CSIR RESEARCH CONFIRMS THE SUPERIOR ENERGY EFFICIENCY OF LIGHT STEEL FRAME BUILDING

By John Barnard, SASFA director

(As shown in the findings) the LSFB house 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.

SOUTHERN AFRICAN LIGHT STEEL FRAME BUILDING ASSOCIATION

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A recent research project by the Built Environment Division of the CSIR 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.

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 analyses.

A typical 120m^2 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 complies in all respects to SANS 517 Light Steel Frame Building. 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. The effects of adding (i) 40mm insulation in the ceilings, and (ii) similar ceiling insulation as used for LSF buildings (140mm) and 50mm insulation in external walls, were also evaluated.

The Built Environment Division of the CSIR decided to use the Ecotect TM V 5.6 software to carry out the computer analyses. In order to eliminate the effect of user input data which could influence the outcome, it was decided to use a passive analysis, i.e. without making assumptions regarding the occupancy and usage patterns of the house. The heating effect of lights and appliances was also not taken into account.

The analyses were firstly aimed at determining the number of hours of uncomfortably high or low temperatures in each of the buildings. The buildings were considered to be naturally ventilated and the thermal comfort temperature range for naturally ventilated buildings in Pretoria is 17.8°C – 28.3°C. The adaptive model was used in calculating the levels of thermal comfort in the two houses.

The electricity needed for heating and cooling for each of the buildings to thermal comfort levels (ranging from 20°C to 24°C, as recommended by SANS 204) was also determined.

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. The higher thermal mass in the walls of brick buildings reduces the diurnal internal temperature swings towards the average temperature, which could be too high or too low for comfort. It should be noted that the concrete floor in both building types contribute to the thermal mass of the building.

FINDINGS

Results indicate that the LSF house will be warmer than a base case masonry building in winter, as well as in summer. If the hours of discomfort due to too high and too low temperatures are added together, the LSF house performs better than the masonry alternative in all locations but Durban.

As example, the indoor temperature of the LSFB was within the thermal comfort range for 74% of the time in Pretoria's climate, compared with 71% for the masonry base case – a relatively small advantage.

However, the analyses indicate that 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.

THERMAL PERFORMANCE COMPARISON: LSF vs MASONRY DWELLING						
	Discomfort hours (hrs)			Annual heating & cooling energy (GJ)		
	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	12.8	9.7	22.5
Bloem	299	3229	3528	74.9	4.3	79.2
Cape Town	45	2878	2923	60.7	1.8	62.4
Average	**330**	**2096**	**2426**	**46.3**	**5.6**	**51.9**
	Base case brick					
Pretoria	116	2411	2527	69.3	30.6	99.9
Durban	127	749	876	25.1	37.9	63.0
Bloem	80	3820	3900	158.6	22.3	181.0
Cape Town	0	3818	3818	117.4	5.5	122.9
Average	81	2700	2780	92.6	24.1	116.7

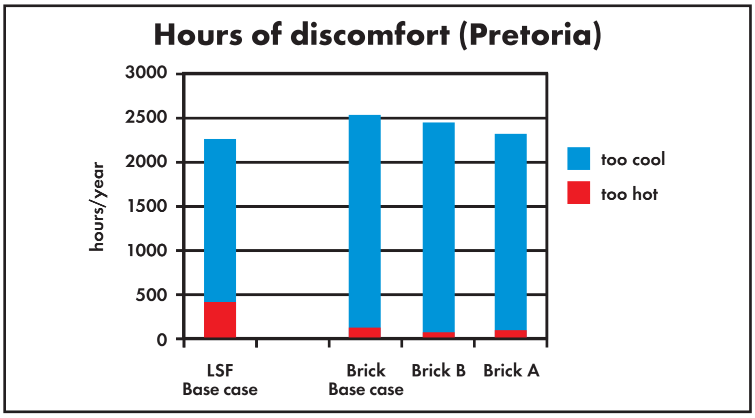
If cooling to comfortable temperatures is required, it will take on average three times more electricity to cool the masonry building down to thermal comfort levels compared with a LSFB.

This enormous increase in the amount of electricity required to heat or cool the internal spaces of a masonry building can be ascribed to the thermal mass of the walls – 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 and a delay in the change of the internal temperature. The inverse happens when cooling, when the heavy masonry walls have to be cooled down together with the air inside the building.

When the brick building is insulated, the performance improves. *Graph 1* compares the hours of thermal discomfort in a LSFB with that in three alternative masonry buildings:

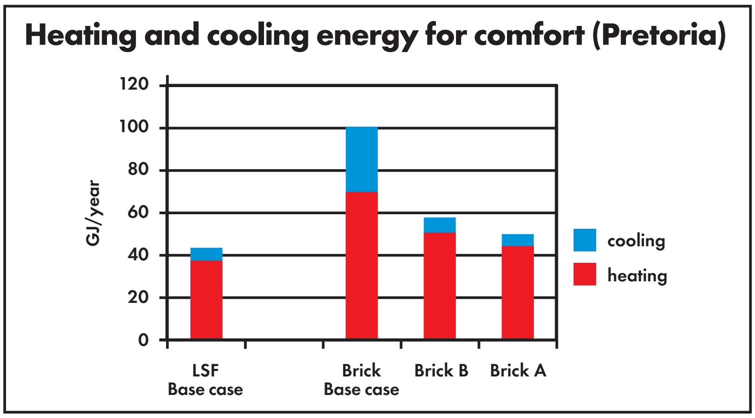
- Brick base case: no ceiling or wall insulation
- Brick B: 40mm thick glasswool insulation in ceilings
- Brick A: 140mm thick glasswool insulation in ceilings, and 50mm polystyrene insulation in the cavity of all external walls.

While the LSFB will result in more hours of discomfort without heating and cooling in Pretoria's summer climate than the masonry alternatives, occupants will have less discomfort in winter, and less discomfort in total.



Graph 1.

As is shown in *Graph 2*, 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.



Graph 2.

Savings in electricity for heating only:

LSF compared with Brick Base Case:	32.7 GJ/yr (89%)
Brick B:	13.5 GJ/yr (37%)
Brick A:	7.7 GJ/yr (21%)

CONCLUSION

The CSIR's comparative thermal analyses indicate that LSFB offers improved energy efficiency compared with conventional masonry buildings – this means significant savings (between 20% and 90%) of electricity required for heating of residential buildings in Pretoria, as example.

These findings are generally supported by testimonials received from occupants of LSF houses. In a recent survey carried out by SASFA, 57% of respondents reported that their LSF house was cooler in summer, while 71% said it was warmer in winter.

The CSIR research also indicated specific areas where further gains in energy efficiency can be captured for LSFB, and these will be investigated and implemented in the LSF building methodology.

Reference: 'A predictive comparative thermal performance analysis for light steel frame and masonry residential buildings', T Kumirai and Dr D Conradie, CSIR.

SASFA NEWS

ABSA SUPPORTS NEW BUILDING TECHNOLOGIES

One of the key drivers in Absa's aim to contribute towards solutions for the housing demands of the nation is through the identification and financing of innovative and affordable housing solutions.

Over the past few years, Absa has, in association with its partners, conducted two highly successful Housing Innovation Competitions in both the affordable and subsidy housing markets. The objective of these competitions was to stimulate imaginative and viable alternative building designs which challenged traditional masonry construction and offered a variety of affordable, high quality housing solutions which were then rolled out by tender through provincial and local government developments.

These competitions, held in Gauteng and the Western Cape, were endorsed by the Minister of Human Settlements due to the affordable, innovative and energy efficient alternative solutions they could provide. The competitions are also attracting a growing interest from local and international developers wishing to showcase new and innovative building systems. This has resulted in a third competition anticipated to take place early next year in one of the provinces (to be announced shortly).

The competition will have a rural theme and setting, focusing mainly on:

- Affordable and subsidy housing
- Green housing technology
- Energy efficiency
- Planning and an eco-site design
- A rural character where housing compliments the beauty of the natural environment without compromising sustainability, safety and comfort for its inhabitants.

To date, Absa has a number of approved alternative building technologies which it considers financing. The criteria broadly include:

- The cost of the technology and its affordability to customers
- The durability, architectural design and quality of housing products
- Cost effectiveness and value for money
- The speed of construction
- Energy efficiency
- The verification of energy products for finance
- The acceptability of the innovative building system to targeted customers
- Absa's internal mortgage lending policies, terms and conditions

Absa has since the outset accepted light steel frame building (LSFB) in principle, and has granted finance to LSF housing projects subject to the above. SASFA remains in close contact with Absa, and provides information on the LSFB industry and products when required.

REPORT: LSFB TRAINING FOR BUILDING CONTRACTORS, CAPE TOWN, OCTOBER/NOVEMBER 2011

SASFA's six-day training course for building contractors was presented at Saint-Gobain's facility in Epping, Cape Town, from 31 October to 5 November 2011. This was the 7th time we offered the course.

Attendees of the LSFB Training for Building Contractors Course in Cape Town.

We received 10 registrations for the course, four from Gauteng, two from Eastern Cape, one from the Free State, and only three from the Western Cape.

The four-day section on steel frame manufacturing and erection was presented by John Barnard (SASFA) and Richard Bailey (consultant, previously from MiTek). Kevin Gargan (Academy manager Saint-Gobain, Cape Town) and Johnny van der Merwe (estimator/draughtsman Everite Technical Services) presented the one and a half day section on cladding, lining and insulation. As in the past, we had Hilti illustrate the use of their laser levels, as well as their range of anchor bolts, and Speedfit Africa illustrated the installation of plumbing in LSFB using their product range. Students each received a set of course notes, a copy of SANS517, and product literature from both Everite and Saint-Gobain.

Saint-Gobain had cast a 6m x 4m slab inside one of their training buildings, on which the light steel frame, supplied by Razorbill, was erected by the students as part of the practical component of the course.

Cladding, lining and insulation materials were supplied by Saint-Gobain and Everite for fixing to the steel frame, under the guidance of Kevin, Riaan (also from Saint-Gobain) and Johnny. Joints were completed on the internal lining, and even the repair of a hole bashed through the lining was illustrated.

The students had to write two tests, to assess the level of their knowledge. The average combined score for the two tests came to a very good 78%. All the students achieved in excess of the required minimum of 60%, and hence all qualify for the SASFA certificate for successful completion of the course.

SASFA aims for 15 to 20 enrolments per course, and would have preferred a slightly larger group. However, judging by the students' response, presentation of the course was certainly worthwhile.