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INITIAL MATERIAL CHARACTERIZATION OF STRAW LIGHT CLAY

INTRODUCTION

North America has seen a steady growth of interest in natural building techniques over the past several decades. Many of these techniques and systems are contemporary adaptations of traditional methods, and Straw Light Clay (SLC) is no exception. SLC is a contemporary variant of earth building techniques used by advanced civilizations for thousands of years. SLC is prepared by coating a straw aggregate with a clay binder. This process creates a versatile, non-structural infill material with very low embodied energy. In most applications SLC is formed in situ, with some practitioners experimenting with pre-formed blocks.

A defining characteristic of current building practice is the requirement to adhere to building codes and standards. These codes are often based upon evidence gathered from laboratory analysis of materials characteristics. Therefore, placing natural building materials in a contemporary context requires testing to demonstrate basic material properties. A research program was undertaken as an initial step towards establishing the material properties for SLC. The research attempted to combine experiential and anecdotal evidence, as provided by builders and regional tradition, with established testing protocols. Research methodologies were developed with the assistance of Dr. John Straube of the University of Waterloo, where many of the laboratory tests were conducted.

RESEARCH PROGRAM

Research on SLC in North America is limited. The recent translation of the German text, *Earth Construction Handbook*, by Gernot Minke, and a number of papers published by Dr. John Straube of the University of Waterloo, provided the methodological framework for the research project.

The research set out to investigate the thermal resistance and moisture-related performance characteristics of SLC in order to assess the viability of this material for Canadian climates, and identify future research opportunities. Fire resistance, shrinkage and swelling, compression and bending, and density were also tested.

RESEARCH RESULTS

Based on the literature review and testing results, which are fully outlined in the research document, a number of conclusions are presented. Straw Light Clay has a very high vapour permeability rating (a low vapour diffusion resistance value), allowing this material to release moisture via vapour diffusion rapidly, thereby ensuring fast drying. This quality indicates that straw light clay, combined with earth or lime-based plasters, may play a significant role in balancing interior humidity levels. Although SLC has a very large moisture storage capacity, the application of a vapour diffusion retarder may compromise the ability of Straw Light Clay to release moisture rapidly and stay within the moisture storage capacity of SLC.

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The thermal conductivity ranged from 0.068 to 0.18 m^2K/w (0.8 to 2.1 hft^2F/Btu), per inch, with higher densities equating with lower insulating values. This range meets the minimum thermal resistance value prescribed by the Ontario Building Code. Thermal bridging in SLC wall assemblies is minimal, therefore the whole wall R-value calculation will be closer to the required R-value compared to "conventional" products. The research suggests that in regions with large diurnal temperature swings, the thermal mass of SLC is able to store heat during periods of high temperature, and then release this heat during cooler periods.

It should be noted that reaching target densities is challenging given the variability of materials and workmanship. A fair degree of experience with specific, local materials is required to consistently and predictably reach both lower and higher density ranges.
The mid-range density class is the most easily obtained. The table below highlights property results for a mid-range density sample.

Property	Density class	Results
Thermal Resistance (per inch)	647 kg/m^3 40 pcf	RSI = 0.28 R = 1.6
Thermal Conductivity (W/mK)	642 kg/m^3	0.090
Moisture Properties - Permeability (ng/Pa ms) - Permeance (ng/Pa m^2s) @ 10 cm (4 in) thickness - Absorption ($kg/m^2h^{0.5}$)	 Same as above Same Same	 45.9 451 3.4
Compression (at 5% strain)	680 kg/m^3 42.5 pcf	0.08 MPa 11.9 psi
Bending - Rupture Modulus - Modulus of Elasticity (compression)	 Same Same	 0.23 MPa 34 psi 1.36 MPa 200 psi
Settlement (after drying to equilibrium)	720-800 kg/m^3 45-50 pcf	7%
Fire Penetration (after 4 hrs of propane torch)	same	51 mm (2 in)

Table 1: Property results for a mid-range density sample.

The literature review and testing program indicate that the settlement of straw clay is problematic, requiring remedial work which significantly increases labour output. The report refers to demonstrated solutions with some practitioners using an internal bamboo matrix or pre-formed blocks to mitigate settlement problems. The fire testing results in the report—based on ASTM standards E 119 and E 84—indicate SLC would very likely meet the conditions required for a fire resistance period of four hours. As a final point, Straw Light Clay is a highly ductile material, with the potential to absorb a fair amount of energy in the event of seismic activity.

IMPLICATIONS FOR THE HOUSING INDUSTRY

This research program served to demonstrate the material characteristics of Straw Light Clay. Results were consistent with findings presented by German practitioner, Gernot Minke, in the recently translated *Earth Construction Handbook*. The research program also demonstrated the effectiveness of a hybridized field/laboratory approach to the testing of natural materials such as SLC.

Initial results indicate that SLC has many worthwhile material properties, including thermal and fire resistance. In addition, SLC, made on-site by an owner/builder using local materials, has the potential to eliminate manufacturing, transportation and construction waste costs associated with conventional building products. Furthermore, SLC enables participation by a broad range of people given that only a few, inexpensive tools are needed, and limited construction experience is required for mid-range density classes.

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