale house with exterior lime plaster. The purpose of this paper is to explore less costly and more accessible ways for permit applicants to prove the performance of their alternative solutions.

PAST PERFORMANCE

A question that is begged by the previous section is: what role do previously permitted alternative solutions play in decreasing the burden of proof on future applications? The simple answer is that it varies across jurisdictions and that previous successes are largely underleveraged. Though Div C 2.1.1.1.(1) (b) states that past performance can serve to permit the use

of an alternative solution, the decision resides with the CBO (or registered code agency) as to whether or not past performance of an identical assembly is sufficient proof. According to many in the natural building world, this is rarely the case.[7]

To this end the most urgent action item is the creation of provincial and national registries of accepted alternatives. This would give those in charge of permitting alternative solutions access to information that would make their decision making process easier. A 2007 Ontario Building Officials Association training manual highlights this need: "no national, provincial or territorial registry of accepted alternative solutions exists as of July 2007. [Though] a Principle Authority may have a database of previously accepted equivalents and alternative solutions" (Thorton, 2010).[8]

The compilation of this data would lead to a more streamlined permitting process which would drive project costs down and increase predictability of project timelines; both of which would lead to more and better projects. Another benefit of the registry approach is that it could lead to increased standardization of designs and construction across the province and the country. This would lead to increased testability of the building stock, assuming that these designs performed as well as the accepted solution for which they were substituted.

The Ontario Straw Bale Building Coalition (OSBBC) is the most important trade organization for alternative construction in Ontario and consists of builders, designers, engineers, owners, and enthusiasts. With over 1,000 members, the OSBBC community has been involved in many of the alternative construction projects in Ontario. As such they are in an important position to assist in the creation of provincial and national registries. Their recently created building registry (http://registry.osbbc.ca/) is a compilation of projects that could prove to be crucial should the code agencies embark on the creation of project registries.[9] The OSBBC is also an important site for research, whether conducted or compiled by members. Because of this, it stands as a major force in Ontario pushing for the strategies that have been described thus far.[10]

OTHER EVALUATIONS

The last of the three strategies by which an alternative solution can prove equivalence is through so-called "other evaluations" (MMHA, 2006, p. C2-3). A 2007 OBOA training manual lists the following as acceptable "other evaluations"

- *Evaluation of Scenarios*
- *Engineering Analysis and Mathematical Modeling*
- *Computer Modeling*
- *Previous Approvals by Other Person Having Jurisdiction*
- *Manufacturer's Information*
- *Published Standards Not Referenced in the Code*
- *Research Papers*
- *Code Analysis*
- *Risk Analysis; Performance Assessment Methods (peer review)* (Thorton, 2010)

It is important to note that each of these on their own could be used to prove acceptability; or all of them could be required (Thorton, 2010). This is one of the reasons why the permit process differs across jurisdictions. Now, though an architect or engineer can circumvent this

process by 'stamping' a design (thus assuming liability for its performance), it is important to prove acceptability using the process—onerous as it is—made possible by the objective-based codes. As Thorton (2010) points out: "if we don't use it, we could lose it" (Thorton, 2010).

The final strategy to explore is presented in the 2006 Building Code Act (BCA). Beyond emphasizing the variable burden of proof, Section 9 of the BCA shows that a registered code agency (RCA) can have the same permitting power as a CBO:

> *Section 9. Equivalent materials, etc.*
> *(1) The chief building official or a registered code agency may allow the use of materials, systems and building designs that are not authorized in the building code if, in the opinion of the chief building official or registered code agency, the proposed materials, systems and building designs will achieve the level of performance required by the building code.* 2002, c. 9, s. 15.
>
> (MMHA, 2006, p. 18)

Heal (2007) explains the role of an RCA: "the new BCA allows municipalities to outsource plan review and construction inspection functions to Registered Code Agencies" (Heal, 2007, p. 3). In other words, an RCA could be created which specializes in alternative construction and has at its disposal the tests, proof of past performance, and/or 'other evaluations' necessary to successfully permit-worthy applications. Those involved in the RCA (likely experienced natural builders, designers, engineers, and architects) could be hired by CBO to carry out reviews and inspections of alternative construction projects. It becomes clear quickly that the creation of an RCA that specializes in natural building systems is an important emergent strategy for those interested in streamlining the permitting process.

CONCLUSION

The introduction of objective-based codes in Ontario's 2006 code, as well as the introduction of the International Green Construction Code (IGCC) in 2010 are more than ostensibly progressive steps. They indicate that the system is willing, and increasingly *able*, to accommodate change. The 2006 code is, by and large, seen as a progressive step while the prescriptive codes were seen to "limit variation and impede innovation" (Eisenberg, 2005, p. 22). There is even a certain humility that the NBC alludes to when insisting that "a code cannot describe all possible valid design and construction options" (CCBFC, 2005, p. x).

Along these encouraging lines, experienced architect Martin Liefhebber says "things are easier now; officials are more willing to entertain the really green stuff. In fact they are excited by it" (Liefhebber, 2010). Leveraging of existing successful and permitted buildings, along with implementing the strategies discussed in this paper, is sure to increase the excitement and legitimacy surrounding the four natural building systems described in this paper.

Granted, there are numerous challenges faced by natural builders that have not been mentioned in this paper along with stigmas to overcome and modern ascetic norms to appease. The purpose of this paper is to show that there are numerous barriers that exist only because the work has not been undertaken to eliminate them. Perhaps those most affected by these barriers are unable to address them, busy as they are carving out a living as Ontario's first wave of natural builders. This paper is one small step in the collective effort to enable legitimate natural building systems to flourish in Ontario, in Canada, and beyond.

NOTES

1. There are 64 'Functional Statements' in the OBC; examples include: "To limit the severity and effects of fire or explosions; To support and withstand expected loads and forces" (MMHA, 2006, p. A3-3). There are 132 'Objectives' in the OBC which are separated into these 7 categories: Safety (OS); Health (OH); Accessibility (OA); Fire, Structure, Water and Sewage (OP); Resource Conservation (OR); Environmental Integrity (OE); and Conservation of Buildings (OC) (MMHA, 2006, p. A2-3). Examples include: "An objective of this Code is to limit the probability that, as a result of the design or construction of a building, a person in or adjacent to the building will be exposed to an unacceptable risk of injury due to structural failure" or "An objective of this Code is to limit the probability that, as a result of the design, construction or operation of a building, the natural environment will be exposed to an unacceptable risk of degradation (MMHA, 2006, p. A2-3).
2. To be clear, the OBC does not include as "acceptable solutions" any of the natural building systems mentioned in this paper.
3. The author is not making the point that the process is unduly onerous, nor that it should exempt natural building systems from its rigor. Rather the purpose is to show the process by which alternative solutions can come to be considered acceptable.
4. This begins to explain why some jurisdictions in Ontario are more lenient than others.
5. Moreover, research, as will be shown, is one of the "other evaluations" that can permit alternative solutions.
6. These questions are well suited for future research in this area.
7. Exact numbers on this are another key area for future research.
8. Another area of future research that would have a great impact on the state of green construction in Canada.
9. A similar resource is being developed for Earthship builders and enthusiasts at http://www.earthship.net/canada.
10. The recent creation of *The Natural Building Engineering Group* (NBEG) is striving to mobilize design professionals with natural building experience.

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APPENDIX

"The Canadian Construction Materials Centre (CCMC) offers a national evaluation service for all types of innovative building construction materials, products, systems and services. CCMC operates under the general policy and technical advice of the Canadian Commission on Construction Materials Evaluation." (National Research Council Canada, 2011)

"The Building Materials Evaluation Commission (BMEC) is a regulatory agency authorized under the *Building Code Act*. It has a mandate to conduct or authorize the examination of materials, systems and building designs for construction. When approving a material, system or building design, the BMEC may attach certain conditions for its use. The BMEC may also make recommendations to the Minister regarding changes to the BCA or Building Code." (Ministry of Municipal Housing and Affairs, 2011)

"The Ontario Building Code Commission (BCC) is an adjudicative tribunal, authorized under the Building Code Act. Its mandate is to resolve disputes concerning the sufficiency of compliance with the technical requirements of the Building Code, time period disputes for site inspections and time period disputes for processing permit applications. Parties to the BCC are typically builders, developers, architects, engineers, etc. as applicants and municipal plan reviewers, building inspectors, registered code agencies and health officials." (Ministry of Municipal Housing and Affairs, 2011)