

Rethinking the Wall:

A Comparison Study and Decision-Making Tool for Alternative Home Construction

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Introduction

Approximately 40% of the energy produced in the United States is used in the daily operation of our built environment. While wood frame construction has been the residential standard for over a century, recent research and consumer demand has led to the production of many new, alternative wall construction methods and materials with great energy savings potential. Three of the most common methods used today, other than wood frame, are straw bale, structural insulated panels (SIPs) and insulated concrete forms (ICFs). While all four of these are realistic options, each owner/builder naturally seeks to fulfill a unique set of design priorities, suggesting that a different method or material may be suitable for each consumer. How can the decision to choose one building method over another be made simpler, given a specific consumer's priorities? A tool comparing these four common building methods over important criteria can simplify that decision, making the practice of "green" construction more approachable for potential owners and builders.

Methods

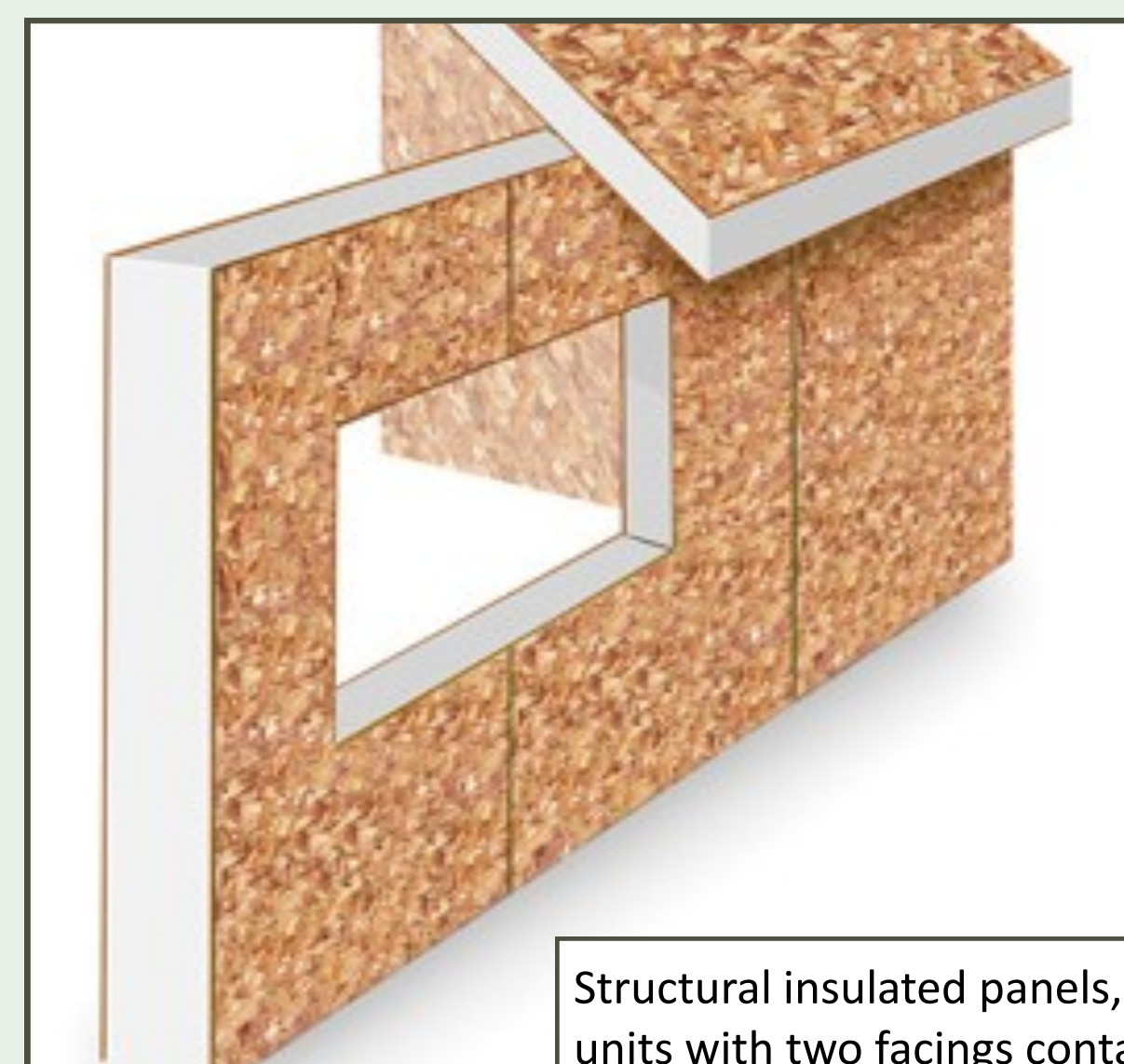
The bulk of the research for this project was conducted through an extensive review of alternative construction literature. Important sources include books and articles comparing various building techniques, scientific studies analyzing the performance of certain systems, and various construction periodicals. Several interviews with manufacturers, builders and homeowners were also conducted to gather information and insight. The results were compiled and analyzed to establish general performance evaluations for each material in each of eight criteria: cost, energy efficiency, environmental impact, interior air quality, speed of construction, durability, social impact and aesthetic. Using standard wood construction methods as a baseline average, each of the other materials' performance was comparatively analyzed and given a rating of below, equal to, or above average in each criterion, as displayed in the table at right.

Wood Framing



Wood framing is the standard method of home construction in the U.S. usually consisting of 2"x4" or 2"x6" dimensional lumber and fiberglass insulation. While it is a quick and inexpensive way to build, it lacks in energy efficiency.
Photo: http://en.wikipedia.org/wiki/File:Wood-framed_house.jpg

Structural Insulated Panels



Structural insulated panels, or SIPs, are prefabricated wall units with two facings containing a polystyrene foam core as insulation. They provide an extremely fast and airtight, energy efficient building system, but there are air quality concerns regarding the use of EPS insulation.
Photo: <http://www.foamlaminates.com/>

So many good options, but how do you choose?

Here's how they perform:

	Wood Framing	Straw Bale	SIPs	ICFs
Minimize Cost	Average	Below to above avg.	Below avg.	Below avg.
Maximize Energy Efficiency	Average	Above avg.	Above avg.	Above avg.
Min. Env. Impact	Average	Above avg.	Average	Average
Max. Interior Air Quality	Average	Above avg.	Below to above avg.	Below to above avg.
Max. Build Speed	Average	Below avg.	Above avg.	Average
Max. Durability	Average	Average	Above avg.	Above avg.
Max. Social Impact	Average	Above avg.	Avg. to above avg.	Avg. to above avg.
Aesthetic	Standard	Thicker, plaster walls	Standard	Slightly thicker walls
Payback Period	N/A	0-10+ years	3-5 years	5-10 years

Table 1. Each of the materials here shows a performance rating relative to the baseline of wood frame construction, based on comparative case study analysis. Some show variation, expressing potential for better performance if the right investments are made. Once a specific home owner/builder has prioritized certain concerns, this tool can be utilized to help decide between these materials, so that it can be done simply and with greater attention to their economic, environmental and social priorities. For instance, if an owner/builder was most interested in minimizing environmental impact while activating the local unemployed workforce to make a strong social impact, straw bale would be the clear choice.

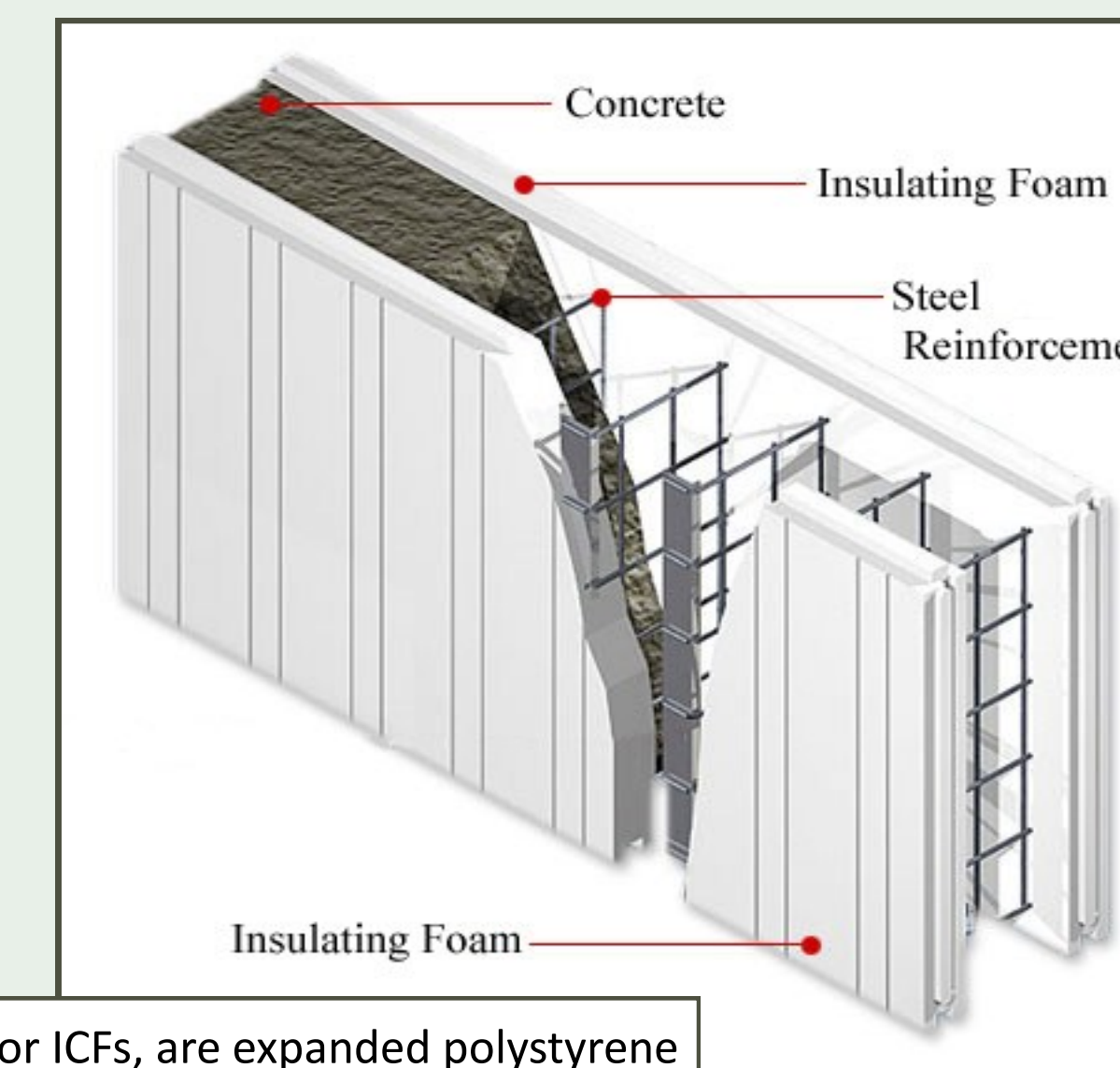
Source: Author. See full bibliography for specific articles and studies used to evaluate the materials.

Straw Bale



While straw bale building may seem primitive, it is actually highly efficient and the materials can often be sourced locally and inexpensively. Though not shown here, it is generally covered with plaster once construction is complete, to seal out moisture and reinforce the structure.
Photo: <http://allabouthealth.co.za/starflower/?p=362>

Insulated Concrete Forms



Insulated concrete forms, or ICFs, are expanded polystyrene (EPS) insulation sheets or blocks used as forms for poured concrete walls, then left in place to insulate the wall. They excel in energy efficiency and durability, but they are expensive and there are some air quality concerns with the EPS insulation used to make most ICFs.
Photo: <http://nickbugbee.files.wordpress.com/2011/01/icf-walls.jpg>

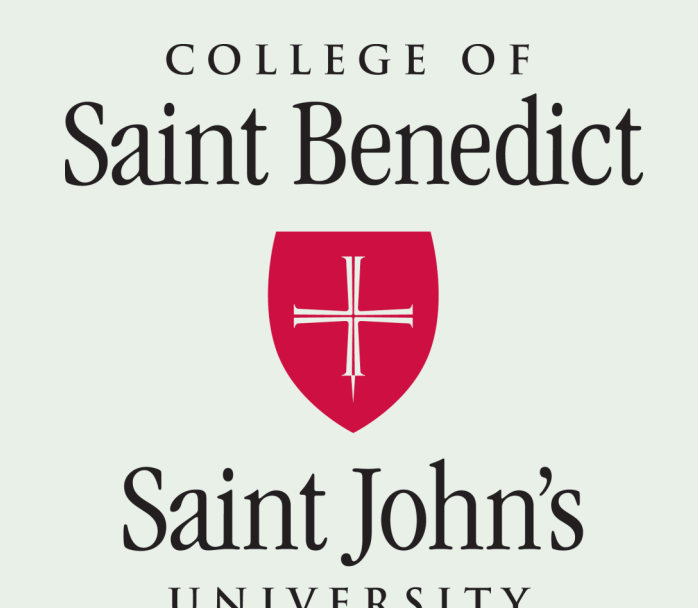
Conclusions

The findings of this comparison study are represented most clearly in table 1, synthesizing the performance of these four building methods over the eight criteria chosen, relative to the wood frame construction standard. In each performance criterion, one or two of the materials inherently perform significantly better than the others, so a builder prioritizing one concern over another might choose a material based on its performance in that area. Overall, the three more alternative options (straw bale, SIP and ICF) perform better than wood framing, but if one's priorities were cost and speed with limited investment in durability or energy efficiency, a wood frame house is still a worthwhile option.

Additional costs due to high quality building materials and a specialized labor market are often associated with the alternative options presented here, which tend to pose barriers to the average homebuilder. Further research and development of appropriate technologies, paired with continued education of builders and consumers can overcome this. By making "green" building a more approachable concept for consumers, this research contributes to that effort.

Suggested Readings

- Snell, Clarke, and Tim Callahan. *Building Green: A Complete How-To Guide to Alternate Building Methods*. 2nd ed. New York: Lark Books, 2009.
- Elizabeth, Lynne, and Cassandra Adams. *Alternative Construction: Contemporary Natural Building Methods*. New York: Wiley, 2000.
- Woolley, Tom. *Green Building Handbook: A Guide to Building Products and Their Impact on the Environment, vol. 1*. London: E & FN Spon Publishing, 1997.
- Kahhat, Ramzy et al. "Environmental Impacts over the Life Cycle of Residential Buildings Using Different Exterior Wall Systems." *Journal of Infrastructure Systems* 15, no. 3 (2009): 211.



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