DEEMED TO SATISFY REQUIREMENTS FOR NATIONAL STANDARDS

The CR product requirements proposed for incorporation into regulations and standards are developed from the minimum Life Cycle Cost options. By selecting the walling option based on this principle for the Deemed-to-Satisfy (DTS) proposal, the economic viability is reassured, for both that climatic region and for the occupancy cluster.

The tendency toward lightweight industrial building systems facilitates the incorporation of thermal resistance aspects, but not thermal capacity. Much has been made of the thermal efficiency of such systems, but it has been proved that only when combined with thermal capacity are optimal results achieved.

Most thermal insulation materials are low in mass and most brickwork is high in thermal conductivity, but it can be foreseen that some materials are more cost effective than others. For these materials and combinations thereof, a rational design compliance route as per SANS 204 would be more appropriate.

Wall systems that have low, or no, thermal capacity will not meet the DTS requirements. In such cases a rational design should be implemented to prevent construction that will not meet the national energy reduction goals.

The area of windows relative to high mass walling has similar importance. Any figure over 20% for residential or retail buildings or 25% for offices and institutions will decrease the benefits of thermal capacity. For residential buildings the DTS rule specifies northerly facing windows not exceeding 45% of the northerly facade, and 40 to 50% for south facing windows. For non-residential buildings it is 45% north and south.

Minimum thermal capacity & resistance CR product, in hours, for external walling

Occupancy Group / Climate Zone	1	2	3	4	5	6
Residential E1-3,H1-5	100	80	80	100	60	90
Office & Institutional A1-4,C1-2,B1-3,G1	80	80	100	100	80	80
Retail F1-3,J3	80	80	120	80	60	100

Table 1 : Minimum Thermal Capacity & Resistance Products by Region and Occupancy

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* Information correct as at time of going to press - March 2010

PRACTICAL RELEVANCE

To relate these DTS values to existing walling systems, can be achieved with a range of standard high mass walls, such as a 106mm double brick construction e.g. face brick externally and plastered internally, with a minimum thermal insulation provided by a 50mm air-cavity, through to a similar wall with 30mm of expanded polystyrene in the cavity, in order to achieve higher CR values.

To achieve the DTS CR product requirements, the external wall system must contain a minimum level of thermal capacity (C) and thermal resistance (R).

Clay brick is an ideal material that features both qualities; however to meet the CR product requirements, additional thermal resistance is required in some climate zones. Thermal resistance and thermal capacity are both essential to reach the optimal energy consumption and life cycle cost.

Architects and specifiers will be able to use clay brick in combination with thermal insulation in cavity wall constructions to easily meet the new Deemed-to-Satisfy requirements of SANS 204.

A limited survey among Building Contractors resulted in the predominant opinion that with correct training Energy Efficiency could be achieved without compromising productivity and quality.

Environmentally Friendly

CLAY BRICK for good

CLAY BRICK INITIATIVES TO ACHIEVE ENERGY SAVINGS

ClayBrick.org supports all initiatives pertaining to the reduction of energy usage in buildings, including the development of national standards for walling, as set out by the South African Bureau of Standards in consultation with the National Regulator of Compulsory Specifications, i.e.:

- The SANS 204 series for Energy Efficiency in Buildings
- The new SANS 10-400XA – Energy Usage (The application of the National Building Regulations - soon to be compulsory)

To fully substantiate the performance of Clay Brick, as an energy efficient building material, ClayBrick commissioned WSP Energy Africa to develop a rationale for the selection of thermal capacity and thermal insulation in external walling, for inclusion in SANS 204.

Findings from this research showed that the South African climate, the building's physics and the choice of building materials used impacted significantly on the energy efficiencies in buildings. Here, Clay Bricks contribute towards an even greater level of reduction in energy usage, compared to the intended 30% energy reduction requirement of the RSA Energy Strategy, without adding to the life cycle cost of the building.

SOUTH AFRICAN CLIMATE ISSUES, COMFORT AND ENERGY USAGE

Most interior South African climate regions are characterised by high daily temperature ranges, cool winters and moderate absolute summer temperatures. This is a result of the (+/- > 1000m) altitude and the latitude (20 to 34 degrees South) and is typical of Continental type climates. In many cases, coastal towns benefit from the warm Mozambique current, and their proximity to the sea.

The use of thermal capacity in buildings located in interior climates is found to be particularly beneficial for reduced space heating and cooling energy. This is hardly surprising given the prevalent use of clay bricks in South African buildings.

For each climatic region an optimum thermal neutrality point exists for the building's occupants and their activities.

The primary determinants of the energy performance requirements of an external walling system in any climate is the building Occupancy Type – which dictates density, activity levels and heat load in the building, as well as the desired thermal comfort ranges.

BUILDING PHYSICS REVISITED

One of the major influences on the internal climate, comfort levels and the energy usage of buildings is the thermal capacity and thermal resistance of the walling.

- The thermal capacity of a layer in a wall can be calculated from first principles as: Specific heat (kJ/kg.K) x density (kg/m^2) x thickness (m) = kJ/m^2.K ("C")
- The thermal resistance of a layer in a wall can be calculated from first principles as: Thickness (m) x (1/thermal conductivity) (m.K/W) = m^2.K/W ("R")
- The active thermal capacity of a layer in a wall can be estimated as: Thermal capacity x a weighting factor = kJ/m^2.K ("Cact"). The weighting factor is determined by the position of the layer relative to the internal environment, and the thermal resistance of the adjacent layers.

When dealing with a composite wall the final result is the sum of the resistance, capacity or active thermal capacity of all layers. This serves as a suitable composite measure of the thermal performance of a wall, in that both the thermal capacity and thermal resistance are considered.

DESIGNING TO MINIMISE INTERNAL BUILDING TEMPERATURES

Average internal temperatures can be maintained within a range of comfort around the desired thermal neutral point by using appropriate combinations of thermal capacity and resistance in the external walls. In the very same way, the amplitude ratio (internal temperature range / external diurnal temperature range) within a building structure can be kept to a minimum. The thermal capacity and resistance features of clay brick make it ideal for this application.

Research into the relationship between the amplitude ratio, the active thermal capacity and the thermal resistance of the building shell in the SA climate resulted in a set of building physics formulae commonly referred to as the CR Method. The desired amplitude ratio can therefore be selected which will in turn have a required active thermal capacity and / or CR product.

The average internal temperature rise is proportional to the solar radiation transmitted through glazed openings in the external wall, the internal floor area and the specific thermal resistance of the shell of the building. Air leakages hinder the beneficial effects of C and R.

CONVENIENT PERFORMANCE REQUIREMENT FOR ENERGY EFFICIENT WALLING

The thermal performance of external walls directly influences thermal comfort only in the perimeter zone of buildings, with a diminished effect in the interior zone - no matter the size of the building.

The CR product (arithmetical product of thermal capacity and thermal resistance) has been adopted as the performance criteria for the deemed-to-satisfy rules.

The CR product of a composite wall is the "time constant" or thermal lag characteristic of that wall, measured in hours. This is a constant that is not influenced by internal or external loads.

The optimal wall parameters were developed by graphical analysis, which were then proven by thermal modelling of energy consumption and life cycle cost.

RESEARCH FINDINGS

Increasing levels of thermal capacity and resistance in the external walls result in lower energy consumption, See Figure 1 below.

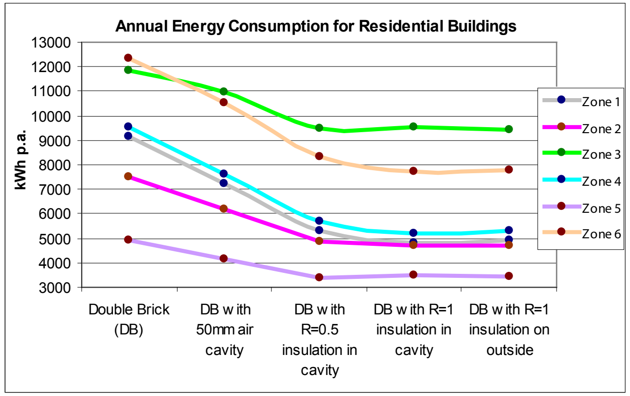


Figure 1 : Energy Consumed in Residential Buildings

When life cycle costs are considered, an optimum wall system for each of the six climate zones and occupancy type combination can be identified.

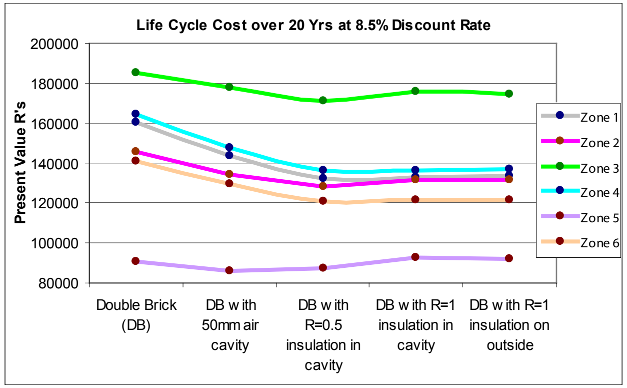
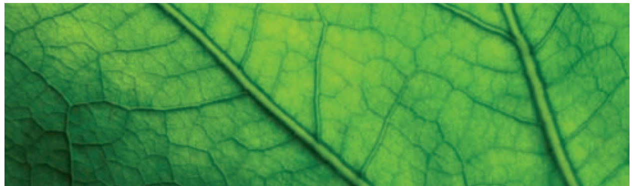


Figure 2 : Life Cycle Costs of Residential Buildings for six climatic regions



RESEARCH CONCLUSIONS

To achieve optimal energy reduction and life cycle cost minimisation, a minimum amount of C and R are required for walling in the particular localities within South Africa. These are different for various occupancies within these climatic localities.

These minima can be combined into an easily understood performance criteria – namely the CR Product. These are set out in the table 1.

The positioning of layers with high R values is a critical determinant. The optimum position for thermal resistance is inside the wall cavity. By placing a thermal resistant layer on the inside face of external walls is detrimental to active thermal capacity levels and results in increased energy consumption, whereas, by placing thermal resistance on the outside of external walls sometimes shows a greater reduction in energy consumption over insulation inside the wall cavity. However, when considering energy consumption, costs and other practical issues, the placement of insulation between two layers of material with high thermal capacity is still the most favourable.