CLAY BRICK

For all seasons and only the best of reasons

BOTHASIG
Social housing - you cannot do better than brick

CLAYBRICK
for good

Clay brick underpins sustainable, energy efficient infrustructure at its best.

Addressing all the basics for affordable quality living, with safety and security a given, clay brick in construction has demonstrated the flexibility to work well with all design styles to bring authenticity and appealing human scale to buildings.

School building infrastructure is no exception with clay brick construction proving more relevant today than ever for providing proper, safe and secure, low maintenance thermally efficient built environments conducive to better learning.

Bongolethu and Heideveld Primary Schools below are just two of many recent examples of clay brick's contribution to efficient school infrastructure buildings.

Attractive aesthetics with the flexibility of clay brick in design these affording elements of interest and texture that stimulate the senses.

Notwithstanding the track record of clay brick in providing sustainable, thermally comfortable and cost effective infrastructure buildings with an assured low lifecycle cost, Dr Llewellyn van Wyk, Principal Researcher at CSIR Built Environment Division endorses IBTs as being more efficient than clay brick wall construction for school buildings. He supports his case by highlighting that some "32 Agrément certificated IBTs identified for use in the construction of schools perform better than conventional building" (Walls and Roofs Journal 4 – July 2014). In Built, July 2014, he highlights the benefits of IBTs being "improved energy efficiency and quality control".

Mr John Barnard director of SASFA emphasises the benefits of Light Steel Frame Building (LSFB), "as wide ranging compared with conventional building methods in terms of quality, cost, durability and speed" (SA Roofing July / August 2011).

Heideveld Primary School – Warm and inviting internal communal spaces

South Africa's 'highest certificated' Innovative Building Technology walling system in Africa (reference 2010/376 and 2011/400) is promoted as "the only innovative building technology that compares with double brick plastered in terms of structure, fire, acoustic attenuation and thermal properties". With respect to thermal properties and to infer superior thermal comfort, they claim their Panel walling systems have "better thermal ratings than clay brick".

No evidence found to validate IBT claims

What follows is a review of evidence that contradicts the notion that lightweight IBTs provide better performing social infrastructure buildings than what clay brick construction provides.

In the first instance a look at the Physical Characteristics pamphlet and the Agrément certificates 2010/376 and 2011/400 pertaining to the highest certificated IBT wall panel system shows the following comparison with 220 mm double brick solid walls:

Strength: Relative Strength Factor
50mm Panel – 3.8
75mm Panel – 3.8
Solid Masonry Wall – 5.8

Fire Rating: Comparative Fire Ratings
50mm Panel – 1 Hour
75mm Panel – 2 Hours
Solid Clay Brick – 4 Hours

The 220mm solid clay brick wall values above are superior to that of the IBT wall panel system.

As for comparative thermal performance, Table 2 of Agrément certificates 2010/376 and 2011/400: Habitability, Sections Thermal Performance and Energy, state:

Affordable housing should be affordable over the entire life cycle.

1. **"The thermal performance of both Panel Building System buildings without insulation in the ceiling will be inferior to that of a standard brick house (SBH)** [A standard brick house comprises 220mm solid double skin walls with no insulation in the ceiling] and will perform better when insulated ceilings are installed".

2. **"The energy required to heat both Panel Building Systems without insulation ceiling will be up to two times that required to heat the SBH".** Certification requires that insulated ceilings must always be installed.

It is ceiling insulation therefore, and not the supposed 'higher thermal rating' of the Panel Systems, that lowers the 'heating' energy usage to below that of an uninsulated solid clay brick walled house.

With the highest certificated IBT in Africa shown up as failing to compare with basic solid double brick wall construction, it poses the question as to just how comparable the walling systems of the 31 other supposedly better performing IBT walling systems might be for meeting the challenges of providing sustainable social infrastructure buildings any way comparable to that which clay brick construction has done over the decades.

Thermal Comfort Claims in Context

The Agrément SA certificates 2010/376 and 2011/400 only reference 'heating' energy and in South Africa heating energy is only part of the energy consumed in buildings. **There is a plethora of scientific research, both empirical and modeling**, as highlighted in Chapter: "The true thermal performance and energy efficiency of different walling envelopes"- The Sustainable Energy Resource Handbook Volume 6, **that confirms the comparative inefficiencies of insulated lightweight walled buildings in attenuating indoor temperatures to thermal comfort levels on summer days.** The 'unsupported' superior thermal performance claims of the proponents of lightweight IBT for school buildings aside, credible thermal modelling points to 220mm solid double brick walls providing longest periods of thermal comfort during day-time. The extent of this superior thermal comfort clay brick construction provides, relative to lightweight IBTs such as LSF specified SANS 517, is well shown in the findings of the University of Pretoria, "A thermal performance comparison between six wall construction methods frequently used in South Africa" (April 2015).

This research, that has passed critical review, involved the modelling of three building typologies, the one being of a 2,000m² office/institutional day-time occupancy building, referenced in Table 1 below.

Clay Brick well out performs Lightweight

Solid 220mm double brick walling outperforms SANS 517 LSFB by between 10% and 57% depending on the climatic zone concerning the added value that thermal mass brings to the day-time energy efficiency equation.

TABLE 1

GROSS ANNUAL HEATING & COOLING FOR THE 2,000M² OFFICE EXPRESSED IN KWH						
Climatic Zone ▸ Wall Type ▾	Zone 01 Bloemfnt	Zone 02 Pretoria	Zone 03 Musina	Zone 04 Cape Town	Zone 05 Durban	Zone 06 Upington
220mm Solid Clay Brick	51 088	82 892	222 937	67 032	140 756	190 548
270mm Cavity (50mm) Clay Brick - Uninsulated	52 630	87 268	228 858	71 218	148 191	192 934
280mm Cavity (50mm) Clay Brick - Insulated	56 178	93 772	236 063	78 817	158 572	197 806
140mm Hollow Concrete Block	45 731	85 317	225 654	69 127	143 983	191 781
Light Steel Frame to SABS 517	68 921	117 083	250 258	105 389	180 980	209 769
Timber Frame with Fibre Board	76 207	113 005	245 870	97 846	177 095	206 635

Bongolethu Primary School – Built Real and Performing Proper

The Clay Brick classroom environment at Chief Albert Luthuli Primary School – in a different class to that of lightweight.

Today, and thanks to a decade of empirical research and analysis of real buildings under real world conditions at the University of Newcastle, Priority Research Centre for Energy, various parametric studies, and no less than five thermal modelling studies of different building typologies comprising different wall construction types, the clay brick industry has substantive evidence confirming that wall construction types that include clay brick will outperform LSF specified SANS 517 walled buildings in South African climates. The thermal mass inherent in clay bricks is what brings the 'X' factor to the thermal efficiency equation.

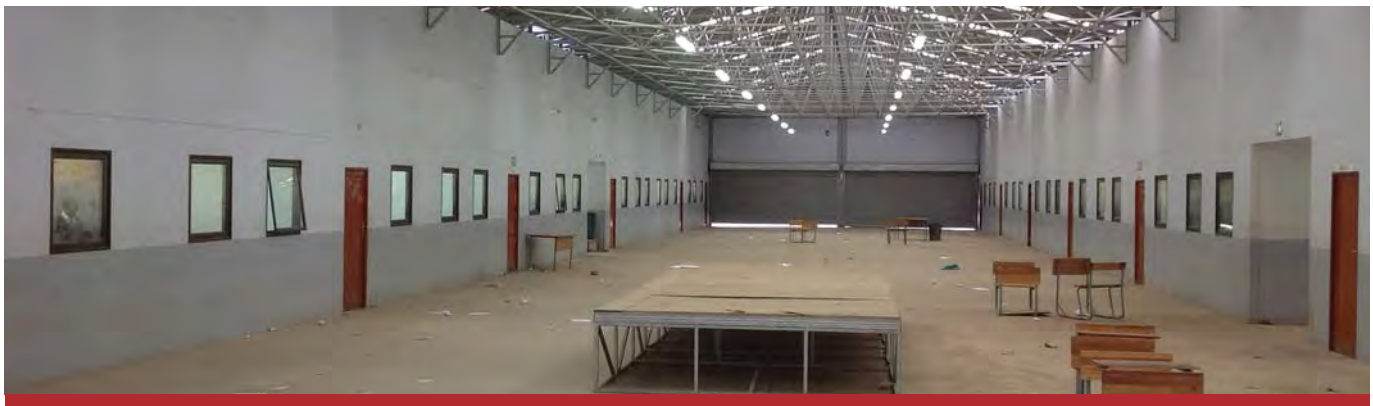
While research confirms insulation in the walls is an important contributor for achieving energy efficiency in 40m² and 130m² house types, particularly in the colder winter climate zones, **(insulated cavity brick, in compliance with SANS 204 Energy Efficiency Standards for masonry buildings, is the top performer)**.

The research has dispelled the notion that the wall R-value is the all-important thermal performance property.

As depicted in Table 1, when it comes to office/institutional type buildings solid 220mm double skin clay brick walls (R0.45) and 270mm clay brick cavity walls (R0.65) provide requisite thermal mass and resistance to outperform SANS 204 compliant lightweight walling (R1.9 and R2.2) in terms of day-time thermal efficiency.

The University of Pretoria study produced some key findings that included:

- "Solid clay brick masonry is the most thermally and energy efficient walling system considered for day-time or non-residential occupancy buildings, (or for Climatic Zone 4, a 270mm clay brick cavity wall)"
- "The most efficient South African walling system for residential buildings is a 280mm insulated cavity brick masonary wall".
- "Clay brick masonry cavity walls are generally the more thermally and energy efficient walling system for all day or residential occupancy buildings".
- **"Light steel frame wall construction presently specified models in SANS 517 is not thermally efficient and uses more heating and cooling energy compared to clay brick masonry cavity walls in all climatic regions"**,
- **There is a significant energy cost premium (20-30%) associated with the use of lightweight partitioning systems in all 3 building typologies modelled.** This latter finding, correlates with that of the empirical research at the University of Newcastle, where clay brick internal partition walls enhanced energy efficiency of buildings no matter the external walling construction type. The study found that clay brick partition walls enhanced the thermal performance of the insulated lightweight walled building by 20%.



Pakamani Primary School – Shabby internal communal space and cracked poor quality internal LSF partition walls.

Lotus Gardens Primary School – LSF has not provided better quality nor better day-time thermal comfort than clay brick construction.

Full Life Cycle Assessment

Adding further support to clay brick construction's sustainability credentials are the findings of the full Life Cycle Assessment by Energetics in Australia.

This thermal modelling study done as part of the LCA, considered two house floor plans placed in three climatic zones and four orientations, constructed with cavity walling comprising five different walling material options, the lightweight walling option being of Timber Frame insulated weatherboard construction.

Table 2 below that presents a summary of heating and cooling energy Green House Gas –GHG-(kg CO2-e) emissions over 50 years, shows that both the double skin clay cavity walled house (wall R-value 0.65) and the same with insulation (wall R-value 1.3) on average provide superior thermal comfort and lower annual heating and cooling energy usage compared to the insulated Timber Frame alternate.

On average the double skin cavity walled house (wall R-value 0.65) used 7 percent less energy [kWh] to achieve target thermal comfort and the double brick with insulation (wall R-value 1.3) 14 percent less energy. This translated into similar savings in Green House Gas (kg CO_2-e) emitted, as detailed in Table 2.

When total energy (embodied plus operational) was considered over a 50 year life cycle the operational energy savings provided by **the greater thermal efficiency of the clay brick options translated into the uninsulated cavity brick buildings having lower total GHG emissions in most situations and insulated brick having lower total GHG emissions in all situations.**

A Case for Wider use of Clay Brick

The evidence from the different research touched on above makes a solid case for the wider use of clay brick construction for most energy efficient sustainable infrastructure buildings.

In doing so it presents the marketing speak of the advocates of lightweight Innovative Building Technologies as a contradiction in terms. This contradiction becomes further amplified when one looks at the other important areas of durability and lowest lifecycle cost.

In Loco School Inspections

In loco inspections of five IBT schools built and handed over in recent years provided evidence of how poorly the IBTs external walling systems are performing under real world environments. Separation between panels and extensive cracking of the panels has highlighted an apparent inability of the panel systems to deal appropriately with the differential movement between the light steel frames and the cladding materials.

South Africa, unlike Europe, is characterised by significant diurnal temperature swings between night and day and it is such **diurnal swings that accentuate the differential movement problem for IBT's.**

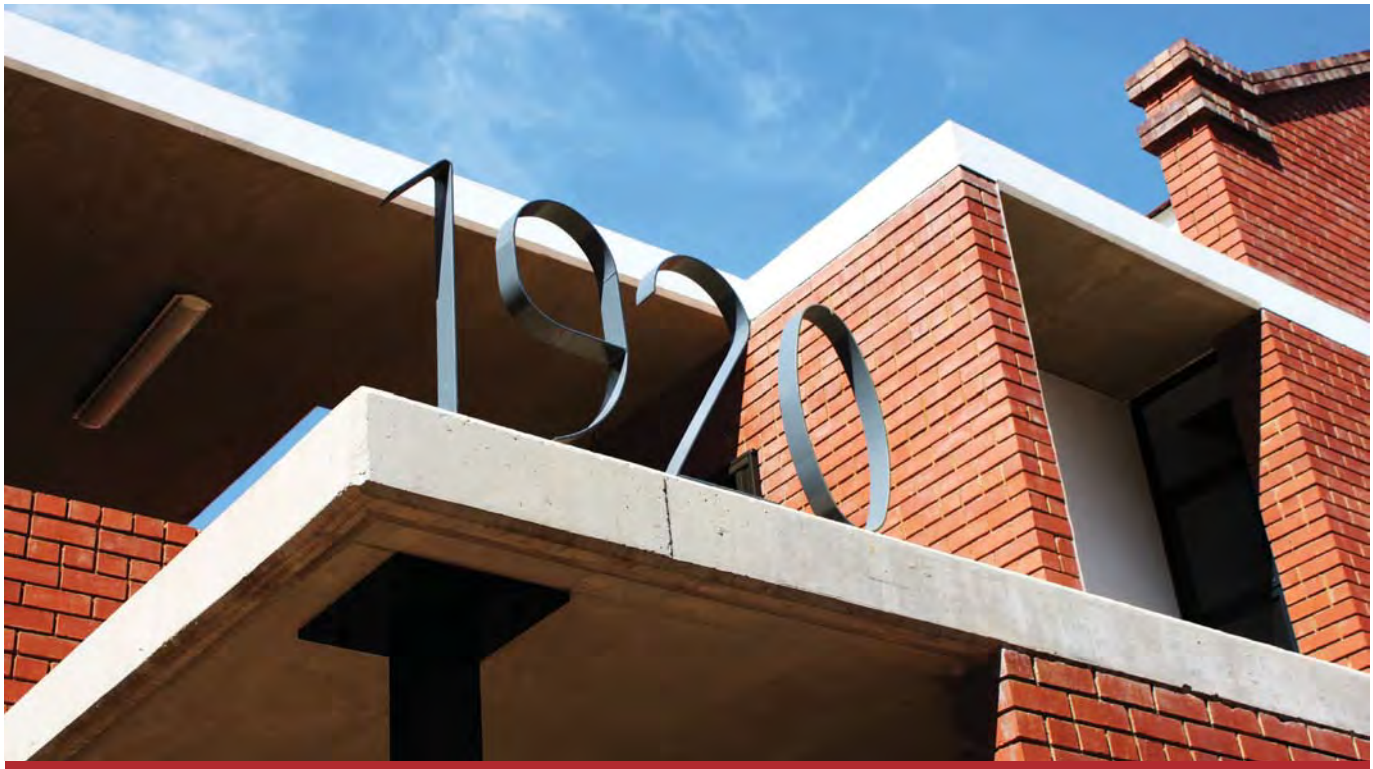
The pictures displayed in this review of just two IBT schools inspected, hardly depict the true extent of the cracking and disrepair evident on their exteriors and interiors. Similar disrepair was found on the other three IBT schools inspected; presenting a '100 percent' comparative 'failure' rate relative to the 'performance promise' inferred by either Agrément or SANS 517 certification.

TABLE 2

THERMAL MODELLING OF VERDANT AND SIROCCO HOUSE PLANS - AVERAGE HVAC GREEN HOUSE GAS (kg CO_2-e) EMISSIONS OVER 50 YEARS

COMPILED FROM ENERGETICS FULL LIFE CYCLE ASSESSMENT

LOCATION	Uninsulated Double Brick	Insulated Double Brick (R1.3)	Insulated Timber Frame	Insulated Timber more / less GHG than Double Brick	Insulated Timber more/less GHG than Double Brick Insulated (R1.3)
NEWCASTLE Climatic Zone	54 137	51 236	60 457	11.67%	18.00%
MELBOURNE Climatic Zone	73 050	63 641	72 570	-0.66%	14.03%
BRISBANE Climatic Zone	64 924	65 010	72 554	11.75%	11.60%
AVERAGE GHG	64 037	59 962	68 527	7.01%	14.28%



Affies School built in the 1920's is just one example of many, of the enduring qualities of clay brick – it simply cannot be beat!

The structural integrity and look and feel (quality) of the five clay brick schools inspected was palpably superior, similar to that of the Bongolethu and Heideveld schools. As for thermal comfort, the **"efficiency" with which insulated lightweight IBTs facilitate 'hotbox' indoor environments during summer days, will forever detract from the quality of the teaching and learning experience.**

There was zero evidence from the inspections or research that included the University of Pretoria findings, to support Dr van Wyk's general assertion that IBTs provide "improved energy efficiency and quality control" (Built- July 2014).

There was zero evidence of LSF providing any benefits over conventional building to give credence to Mr Barnard's general assertions that LSF provides better quality, cost, durability and speed.

All evidence points to IBTs specified SANS 517 presenting a compromise on clay brick construction.

If we are serious about best value, sustainable infrastructure and job creation, as we should be, then fabricated or prefabricated, high maintenance, less energy efficient, limited lifecycle lightweight IBT buildings, as evidenced in these Agrément certificated and SANS 517 compliant system built schools, seems hardly a plausible approach.

Olivenhoutsbosch Primary School – Separation between and cracking of panels

Sustainable Building

Energetics, in their full Life Cycle Assessment noted that, today's environmental paradigm requires we build buildings able to endure, with little maintenance, and definitely no materials replacement, way beyond the 50 year life cycle. Clay brick buildings in their various forms have proven themselves over the centuries to be more than up to this task.

Looking to a sustainable, energy efficient future

It may be considered most fortunate that the South African building industry has been founded on a masonry tradition that predominates to this day; a simple, cost effective building methodology that science now proves so relevant for achieving a more sustainable built environment.

Holistic Value

The proven, multi-faceted sustainable value of clay brick construction, buoyed by the scientifically proven superior thermal outcomes double skin clay brick walls provide day-time occupancy social infrastructure buildings, simply amplifies the extent of the added value clay brick construction offers over alternative lightweight systems for building a more sustainable, more energy efficient future and keeping our world a better place. All the evidence conspires to present IBTs - like LSF specified SANS 517, as a compromise.

REFERENCES:

1. A Thermal Performance Comparison Between Six Wall Construction Methods frequently used in South Africa – (April 2015) (Prof. P Vosloo, H Harris, Emeritius Prof. D Holm, N van Rooyen , G Rice.)

2. A study of Thermal Performance of Australian Housing, Priority Research Centre for Energy, University of Newcastle, Australia. (Prof. A Page, Prof. B Moghtaderi, D. Alterman, S Hands.)

3. Full Life Cycle Assessment by Energetics (Pty) Ltd, Australia (2010) for Think Brick Australia (www.thinkbrick.com.au).

4. Real life experiences, observations and the records of inpections of 5 IBT schools and 5 Clay Brick schools visited by members of the Clay Brick Association (2012 -2015).

www.claybrick.org.za