Building energy modelling of Hout Bay House

The unique and exciting Hout Bay House project has already been introduced in previous issues of Timber iQ. Those earlier articles looked at the technology of glued timber, solid wood construction, wood degradation, wood treatment, and future research at Hout Bay House. In this edition, we take a closer look at a specific chapter of this research, namely predictive thermal performance modelling.

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The Hout Bay House makes use of a highly insulated, lightweight façade. In order to test how this building performs, the temperature, humidity, and CO_2 concentration levels are measured at select locations throughout the building. As part of the research experiment, the wall insulation will be changed from 80mm in the first year to 120mm in the second year. The main goal of this research is to compare measured data with modelled data, and to optimize wall insulation thickness for the Cape Town climate region.

To gain a better understanding of building performance modelling, we asked Thomas Hugo, an engineer at Greenplan Consultants and a member of the Hout Bay House research team, some questions on this topic.

TIMBER iQ: What is building energy modelling and how does it benefit us?

HUGO: Building energy modelling is a scientific method used to predict the building's energy requirements and thermal response to the prevailing climate. Modelling engineers use computers with state-of-the-art software to perform many sophisticated calculations in order to extract engineering parameters that describe building behaviour throughout a typical year. The results can then be analysed and used to inform the design, or solve an existing problem. Often, modelling helps us to select the ideal cost-benefit design for the building.

TIMBER iQ: What input data is normally required for the building energy model of a typical house?

HUGO: For a basic thermal model, we normally require: (1) Hourly weather data close to the site that covers a full year; (2) Drawings and geometry details to create a representative 3D energy model; (3) Thermal properties for walls, windows, the roof, etc. and (4) Details about the human activity and building use.

All these different inputs affect the heat transfer, resulting in a unique energy model. The level of detail required tends to vary between different projects, and more specific detail may be required depending on the complexity of the building design and the objective of the model.

TIMBER iQ: What thermal or other parameters of the building are you able to estimate using building energy modelling?

HUGO: The output of modelling is mainly dependent on the level of detail of your building energy model, and the energy modelling software that is used.

In a typical thermal performance analysis of a house, we would normally analyse the following: room air temperature, surface temperature, thermal comfort (PMV), and heating and cooling electricity consumption. These parameters will highlight problematic areas, and suitable solutions can then be suggested and evaluated.

At Greenplan, we use DesignBuilder (EnergyPlus) software, arguably one of the most advanced building simulation software programs available today. The software can go down into astonishing detail, such as various physical and scientific parameters used in background calculations, or various performance parameters of heating, ventilation and air-conditioning (HVAC) components. The data can also be analysed at different levels of your model (i.e., a wall, a room, or the whole building). Often, however, we find that with modelling, less is more, provided you know what data you want to look at.

TIMBER iQ: What are the biggest differences in the thermal behaviour of Hout Bay House in comparison with typical South African houses?

HUGO: At this point we can only comment on the design differences, as the simulation and data collection is still in progress. In principle, the Hout Bay House has a lightweight structure with highly insulated walls, roof and windows. In South Africa it is typical to have a structure with thermal mass (brick walls) and much less insulation. The example in the table below shows a comparison of wall insulation. A higher R-Value represents a better insulation.

WALL TYPES	R-VALUE (m^2K/W)
SA minimum requirement (SANS10400-XA)	0.35
SA typical brick cavity wall	0.70
Hout Bay House wall (84mm NOVATOP, 80mm Pavaterm-Combi insulation)	2.6
Hout Bay House wall (84 mm NOVATOP, 120 mm Pavaterm-Combi insulation)	3.5

However, keep in mind that thermal resistance is not the only important parameter. Thermal mass in walls delays the time for heat to penetrate a building and therefore works well in certain climates.

TIMBER iQ: What are the most significant parameters that influence the thermal properties of a building?

HUGO: All of the input data mentioned previously can have a significant effect under certain conditions. Therefore, the best available data should be used. From the results one can determine the significance of different parameters.

Many of the input parameters are also relatively fixed; that is, they are significant yet unlikely to change. Examples may include site weather data, human activity, and sometimes the aesthetic design of the building. This leaves only certain parameters that can be changed to significantly improve a building's performance. Normally these parameters include the envelope insulation, shading, the glass type, as well as passive heating and cooling strategies.

TIMBER iQ: Why is it important to get familiar with the thermal behaviour of a building?

HUGO: If a building is not well designed for its climate, occupants may experience thermally uncomfortable conditions. This means the building occupants can experience the building as either too hot or too cold at times. Ensuring thermal comfort inside buildings is crucial in extreme climates. In relatively mild climates, like many places in South Africa, thermal comfort conditions can be considered uncomfortable but bearable.

TIMBER iQ: What requirements for the thermal performance of buildings exist in South Africa?

HUGO: According to the National Building Regulations, new buildings and renovations to existing buildings need to comply with SANS10400-XA. The standard prescribes two alternative routes for compliance:

- A strict deemed-to-satisfy approach that lists various requirements for building design, OR
- Using a rational assessment that applies all the attributes of the proposed new building into one holistic energy model and then compares the result to a reference building model that adheres to the building regulations.

TIMBER iQ: Do you personally think the results of the research may influence the building sector in South Africa?

HUGO: I believe with positive results from the research this would be possible.

From a thermal and sustainability point of view, I believe the research will shed light on the performance of highly insulated lightweight buildings. The result of the research is likely to suggest a cost-benefit trade-off, which may incentivize that these construction methods are considered for more buildings in South Africa. Additional research may be required to extrapolate the results of the research to other climate regions in South Africa.

For more information, visit www.houtbayhouse.info.