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WSP Report – ClayBrick Extension Report

ClayBrick.org
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Executive Summary

The determination of the energy usage premium allied to the use of external walling systems that do not comply with the deemed-to satisfy (DTS) requirements for walling with a surface density greater than 180kg/m2, in the SANS 204 standard for Energy Efficiency in Buildings.

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For the Clay Brick Association

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1 Introduction

The Clay Brick Association recently funded research with the objective of developing scientifically based deemed-to-satisfy requirements for external walling in South Africa. After a process of critical peer review, this research has culminated in the final report dated 1 March 2010. This work was carried by WSP Energy Africa in conjunction with Professor Dieter Holm as specialist consultant, and resulted in a recommendation that a table of minimum CR values be adopted into the standard. Any wall system would, therefore, have to achieve said values to be deemed-to-satisfy. A further recommendation was that should wall systems with low thermal capacity and / or thermal resistance be selected for a building design, then such a design should be subjected to a rational approach by a competent person.

The WSP report was reviewed by the members of the SABS Steering Committee 59G and was accepted as the basis for a table of deemed-to satisfy CR product requirements for walling systems of surface density greater than 180kg/m2. This was to allow walling systems of less density, typically of low thermal capacity and higher thermal resistance, to also be deemed-to-satisfy. The Clay Brick Association noted the concern of the committee with this situation as the research showed that walls should contain minimum levels of both thermal capacity and resistance if energy efficiency goals are to be achieved.

In order to quantify this concern, the Clay Brick Association has extended the research project to include some further modelling of the same building designs which were developed in the research process, with three alternative low mass / surface density walling systems.

2 SANS 204 Walling Deemed To Satisfy Requirements

The following table of C * R Products was developed and adopted for SANS 204 external walling requirements:

Optimal Thermal Capacity & Resistance Product by Region and Occupancy (h)						
Occupancy Group Region	1	2	3	4	5	6
Residential	100	80	80	100	60	90
Office & Institutional	80	80	100	100	80	80
Retail	80	80	120	80	60	100

3 Additional Walling Systems

The following additional walling systems were evaluated:

- A light steel frame structure, without thermal insulation (low capacity and resistance).
- A light steel frame structure, with thermal insulation to SANS 204 requirements for low mass surface density walling (low capacity and high resistance).
- A 140mm hollow concrete block wall with 12mm sand cement plaster internally, bagged and painted externally (moderate capacity and low resistance).
- Solid brick (106mm wide) double wall, no cavity (high capacity and moderate resistance).

4 Combinations Of Thermal Capacity & Resistance To Comply With SANS 204

The table below is based on the standard 106mm facing brick and common plaster brick in a so called double brick wall, with added insulation installed in the cavity as is required to meet the various determined performance levels for energy efficiency, as per SANS 204. The cost data was provided by WSP Green-by-Design, as part of previous research work performed for Corobrik. From discussion with building contractors it was ascertained that to attribute a cost to creating the cavity wall was unnecessary as there was very little extra labour and no additional material added when building double brick cavity walls, and the foundations thereto.

Thermal capacity & resistance combinations to meet DTS requirements and the cost thereof

C * R product (h)	Thermal capacity (kJ/K) of wall per m^2	Thermal capacity (Wh/K) of wall per m^2	Thermal resistance requirement to achieve C*R product (m^2.K/W)	Thermal resistance of masonry portion of wall (m^2.K/W)	Added thermal resistance (m^2.K/W)	Added thermal insulation thickness (mm)	Cost of added thermal insulation per m^2	Added cost of improving Energy Efficiency of residential design
40	326	90.56	0.44	0.44	0.00	0	R 0.00	R 0.00
60	326	90.56	0.66	0.44	0.22	0	R 0.00	R 0.00
80	326	90.56	0.88	0.44	0.44	20	R 15.00	R 1,897.50
90	326	90.56	0.99	0.44	0.55	25	R 20.48	R 2,591.13
100	326	90.56	1.10	0.44	0.66	30	R 21.58	R 2,729.43
120	326	90.56	1.33	0.44	0.89	40	R 23.76	R 3,006.02

Assumptions

Thermal conductivity selection W/m.K	0.045
Thermal capacity selection kJ/m^2K	326
Thermal resistance of walling	0.44
Cost per added mm of insulation	R0.22
Basic cost of 20mm insulation R/m^2	R 15.00
Area of walling in house m^2	126.5

5 Methodology

The basic building designs modelled in this project were as developed for the research project into deemed-to-satisfy requirements for SANS 204. These are synthetic building designs which are intended to test the thermal efficiency of walling systems, and therefore exclude other high thermal mass elements typically found in such a building. The building is $130m^2$ in size, and is adapted for the three occupancy clusters; residential, office/institutional and retail. The occupancy based variables such as window design, lighting requirements, hours of usage and density of occupants are built into the comparison.

The buildings are modelled for an entire year, thorough all seasons, and with the daily climatic fluctuations of a typical climatic year. Climate data is as developed for the Department of Minerals and Energy for various research projects conducted for the department.

The programme used is Visual DOE as was developed by the US Department of Energy and adapted for easier use by Green Building Tools of California.

6 Results

The detailed modelling results are set out in Annexure A.

On average, the synthetic designed 130.5m2 residential building energy usage is an arithmetic average of 7286kWh per annum, if the building is installed with walls complying with the SANS 204 deemed-to-satisfy level of minimum CR values.

For the residential occupancy group, using the above result as a base for comparison with other systems which do not comply with the minimum CR requirement, the following table of average percentage increases for energy usage over all regions, and average increased annual energy usage (kWh/m2), is observed.

Light steel frame, without thermal insulation	64%	35.7 kWh/m2
Light steel frame structure, with thermal insulation to SANS 204	41%	22.9 kWh/m2
140mm hollow concrete block wall with 12mm sand cement plaster	36%	20.1 kWh/m2
Solid double 106mm brick without cavity	30%	16.7 kWh/m2

7 Conclusion

The levels of stringency imposed in SANS 204 in terms of the minimum CR product values for walling systems with surface density greater than 180kg/m2, will result in significantly lower energy usage in buildings, when compared to buildings constructed of walls with low capacity and / or resistance.

8 Recommendation

It is apparent that, in our South African climate, external walls of buildings should contain minimum levels of thermal capacity and resistance. These findings support previous thermal modelling research in South Africa. Given our urgent need to save energy, it is important for government, regulators and standards bodies to take these findings seriously and move rapidly to a deemed-to-satisfy standard that facilitates maximum energy savings. Alternatively, deemed-to-satisfy requirements could be replaced by a requirement for a rational design by a competent person, if low thermal capacity and / or resistance walls are selected. This would give opportunity for designers to introduce design elements to mitigate against the additional energy use likely to result from low mass materials being used.

Appendices, Figures & Tables