Optimisation of the thermal and structural performance of an integrated patio door

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Centor produces large glass doors, panels and windows primarily for the luxury household markets, national and international. Typically clients want uninterrupted views to the outside world spanning fairly large lengths of their external walls, however, the constraints of structural integrity, safety and functionality, mean that frames are required and need to be designed to be both structurally strong under design conditions, and insulating.

There are well established international standards for fenestration products and there are software packages available for accurately calculating the heat transfer and structural properties of the door frames and glazed surfaces, but these require detailed CAD input and the turn around time for processing the data is days to weeks; time consuming and expensive to use during the early design stages. With this in mind Centor asked MISG2014 to develop simple and reasonably accurate rules-of-thumb, or formulae, or software, etc, that would help them rapidly design structurally sound and thermally insulating door frames.

The frames of interest consist of aluminium, plastic and wood components with air gaps and are of complex design. Aluminium is a useful structural component because of its strength but its high conductivity is a problem for insulation. Air and plastic are very good insulators but are structurally weak. However the group noted that in order for the frame to be insulating there has to be an 'isolated' insulation layer within the structure to greatly restrict the heat flow across the structure and by identifying this layer one can greatly reduce the complexity of the heat transfer calculations. Furthermore the strength of the frame is determined by its bending behaviour which is primarily determined by the location (relative to the neutral plane) and thickness of the elastically strong components. Figure 1 illustrates these general findings in a specific case. The heat transfer across the frame can be

accurately determined by simply considering the insulation layer. The location and thickness of the stiff outer layer determines the bending strength of the frame.

These simple observations will enable Centor to focus on the important design features and quickly redesign the frame to improve its performance; specific frames have been evaluated.

Whilst the above crude calculations provide good design guidance and reasonably accurate results it would be useful to have a more accurate (but still simple) model. Such a model has been developed and programmed in Excel so that data input and processing is simple. Group members have illustrated the use of this program.

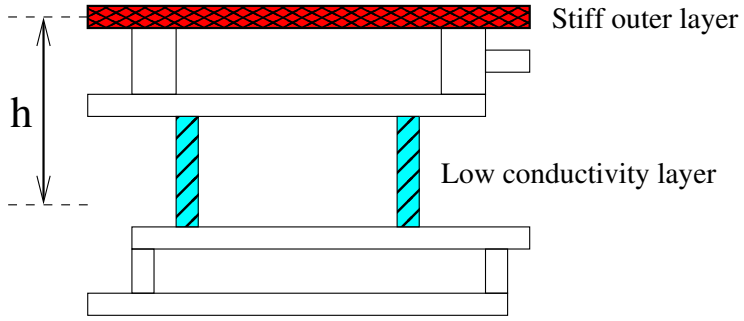

Figure 1: A typical cross-section of a door frame. The frame itself is a slender bar coming out of the plane of the paper. Heat flows from the top to the bottom of this figure, and a mechanical load is applied along the top of the bar causing it to bend.