

NOT JUST ANOTHER BRICK IN THE WALL

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The design and construction of your building's *shell, or envelope*, plays a critical role in occupancy comfort, structural integrity, appearance, operating energy costs and building life, to mention only a few of the areas that this essential building element impacts on. There is a compelling need for the building to be sustainable for its full life cycle, by improving the profits of the owner, being socially acceptable to the community and not harming the environment. Therefore, the challenge to find suitable materials with which to construct the envelope, is a daunting one. Is there a locally available material that neatly balances the requirements for true sustainability? Does it have to be “new”, or so-called “innovative”, or have we had it with us all along? This article proposes that the standard clay masonry unit is a material that meets the requirements of a sustainable solution. Its properties result in admirable performance in the *economic, social and environmental* dimensions of sustainability, thereby producing an optimal “triple bottom line”.

The social acceptability of clay masonry is without question. For the majority of building owners it is the preferred walling material. With the blend of structural strength, pleasing aesthetics, permanence and security offered by clay masonry, it is not surprising that most South African buildings are constructed from these materials. With social acceptance comes economic success, as the building is not only a great place to live, work and play, but an investment for a lifetime. Clay masonry homes are passed on from generation to generation, and it is not unusual to talk of buildings with life spans of up to 100 years or more. The so-called “new” and “innovative” materials have no such track record.

For thousands of years, buildings have been built from clay masonry units. Clay is in abundance in South Africa, having been formed naturally through geological and weathering processes. After inclusion in a wall system, the clay masonry unit has an exceptionally long life, with all the good attributes locked in. Being

completely inert it has no negative impact on the environment. It is true that the production processes consume energy, from clay mining to vitrifying the units in a kiln. However, many local brick makers mine their raw materials on the same site as the factory, and because clay is surface mined, rehabilitation is straightforward, with the majority of quarries being turned into water catchment facilities once mined-out, often improving the bio-diversity of the site.



Also, many brick makers use fuels for their kilns that are sourced from the non-hazardous waste streams of other industries. All clay mines and factories fall under the auspices of the Mineral Petroleum and Resources Development Act of 2002 and as such are subject to rigorous Environmental Management Programmes, including detailed closure plans. The Air Quality Act of 2004 provides for stringent control over emissions, to world class levels. A large South African brick maker has the honour of being the first company in Africa to qualify for United Nations approved carbon credits for using low CO₂ emission natural gas to produce their products

Of course, buildings are complex in that they are used in many different ways, each designed with a particular purpose in mind. For true sustainability, many issues need to be considered and managed over the building's life. Within this myriad of interconnecting issues, the challenge of *reducing energy consumption* for the building's life cycle is, arguably, the greatest and most important. Building energy consumption in South Africa damages the environment in particular due to our electrical power having its origins in coal fired power stations, and with the high cost of this power to the consumer, a poorly designed and constructed envelope can result in the occupants living uncomfortably, and the building losing

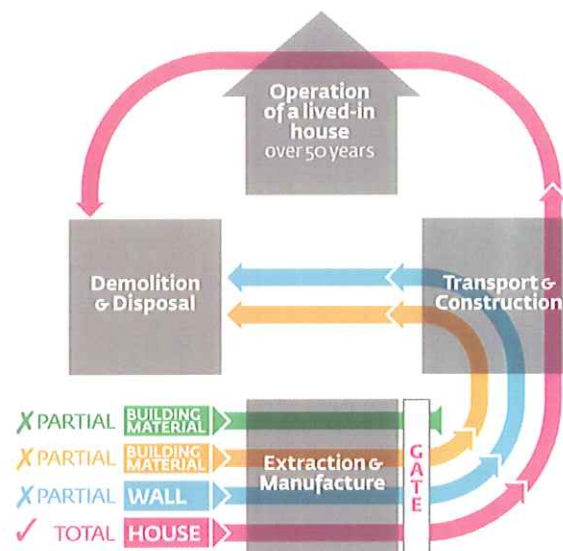
its appeal and asset value over time. Those who can afford to pay for high energy costs to achieve comfort, add to the environmental damage caused by energy generation and consumption.

In order to assess the environmental life cycle impact of various building materials, studies have been conducted globally. Many of these have focused on calculating a “cradle to gate” embodied energy value. A key learning point from these studies has been that in order to compare embodied energy values of materials within the same geographic region, a rigorous and objectively applied methodology is required, and it is difficult to identify and quantify the energy content of a unit of material at each step in the manufacturing process. Furthermore, comparisons from region to region, or country to country are unhelpful and inaccurate, even if it is just due to the fact that the primary sources of energy vary vastly in different regions and countries.

Leading academics and researchers are grappling with the challenge of defining a material’s life time impact, and whilst still in its infancy as a robust methodology, Life Cycle Assessment (LCA) is gaining in popularity and use. Life Cycle Inventory (LCI) databases are being constructed in leading countries, thereby providing the material data needed for a thorough LCA and ultimately an “eco-label” declaring the material to be environmentally sustainable. In a recent Australian LCA study focused on residential housing¹, it was concluded that *“total operational energy (including HVAC, lighting, domestic hot water and appliances) dominates (up to 90% contribution) the performance of the house over its life (including a detailed assessment of the life cycle of construction materials).....This means that systemic improvements will be more easily delivered through effecting efficiency improvements during the use of the house, than in changing the materials of wall construction.”* The study further concluded that *“The design of the house has a greater impact on the lifetime performance, than does the selection of the materials (for the exterior wall*

¹ Life Cycle Assessment Report – LCA of Brick Products, Energetics Pty Ltd, for Think Brick Australia, February 2010.

construction).....The effect which dominates the assessment is how the house is used.”



LCA of a material considers the environmental impact in the 4 stages of its lifecycle

In summary, the requirement is for a walling material that can be *used with building design principles to reduce imported energy consumption.*

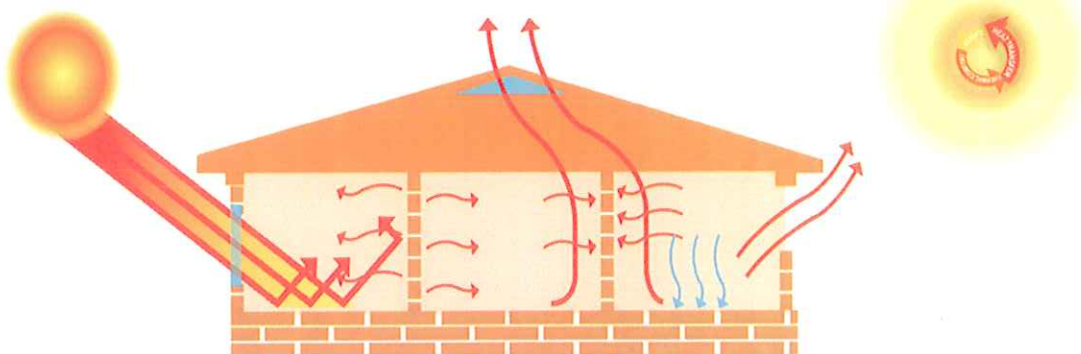
The walls of any building form the barrier and shield for the occupants against the harshness of the external environment. South Africa’s climate is characterized by great diversity due to varying altitudes and a long coastline. The large variation in daily average temperatures (diurnal swing) in many regions, presents the walls with the challenge of moderating the external temperature amplitudes to a more bearable level indoors, whilst ensuring that the average indoor temperature across all seasons is at an acceptable level for the average person. If indoor conditions are comfortable, then there will be a reduction in heating and cooling energy consumption, as the occupants will not use artificial means.

Through the power of modern sophisticated computer modeling, based on years of empirical research data, it is clear that in the typical South African climate, the optimal wall system would have sufficient levels of thermal capacity (C-value) and thermal resistance (R-value). It is well accepted globally that in climates with high diurnal swings and relatively high summer temperatures that thermal

capacity in the building envelope plays a significant role in achieving indoor thermal comfort. Thermal capacity acts like a battery, in that heat energy is absorbed, stored and released at a later time. In the summer months, this slows down heat transfer from outside to inside, often delaying the peak indoor temperature to much later in the day, around the time that the heat flow direction reverses, as the thermal capacity in the wall absorbs heat from the indoor air when the outside cools. This is known as *thermal lag*. In the winter months, similar dynamics are present but the focus is more on the ability to absorb heat energy from the low angled winter sun, transfer it indoors and then keep it inside for as long as possible to minimize the need for heating energy. Clay masonry walls have an inherent R-value in addition to their C-value. This R-value helps to lift the average indoor temperature to comfortable levels in the winter months. For many of the climate zones in South Africa, a double skin clay masonry wall with an air cavity will be sufficient. In the harsher winter extreme climates, it is necessary to add insulation to increase the R-value.

With the abundance of free solar energy in South Africa, designers should always start with *passive solar building* principles in mind, namely, correct orientation, use of natural ventilation, sufficient shading and the appropriate levels of thermal capacity and insulation in the building envelope. Clay masonry units are perfectly suited to this approach, which has as its primary objective, the elimination of imported building energy.

Passive Buildings Collect, Store and Distribute Heat from Solar Energy



Clay Masonry Units play a role in Radiative, Convective and Conductive Heat Transfer.

Some decades ago, the Council for Scientific and Industrial Research (CSIR) published the CR Method², based on empirical data, and providing the user with a tool for determining the levels of C and R-value (together known as the CR-value) that would provide the desired level of indoor thermal comfort. Recent modeling studies have refined the CR Method³, leading to minimum CR-values for external walls for all building types in South Africa's main climate zones, being proposed for the next version of SANS 204 : Energy Efficiency in Buildings⁴.

Next time you look at a clay masonry unit, realise that it is not just another brick in the wall. Rather, it is a tried and trusted material that neatly balances the full requirements of sustainability, with its inherent thermal capacity and resistance delivering the optimal energy performance in one tidy package.

All queries and comments welcome at www.claybrick.org.za

² The Prediction of the Thermal Performance of Buildings by the CR Method, Wentzel, Page-Shipp & Venter, National Building Research Institute, Pretoria, 1981.

³ A Novel Algorithm for the Specification of Thermal Capacity and Resistance in Exterior Walling in the South African Standard for Energy Efficient Buildings, Holm, Harris & Burton, August 2010.

⁴ The Development of a Rational Basis for the Selection of Thermal Mass and Thermal Insulation in External Walling, and a set of Deemed to Satisfy Requirements for External Walling in the SANS 204 Standard, Harris, Holm, Burton, April 2010.