Materials for Net Zero Carbon

Preface

North America reached a radical fork in the road with conventional construction technology only in very recent history, specifically in the post World War II era. The ongoing industrialization of the process of building accelerated in this period and manufacturing processes developed to create standardized, modular and synthetic building materials. The production efficiencies, energy efficiency and gains in the comfort of building occupants were significant relative to prewar techniques, which lead to a brief status quo.

This status quo was (arguably) interrupted with the energy crisis in the 1970's, which saw early (and somewhat limited) adoption of renewable energy technologies, as well as increased attention to design solutions such as passive solar site orientations and increased thermal efficiencies in building assemblies.

Our current era is one in which the "crisis" of the 1970's has metastasized into a wider "climate crisis." Many of the mitigation approaches that were nascent in the 1970's have matured to become widely adopted design practices. Existing and emerging responses are quickly becoming adopted within regulatory frameworks as multiple stakeholders seek to align with policy frameworks which address climate change.

Canada is widely recognized as a global leader in construction with one of the most robust regulatory frameworks, as well as having "one of the most advanced green building sectors in the world."
Where life cycle analysis, energy modelling and appropriate material selection were once seen as "best practices", these analytics are now becoming "required practices" industry wide. The recent development and subsequent roll-out of the **Zero Carbon Building Standard** by the **Canada Green Building Council** offers a framework for the Ashandawin Community Food Centre (ACFC) project to provide a leadership role in the demonstration of best practices in zero carbon construction projects.

The four key components of the Zero Carbon Building Standard are zero carbon balance, efficiency, renewable energy and low carbon materials. The ACFC project will address each of these components. The focus of this document is to describe specifically how we will lower embodied carbon in both the material selection, as well as processing methods of the materials specified for construction.

Natural materials (low processed, locally sourced and renewable) have been used for shelter throughout the history of our species on this planet by every culture on the planet. This historical relationship with the materials of our built environment has allowed our species to not only survive, but to culturally thrive in some of the most "inhospitable" environments on the planet. From arid deserts, to arctic tundra and all points in between, we have an intrinsic relationship with the materials most readily at hand.

This project will demonstrate the role that natural building materials can play in reducing embodied carbon in the built environment. History has demonstrated in regions around the globe that these materials are resilient, often lasting between 500-1000 years, thus increasing the amortization of the initial energy expense of construction. This is particularly significant for public buildings, which represent a significant capital expenditure.

Outlined below are methods to approaching material selection/processing which will reduce embodied carbon, as well as creating community engagement, economic development opportunities and a legacy building with a service life of 500 +/- years, leveraging every dollar invested severalfold.

1. Materials for Transformation

Saugeen First Nation has a history of transforming natural materials into shelter since time immemorial.

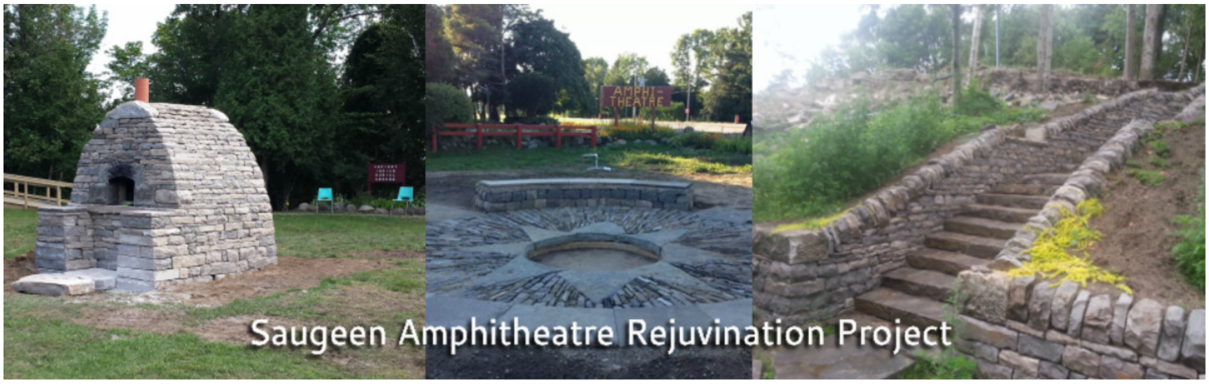

Figure 1.1.1

This project is being approached as a community initiative with "project stewards" which will come from both within Saugeen First Nations as well as the local non-member community.

Recent restoration of the dry laid stone masonry amphitheatre is a testament to the transformation of natural materials at a community level that is ongoing at Saugeen First Nation. Similar partnerships have been formed in this initiative, and this project will build on those successes.

Stone as well as wood, straw and clay will be the primary materials for this project.

This project will lead to opportunities for youth as well as elders, and those with a diversity of physical abilities and social conditions. From the basics of carpentry, to the skills of joinery, the inclusion of the community during the process of construction presents possibilities in a context which result in the manifestation of a built structure that will serve the community for many generations to come.

Figure 1.1.2

Figure 1.1.3

The fundamental enclosure system is a technique knows as "light straw clay." It consists of cellulosic aggregate (in this case straw) mixed with a clay slurry which coats and mineralizes the straw fibers as well as acts as a binder (Fig. 1.1.3). This is then formed into a structural matrix of dimensional lumber (Fig. 2.5.1). Lastly, this is plastered or rendered with earthen plaster which provides a very efficient air barrier and moisture control layer, as well as the wall finish (Fig. 1.1.4 and Fig. 1.1.5). The placing of the straw clay as well as the earthen plastering offer an opportunity for "many hands", as the techniques are labor intensive but relatively straightforward.

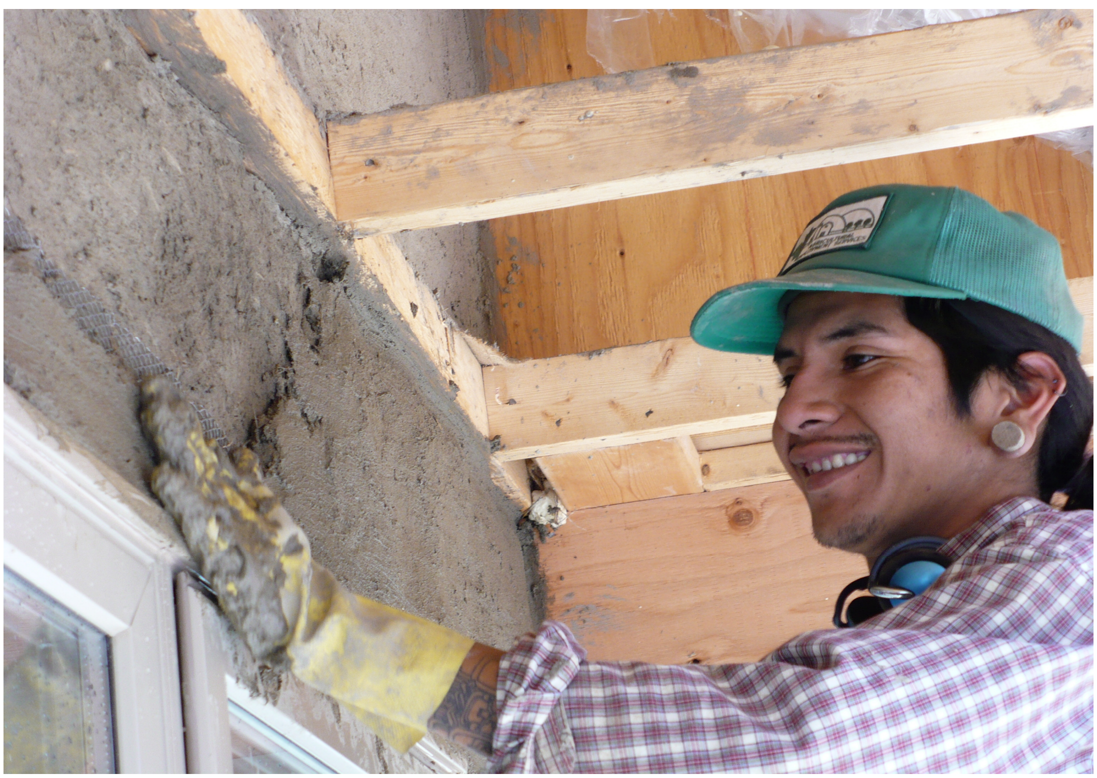

Figure 1.1.4

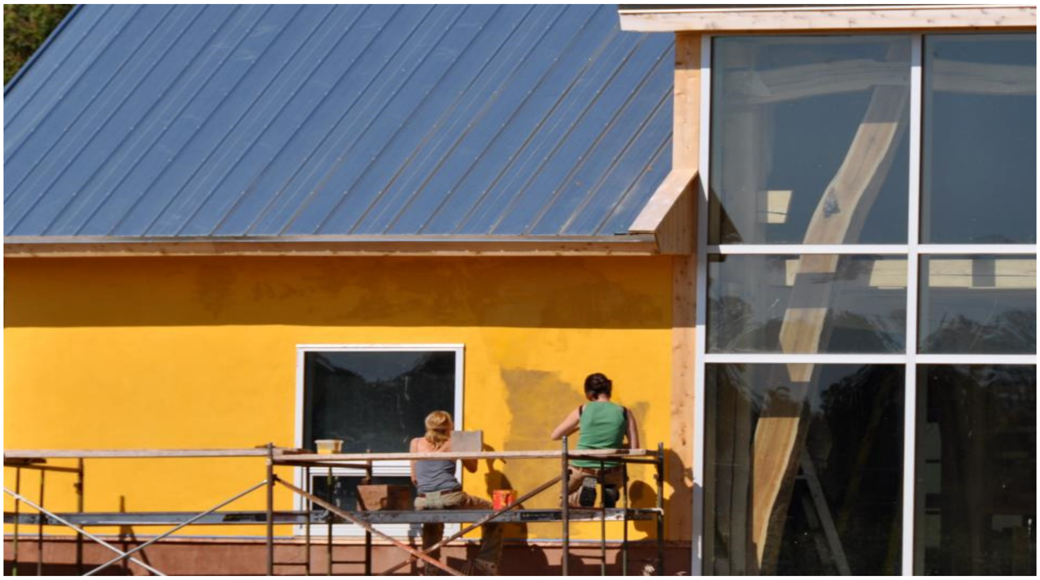

Figure 1.1.5

2. Materials for Harvest

Conventional construction techniques rely on heavily processed materials. The impacts of harvesting/mining, processing, shipping and utilizing contribute to the embodied carbon of a given material or process. This is the environmental impact. The economic impact of these activities is interlinked. Often it can be heard that environmental stewardship is incompatible with economic interests. This project will investigate opportunities for synergy and compatibility between the supply and processing of materials, as well as the stewardship of renewable materials.

On stewardship: the following wood products represent distinct layers of the forest. Working in tandem with lands management and forestry management guidance, the harvesting, management and processing of these materials could lead to economic, as well as environmental benefits.
For this project specifically, several forms of wood product can be used in a natural or very low processed form for this build.

2.1 Wattle (and Daub)

The first material use requirement is for wattle work. This material can be a wide range of species. Cedar saplings or any other flexible when green species can be suitable for building and can be harvested strategically for specific forest management goals. Forest thinning, allowing for more growth of higher value trees, is one approach to obtaining material. Coppicing is another approach, yielding renewable and abundant resources, with the former approach being adopted until such time as coppice stands are developed (usually within 5-7 years) (Fig. 2.1.1). These materials can be used for fencing (Fig. 2.1.2), as well as interior partitions and interior walls (with earthen plaster) (Fig. 2.1.3 and Fig 2.1.4).

Figure 2.1.1

Crews can learn to identify, harvest, manage and build with these materials in very short timeframes (2-day workshops per activity). These materials are often used right away with no further processing and can be gathered/harvested by hand. This work is particularly suited to youth and elders, at-risk youth, and individuals struggling with addictions or precarious housing. These communities are often marginalized economically by the supply chains or construction methodologies used in contemporary conventional construction. In contrast, materials such as wattle can be

Figure 2.1.2

gathered in bundles and left at forests edge for pick-up, and each bundle paid for by the work steward assigned to a particular location.

Figure 2.1.3

Figure 2.1.4

Many programs try to reach people by training for jobs in the workforce. While some are able to find success within this model, others are unable to adapt, leading to further frustration and social isolation. This program offers an opportunity for involvement and inclusion by offering work which can absorb the inconsistent/precarious engagement of people who are not in a position to commit to a standard work week. Furthermore, the work is leveraged severalfold, creating useable material, forest stewardship and health and well-being. This means that every dollar spent benefits the community threefold at the supply level, as well as puts money in the pockets of community members who are more likely to spend it at community businesses.

2.2 Pole Rafters

The second material use requirement is for pole rafters (Fig. 2.2.1). These range in length from 10'-21' and 6-10" at the butt. These are relatively straightforward to harvest and can be of many species. Poplar is good in certain applications and for hybrid poplar which has a lifespan of only about 40-50 years, these can be a renewable source. Larch is fantastic for its weathering capabilities: spruce, pine, fir and hemlock are all viable options as well. Developing a knowledge of the specific needs of the forest and integrating with knowledge of its use in building would help to reaffirm the life cycle awareness that supports and maintains traditional knowledge. These are used green and often require minimal processing which can be done efficiently with hand tools with two days of training. Note, the flattened top of rafters (achieved quickly with hand tools) in Fig. 2.2.1.

Figure 2.2.1

2.3 Live Edge

The third form of timber we use in our buildings are live edge pieces. These often range from 8" to 20" at the butt. These are used in structural applications and are processed with a bandsaw on two faces only. Forestry crews could be trained in a matter of days how to identify and select for these pieces. These pieces are the joined by hand into the timber frame, which is another level of training and economic development opportunity post harvest. The use of marginal timber structurally allows for more select structural material to stay in the bush for longer, while at the same time, harvesting can be integrated into a forest management strategy (Fig. 2.3.1, Fig. 2.3.2, Fig. 2.3.3).

Figure 2.3.1

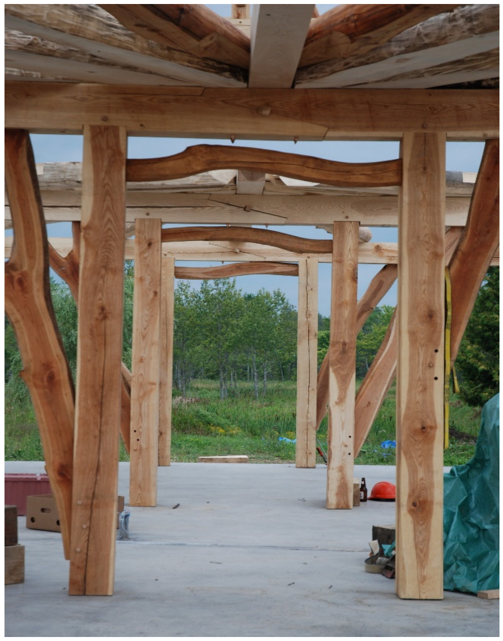

Figure 2.3.2

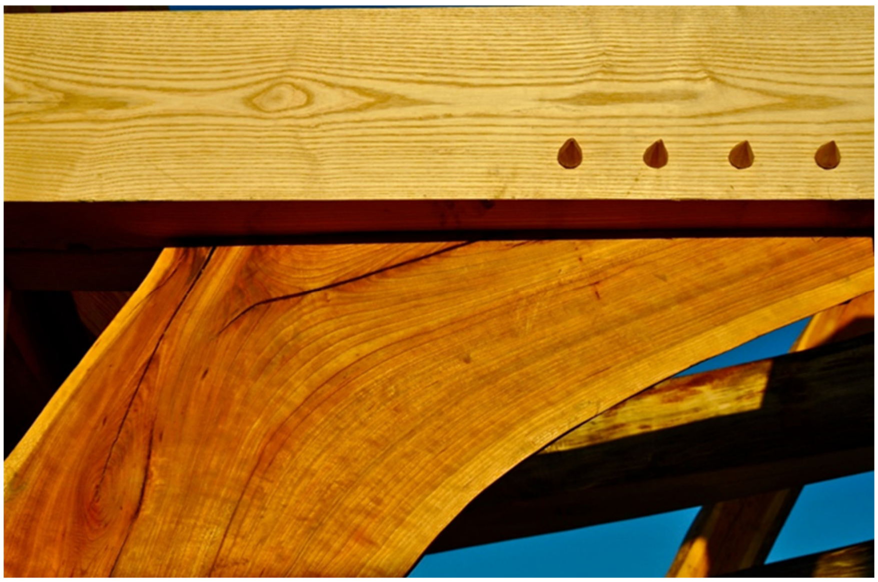

Figure 2.3.3

2.4 cladding

Our fourth material requirement for this project which can be locally sourced is live edge wood cladding (Fig. 2.4.1). A bandsaw mill can produce this product with minimal waste, and local processing. This results in a long-lasting natural cladding which can accommodate up to six people working at the mill during the processing time. Bark peeling, handling, loading and stacking are a few of the immediate requirements. The selection/harvesting of suitable materials is easily learned and will produce more local employment.

Figure 2.4.1

2.4 Structure

Wood will also be used structurally, both in the primary timber frame, as well as the matrix framing for our straw clay enclosure system.

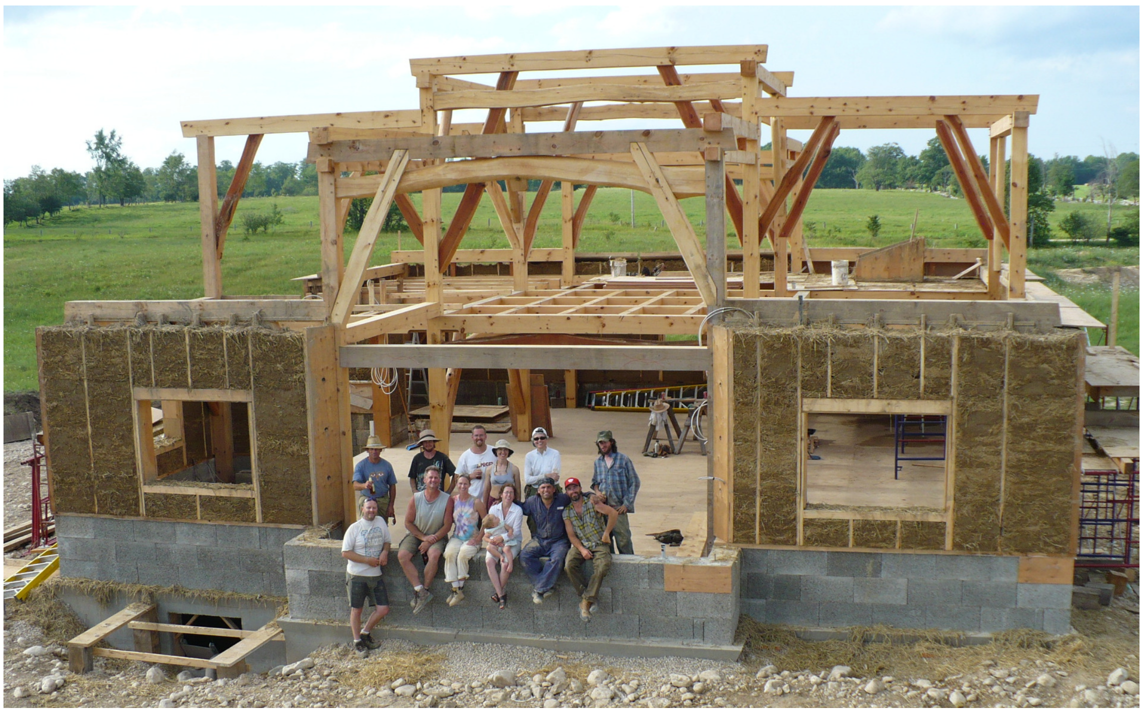

Figure 2.5.1

2.5 Trim

Finally, we will use local cherry on the interior for trim details and this will require milling, stickering, air drying, planning and utilization. Each of these stages can engage labour support throughout the stages of selection, harvesting, logistics, processing and use.

The financial viability of this project requires that these resources be processed locally, which in turn serves the net zero carbon goals of the build. It is absolutely essential that local labour is engaged throughout the process. Further, each and every opportunity presented here has the potential to also serve as a "scaffold" upon which to integrate traditional knowledge/language teachings. This has the effect of leveraging every dollar invested in this project several-fold.

3. Zero Carbon Building Initiative

Using the Zero Carbon Building Initiative for metrics and quantification, we intend to leverage all of our funding sources so that they have the most immediate and farthest-reaching impact. We will incorporate training opportunities, community engagement, and economic development opportunities into the actual process of construction of this centrepiece of community infrastructure. This is made uniquely possible through the use of these natural materials as described above. The net zero carbon standard is currently the only standard we are aware of which recognizes the impact of embodied energy. The materials and techniques described above address this, alongside the other key components of the Zero Carbon Building Standard (zero carbon balance, efficiency and renewable energy).