CSIR Research Confirms the Superior Energy Efficiency of Light Steel Frame Building

A recent research project undertaken by the Built Environment division of the CSIR has confirmed that a light steel frame (LSF) dwelling, built to SANS 517, will result in significant savings of electricity used for heating and cooling of the building, compared with a conventionally built heavy masonry building. This is according to John Barnard, director of the Southern African Light Steel Frame Building Association (SASFA), a division of the Southern African Institute of Steel Construction (SAISC).

Barnard says that in order to obtain an objective prediction of the thermal performance of a light steel frame dwelling compared with a masonry building in the different South African climate zones, SASFA approached the CSIR to carry out the analysis.

A typical 120 m² single storey house was used for the comparison. The LSF and the masonry houses were specified to be geometrically identical, with identical orientation. The LSF house complied in all respects to SANS 517 Light Steel Frame Building, while a typical masonry house with double-leaf external clay brick walls, without any insulation in the walls and ceilings, was used as the base case.

Barnard says that the effects of adding insulation to the masonry house were also analysed, as follows: (a) 40mm insulation in the ceilings, and (b) similar ceiling insulation as used for LSF buildings (140mm) and 50mm insulation in external walls.

The CSIR decided to use the Ecotect TMV 5.6 software to carry out the computer analysis. In order to eliminate the effect of user input data, which could influence the outcome, it was decided to use a passive analysis – that is, no assumptions regarding the occupancy and usage patterns of the house. The heating effect of lights and appliances was also not taken into account.

The analysis, using the thermal neutrality calculation, determined the number of hours of "uncomfortably high or low temperatures" in each of the buildings and the electricity needed for heating and cooling each of the buildings to thermal comfort levels, which range from 20 to 24 o C, as recommended by SANS 204.

The major differences between the two types of building are the thermal insulation and the thermal mass.

The walls in a LSF building have better thermal insulation, but lower thermal mass than masonry buildings.

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The results indicate that the LSF house will be warmer than a base-case masonry building in summer, as well as in winter. If, however, the hours of discomfort due to high and low temperatures are added together, the LSF house performs somewhat better than the masonry alternative in all locations except Durban. In Pretoria, for example, the indoor temperature of the LSFB was within the thermal comfort range for 74%, compared with 71% for the masonry base-case—only a minor difference.

The important differences relate to the heating and cooling of the respective houses. The electricity required to heat the base-case brick building to comfort levels will on average be double that required for the LSF building, ranging from 89% more in Pretoria, to 112% more in Bloemfontein. If cooling to comfortable temperatures is required, it will take on average three times more electricity to cool the brick building down to thermal comfort levels compared with a LSFB.

This significant increase in the amount of electricity required to heat or cool the internal spaces of the brick building can be ascribed to its thermal mass—apart from having to heat the air inside the building, the walls of the masonry building absorb some of the heat, resulting in additional energy consumption. The inverse happens when cooling, when the heavy masonry walls have to be cooled down together with the air inside the building.

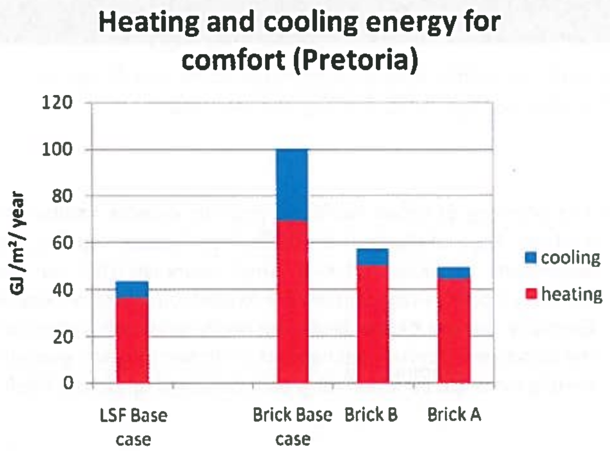
THERMAL PERFORMANCE COMPARISON: LSF VS MASONARY DWELLING						
	Discomfort Hours			Annual heating & cooling energy (GJ/m^2)		
	too hot	too cool	total	heating	cooling	total
	BASE CASE LSF					
Pretoria	414	1824	2237	36.6	6.9	43.5
Durban	562	455	1017	14.8	11.2	26.0
Bloem	299	3229	3528	86.4	4.9	91.3
Cape Town	45	2878	2923	69.9	2.0	71.9
Average	330	2096	2426	51.9	6.2	58.2
	BASE CASE BRICK					
Pretoria	116	2411	2527	69.3	30.6	99.9
Durban	127	749	876	28.9	43.8	72.7
Bloem	80	3820	3900	182.8	25.7	208.5
Cape Town	0	3818	3818	135.4	6.3	141.7
Average	81	2700	2780	104.1	26.6	130.7

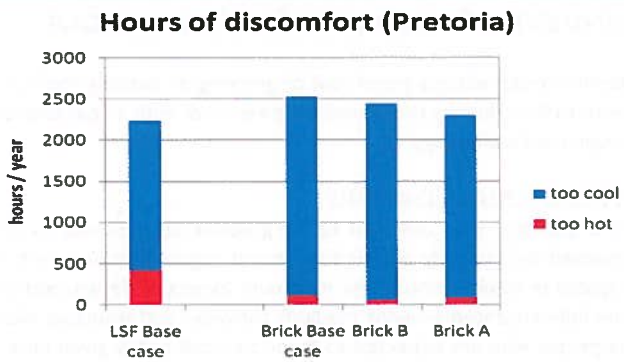
The results demonstrate that when the brick building is insulated, the performance improves.

The graph below compares the hours of thermal discomfort in a LSFB with that in three alternative masonry buildings:

- Base Case: no ceiling or wall insulation
- Brick B: 40mm thick glasswool insulation in ceilings
- Brick A: 140mm thick glasswool insulation in ceilings, and 50mm polystyrene insulation in the cavity of all external walls.

As is shown below, the LSFB will require less than half the electricity to heat and cool to thermal comfort levels than the brick base case, and still notably less than the other two insulated masonry alternatives.





Barnard says that these results vindicate SASFA's long-time claim that while the costs of building LSF and masonry structures may be similar, LSF is significantly quicker and more efficient from an environmental point of view and saves the homeowner significantly in the long run because of these lower energy costs.

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