TECHNICAL NOTE #29

University of Pretoria releases energy usage study of walling in SA

The University of Pretoria has released results of its Thermal Performance Study, which assessed operational energy use of structures built with six different walling materials.

This research is of particular relevance for affordable housing, as the residents do not have the money for high electricity bills

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The University of Pretoria has released results of its Thermal Performance Study, which assessed operational energy use of structures built with six different walling materials.

When selecting building materials, developers and architects of green buildings take into account the embodied energy of their raw materials. While this is an excellent start, in reality energy use over the life of the building dwarfs energy used during production. Operational energy use is an expensive, long-term cost for the property owner and a drain on South Africa's limited resources.

Annual Operational Energy is the sum of all heating, cooling and ventilation electricity costs accumulated over all four seasons in one year.

This research is of particular relevance for affordable housing, as the residents do not have the money for high electricity bills. Therefore ethical housing developers should look beyond cost-cutting during construction, to take into account the long term expense of operation and maintenance.

Methodology of the Study

The size and use of a building influences its thermal performance. The design models applied in this study were used in prior research by the CSIR and the Department of Mineral and Energy Affairs. Best-practice construction methods were assumed, as required by SANS 10400 Part XA: Energy usage in Building and SANS204: Energy efficiency in building.

Three building types were analysed:

- a large 2000m2 commercial building, unoccupied at night and on weekends.
- a middle-income residential home of 130 m2, and
- a low-income home of 40m2 (with heating fuelled by coal or paraffin)

Variables such as floor, roof, windows, doors and occupancy patterns were kept constant.

Climate Zones

South Africa has six major climate zones. Energy use varies depending on the location of the building – warm climate zones use more air-conditioning and ventilation, cold climate zones need heating. High rainfall areas need to deal with humidity and condensation. Lighting requirements have seasonal variations.

Temperatures and other parameters used in the study are acknowledged averages for that zone. The measurements were based on the residents living in reasonable "thermal comfort" which is between 19 and 25˚C.

Wall Types

Six wall types were analysed

1. Double (internal and external) clay brick solid wall (nominally 220 thick, plastered)
2. Double clay brick cavity wall with air cavity (nominally 270 mm thick with an uninsulated 50mm air cavity)
3. Insulated double clay brick wall (nominally 280mm thick, with 30mm extruded polystyrene insulation in the 50mm cavity)
4. 140mm hollow core concrete block (150mm thick with a single external layer of plaster, and bagged internally)
5. Light steel frame, externally clad with 9mm fibre cement board to SANS 517 (nominally 145 mm thick with 0.2mm polymer vapour membrane, 20mm orientated strand board and 0.8mm steel studs. Internal wall of 15mm gypsum board with 75/100mm fibre sound insulation.)
6. Timber frame to SANS 10 082 clad with external ship-lapped tiles or weatherboard (nominally 145mm thick with 20mm orientated strand board and internal cladding of 15mm gypsum plasterboard.)

A wall lifespan of 40 years was estimated, although not all the walling types have been shown to have this lifespan. US housing lifespan is taken at 32 years, influenced by the use of timber frame and lightweight construction systems in the American housing market.

Analysis of the Results

The results showing the variation of heating and cooling energy modelled for the three building typologies, can be summarised as follows:

Best (lowest) Energy Use

- Residential Buildings (all climate zones, all sizes): thermally insulated 280mm clay brick cavity walling
- Non-residential building (climate zone 1): 140mm hollow concrete block walling
- Non-residential building (climate zones 2-6): 220mm solid clay brick walling

Worst (highest) Energy Use

- Residential Buildings (all climate zones, all sizes): 140mm hollow concrete block walling
- Non-residential building (climate zone 1): timber frame walling
- Non-residential building (climate zones 2-6): light steel frame walling

Annual Energy Usage – 130m² House by region

	KZN	GT	WC	FS	LM	NC
280mm cavity clay brick + insulation	322	1164	872	1855	45	2228
270mm cavity clay brick	619	2023	1618	3251	78	3682
220mm clay brick	909	2797	2242	4405	787	4762
140mm Hollow Concrete Block	1337	3986	3166	6285	2739	6314
Light steel frame (SABS 517)	1358	2492	2104	2650	1199	3908
Timber Frame (SABS 10 082)	1332	2537	2152	2902	1102	4085

The low density walling systems (timber and steel frame) show a trend towards higher annual energy use even when they have low U-values. High density walling systems (clay brick) consistently result in lower annual energy use even without additional insulation.

Annual Energy Usage – 40m² Affordable House

	GT	KZN	WC	FS	LM	NC
280mm cavity clay brick + insulation	379	296	218	496	2	1244
270mm cavity clay brick	725	454	479	1009	887	1904
220mm clay brick	1055	590	734	1464	1282	2428
Light steel frame (SABS 517)	1082	827	868	945	1135	2054
Timber Frame (SABS 10 082)	1066	786	862	1012	853	1953
140mm Hollow Concrete Block	1505	749	1079	2164	1623	3087

Conclusion

"Members of the Clay Brick Association of Southern Africa are pleased to see that the study corroborates existing national and international research for clay brick products," says CBA Technical Director Nico Mienie. "This research verified that any of the three clay brick walling formats provide property owners and residents with lowest energy usage and hence greatest thermal comfort.

"This also demonstrates the critical role played by thermal insulation in residential buildings. Perhaps it is time that SA building regulations relook at the thermal resistance and heat bridging requirements of SANS 517 and SANS 10082.

"Thanks to this study, architects, and public and private section developers are able to make more informed decisions about future walling specifications," he concludes. This will protect South Africa's environment and give rise to high performance structures that reduce our reliance on electricity."

For further information:
The Clay Brick Association of South Africa
Website: www.claybrick.org