

*A SUSTAINABLE DESIGN STANDARD
FOR LOW-INCOME HOUSING
IN TROPICAL CLIMATES
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BACKGROUND

A case study comparing three buildings of the same rating was performed on the U.S. Building Council's LEED (Leadership in Energy & Environmental Design) program, revealing serious flaws in the program's method of measuring sustainability. For example, the three buildings had varying impacts on the environment, which depended on what categories most credits were earned in. Some credits proved meaningless because of low standards and easy achievability. Also, there was a lack of accountability in actual building performance; too many credits were based on inaccurate simulations and modeling. Although LEED requires much improvement, it is a valuable tool for architects to incorporate sustainability into the design process.

Similar evaluation systems exist such as UK's BREEAM (Building Research Establishment Environmental Assessment Method) and Canada's BEPAC (Building Environmental Performance Assessment Criteria), but a void needs to be filled for buildings in less developed countries. Using Jamaica as a model, this design project attempts to create a sustainable design standard for low-income housing in tropical climates.

THE NEED FOR A STANDARD

Currently, the majority of new low-income housing in Jamaica is built of concrete or cinder block walls reinforced with steel. This construction is stable for hurricane and seismic zones, cheap, and easy to construct. A house building kit developed by Royal Group Technologies, a Canadian company, takes one month to complete including foundation, sewage, water tank, and kitchen cupboards. A design for Habitat for Humanity is inspired by the classic American rowhouse with few windows.

What these mass-produced homes lack is a response to the climate and vernacular architecture of Jamaica.

Traditionally, the smaller house in Jamaica follows a vocabulary of wood structure, wood louvres for windows, and a verandah as the main living space. Because of the hot, humid climate, life is lived more outdoors than in. Some homes are composed of several connected buildings, each serving a different function. While the current house designs do provide decent shelter, it is possible to create a smarter and more comfortable design without significantly increasing costs.

DESIGN FOR CLIMATE

Because mechanical means of thermal comfort are not available, simple sustainable design measures are particularly well-suited for this demographic. There are essentially four different climatic conditions to consider during the design process. The year-round temperature averages in the low 70's for the lows and upper 80's to lower 90's for the highs. The rainy season is long, approximately 5 months, with October receiving an average of 7 inches. Because of Jamaica's close proximity to the equator, the sun is directly overhead, which makes the maximum heat gains on the east and west sides.

A steady wind blows from the northeast throughout the year.

Design guidelines for hot, humid climates were researched and compiled.

- Windows placed in opposite walls provide for cross ventilation, but should not be directly lined up to promote mixing of the air within the room.
- Casement windows can be used for redirection of the wind if necessary.
- Shuttered windows allow for shade.
- Windows on the east and west walls kept at a minimum create less solar heat gain.

- Louvred windows allow for the maximum ventilation and weather protection.
- Roof space ventilation reduces heat build-up.
- A long and narrow floor plan with the long axis oriented east-west minimizes heat gain.
- Open plan living spaces with high ceilings maximize air movement.
- Walls perpendicular to the air flow should be minimized.
- Elevation of the house improves ventilation beneath.
- Extensive verandahs provide shade.
- Metal roofs with reflective coatings allow rapid cooling at night.
- Materials with high thermal capacity such as bricks, concrete, etc. should be avoided.

DEVELOPING A STANDARD

Because of the narrow scope, a standard based on the structure of LEED can be simplified and more detailed. The criteria gathered can be divided into three different categories: natural ventilation, shading, and materials. Other design factors that could possibly be included are water collection, energy sources, and waste disposal.

Category	Credit	Weight
Natural Ventilation	1.1 Window Placement- indoor airflow parallel to outdoor wind conditions	3
	1.2 Airflow Path- indoor airflow traverses room in non-linear path	2
	1.3 Roof Space Ventilation- airflow through roof space	2
	1.4 Elevation of House- air circulation beneath house	1
	1.5 Window Design- simultaneously providing ventilation and shade	3
	1.6 Flow Compliance- less than 50% of square footage more than 2 rooms deep	1
Shading	2.1 Orientation on Site- long axis of building along east-west direction	3
	2.2 Minimizing Heat Gain- no windows in east and west facing walls	1
	2.3 Optimal Floor Plan- around/at least 1:1.7 ratio width to length	2
	2.4 Outdoor Space Shading- verandahs at least 3' deep covering 50% of building perimeter	3
Materials	3.1 Minimal Heat Absorption- lightweight construction for walls	2
	3.2 Cooling- heat conductive material for roof	2
	3.3 Recycled Content- at least 25% of building materials	1

The credits are weighted to reflect the most essential elements for building in tropical climates. Out of 26 total points, 18 points would have to be achieved to be considered sustainable. The assigning of percentages and hard numbers to some of the credits is somewhat arbitrary; more research would be necessary to determine the appropriateness of each.

APPLICATION & EVALUATION

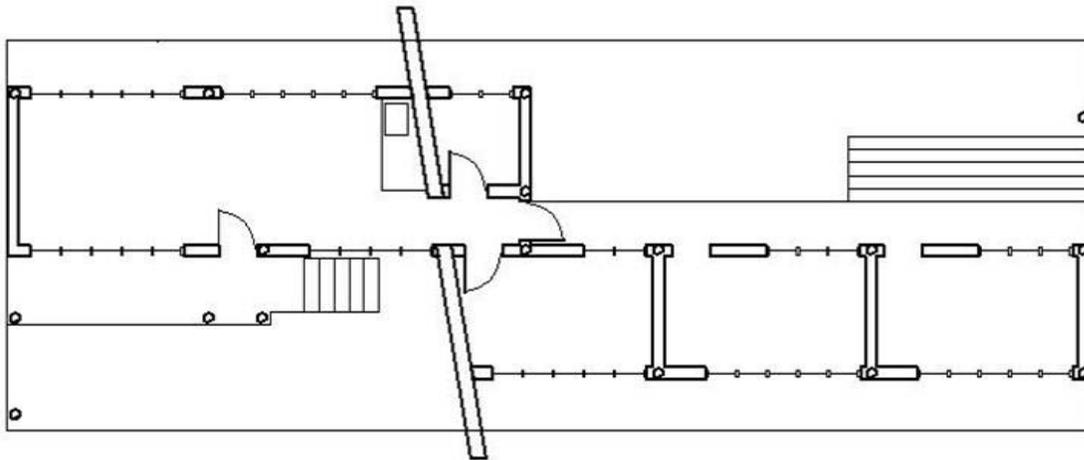
In Jan Wampler's Jamaica House Workshop, a design for a single-family house was created for Habitat for Humanity. The initial square footage requirement was 280, and expansion up to 800 square feet had to be allowable. Although the design focus was on meeting those requirements, basic ideas of natural ventilation were incorporated from the beginning with inspiration from Glenn Murcutt's Marika Alderton house. A long, narrow elevated plan was developed with extensive louvred windows. However, as the criteria for this standard were developed further, modifications were made to the design, such as the reduction of a concrete wall, the off-setting of the roofs for ventilation through clerestory windows, and the expansion



Unexpanded Jamaica House- North Elevation



Unexpanded Jamaica House- South Elevation



Expanded Jamaica House- Plan

Using the standard developed, the original Jamaica House design would have received 17 out of 26 points, while the final design would receive 24 of 26 points.

CONCLUSION

Simply having a guideline for design would improve the sustainability of the housing currently being built in tropical areas. Much growth is occurring in those areas and as resources become scarce, sustainable measure will become increasingly necessary. However, implementation of a standard would be difficult as the infrastructure of the building industry is not quite similar to that of more developed countries such as the U.S. and U.K.

Further steps to take in the development of this standard would be to cover more areas of sustainability and expand it to other building types for a tropical climate. It would also be useful to somehow incorporate building, material, and energy costs as financial resources are limited in these

areas. For example, while the Jamaica House design is more sustainable than the typical concrete house, it is likely more expensive because of its larger footprint and elevation off the ground. However, in terms of long-term sustainability, it may be more cost effective.

Credit	Weight	Original	Final
1.1 Window Placement- indoor airflow parallel to outdoor wind conditions	3	3	3
1.2 Airflow Path- indoor airflow traverses room in non-linear path	2	2	2
1.3 Roof Space Ventilation- airflow through roof space	2		2
1.4 Elevation of House- air circulation beneath house	1	1	1
1.5 Window Design- simultaneously providing ventilation and shade	3	3	3
1.6 Flow Compliance- less than 50% of square footage more than 2 rooms deep	1	1	1
2.1 Orientation on Site- long axis of building along east-west direction	3	3	3
2.2 Minimizing Heat Gain- no windows in east and west facing walls	1		
2.3 Optimal Floor Plan- around/at least 1:1.7 ratio width to length	2	2	2
2.4 Outdoor Space Shading- verandahs at least 3' deep covering 50% of building perimeter	3		3
3.1 Minimal Heat Absorption- lightweight construction for walls	2		2
3.2 Cooling- heat conductive material for roof	2	2	2
3.3 Recycled Content- at least 25% of building materials	1	?	?

Credit Tabulation for Jamaica House