SANS204 - Energy efficiency in buildings

Article by Mike Barker, Simulations by Robert Arnott – BuildingPhysics

SANS204:2008 is an initiative that came out of the Department of Minerals and Energy's 2005 Energy Efficiency Strategy that targeted a 15% Final Energy Demand reduction by 2015 for Commercial and Public Buildings. Further, the DME see SANS204 as being made mandatory by its incorporation into the National Building Regulations.

The SANS204 standard consists of 3 Parts that deal with Energy efficiency in buildings in terms of both design and operation. In summary *Part 1: General Requirements* spells out the terms of compliance as :-

> The *maximum energy demand* (VA/m²) and *maximum annual consumption* (kWh/(m²·a) shall not exceed a given value based on the type of building and the climate zone.

Building type is defined by the occupancy (hospital, office etc) as defined in SANS 10400-A, and the climate zone is as per a map that originated from work done by Dr Dieter Holm of the CSIR.

Part 2 and 3 go on to explain the required approach to the building envelope design. For example the requirements to shade windows from direct sun rays will probably lead to the demise of the out-of-place Tuscan look in favour of climate appropriate designs. Part 2 is aimed at naturally ventilated buildings and Part 3 at those with HVAC services.

Note, compliance with SANS204 will not necessarily produce a green building – but it will produce an energy efficient building by any standard.

For example, the annual consumption of an office in Gauteng shall not exceed 80 VA/m² and 200 kWh/(m²·a), and all this with a power factor of 0.95. Since SANS204 is in reaction to the electrical problem in the country, no mention is made of the use of gas, and we read it as suggesting you are free to use as much non-electrical energy as you want.

How does this figure compare to the rest of the world? We can compare this office building to the average of all US office buildings - 250 kWh/(m²·a) (as per the 2003 CBECS Survey). According to EU passive designs a building is deemed energy efficient if its uses below 120 kWh/(m²·a).

In Australia the almost equivalent climate Zone 4 has a warm dry summer / coldish winter – there the base building BCA compliant value for a medium sized office is 243 kWh/(m²·a)

It's of interest to see that Greek buildings have an impressive average annual consumption value of 135 kWh/(m²·a) because they traditionally don't make use of air conditioners for cooling.

Now while none of these figures are strictly comparable, it seems the SANS204 expectations are certainly ambitious for a country accustomed to a cheap and endless supply of electrical power!

We will do our own modelling to understand this range of energy consumption values further. During 2009 BuildingPhysics will be posting various case studies at www.buildingphysics.co.za , starting with a medium sized office block placed in the 3 main centres. The website will also allow interested parties to download the performance figure so they can then compare the results to their own investigations.

Parts 2 and 3

Apart from just using energy, SANS204 looks at building orientation, building envelope, hot water services that include solar water heating, and then the options of artificial or natural air conditioning.

Part 2 covers the application of the energy efficiency requirements for buildings with natural environmental control, while Part 3 covers the application of the energy efficiency requirements for buildings with artificial ventilation or air conditioning.

The main difference seems to be that Part 3 is about controlling the annual air-conditioning energy consumption, rather than reducing the impact of seasonal peak heating and cooling loads.

Both Parts require the application of a monster of a formula for the fenestration and required shading. Help is at hand – a spreadsheet is typically used by the Australians, and a South African adaption is available at our website at www.buiuldingphysics.co.za

Expected Energy Savings ?

What sort of saving can be expected from SAN204 compared to a traditional current building? Will South Africa's fledgling energy efficiency standard provide the savings as required by government doctrine?

Many of the directives in SANS204 are based on the Australian BCA approach and it's instructive to note that the Australians estimate savings over that of an unregulated building to be 18% to 25%.

Has SANS204 got the mix right to give us the savings we need? It provides no estimates, but we assume that the standard will attempt to deliver the 15 % saving as per the Department of Minerals and Energy's Strategy.

One way to understand the impact is to model and then simulate the performance of a set of typical buildings, firstly without, and then with, SANS204 requirements. This seems to have been done as part of SANS204 development and these results need to be released for comment.

Impact on building design

SANS204 focuses on the insulation of building envelope in order to produce an energy efficient building almost to the exclusion of other acknowledged green design principles such as daylighting and thermal mass. This can be understood since incorporating daylighting and thermal mass are seen as new concepts, although they have been around for ever. As Chris Reardon (Australia's green building guide author) says "Sustainable design is not a recent concept - it's a recently lost one "

The science and art of Daylighting is in its infancy – even the metrics used to measure daylighting are under debate. Daylight factor is now way past its usefulness, and daylight autonomy has yet to be accepted. Evidence further suggests that daylighting plays a critical although not fully understood effect on human health.

Users of SANS204 should recognise that although daylighting is acknowledged widely as being the single most important step to an energy efficient building it is difficult to design into a building. Measuring the overwhelming orders of magnitude difference in shade and direct sunlight, and the computations required to understand the variable and cyclic nature of the moving energy source needs further work.

But the next decade will lead to a better understanding of daylighting as a necessity rather than an amenity, with all the consequences for modern building design.

The other important part of SANS204, offered with little explanation and no guidance, is the use of thermal mass. Future versions of SANS204 would do well to expand on these issues, even if they are not part of the legislative section, perhaps added as an appendix and a form of instruction and guidance.

In South Africa, where we prefer to live out and open up the building to the outside, thermal mass plays an important influence on the comfort of the occupants and the energy consumption of the building. The key, whether it is cold or a warm climate, is to insulate the thermal mass from the outside environment. SANS204 would do well to expand on this requirement to ensure that the deemed to satisfy insulation is applied correctly.

The standards approach to ground coupling is interesting – it only requires insulating the floor slab if under-floor electrical heating is used. Otherwise the standard calls for the vertical outer foundation elements to be insulated and this is in effect a form of ground coupling. Ground coupling is equivalent to adding thermal mass to a building floor and is the topic of recent research and much discussion.

A good start

New building codes don't necessarily lead to good building practices. Any building code takes a while before it gains respect and is seen to be good practice.

SANS204 is far from perfect and we need to look further than just energy efficiency. The stated requirements of SANS204 cover more that just energy efficient buildings - in many cases these requirements are fundamental to comfortable buildings, and to healthy buildings, and to producing such buildings at a reasonable cost.

Since SANS204 is part of the Green Building Council of South Africa's Green Star Rating Tool, and since it was seen as playing an important part in mitigating during the 2008 energy crunch, there may have been some pressure to publish it as soon as possible.

In summary SANS204 is a good start – our often wasteful building designs need to change. This standard will need some fine tuning – that's how standards work! Version 1 is a beginning, and future version will incorporate all the hard earned feedback. As the standard is so heavily based on tried and tested Australian principles there is a good deal of experience available.

SANS204 – Comparing the performance of a SANS204 Structure to a Standard Structure

In order to find out what effect SANS 204 will have on a building, a small, poorly insulated 2 bedroom house was modelled and simulated, then remodelled to comply with SANS 204 specifications and simulated again. The two buildings have identical layouts (only the construction materials are different), with both buildings using typically South African building materials.

In reality SANS204 need only to be applied to commercial buildings of over 500 m². We chose a small residential building as a first test while we waited for the US Department of Energy to release their standard test buildings profiles.

Special care was taken not to exceed the SANS 204 specifications, and priority was given to more conventional building materials (as opposed to materials which may have benefits not required by SANS 204). For example, the standard building's windows are modelled with single glass panes and aluminium frames, while the SANS 204 building is modelled with double glazing and wooden frames. The buildings are set to face north in a typical suburban environment and the simulation makes use of weather data recorded at O.R. Tambo International Airport.

The buildings use electrical radiant heating in winter, but as South Africans tend to live with their windows open in summer, only natural ventilation was used for cooling in summer (this makes a difference to how the SANS 204 building is constructed). In order to properly model the effects of the people living in the building, schedules were set for each room with varying occupancy and metabolic rates depending on what task an individual would likely perform at that time of day. The occupants of the building are set to automatically open or close windows when the building becomes too hot or too cold. The heating and ventilation for the home are only used if the schedule shows that there is someone home at the time.

Figure 1 shows the most significant performance differences between the two buildings, with gains of 40-70% in most areas. To the building owner, the most meaningful result from this simulation is that the cost of heating the SANS 204 building is reduced by well over 80% in the winter months. The next most significant result is the 40 % reduction in discomfort hours over the entire year. The discomfort hours are when an individual would not be comfortable in either summer or winter clothing, based on air temperature, radiant temperature and humidity. For example, if an individual would feel too cold in winter while wearing long pants and a jersey or feel too hot in summer while wearing shorts and a shirt, this would contribute to the total discomfort hours. All totals include periods when the building is unoccupied, giving a better idea of the performance of the building without heating systems running, as would be the case in a power failure.

The only negative impact that this particular implementation of SANS 204 has on the building in winter is the lower solar gain through the windows, which is due to excessive shading being added on the north side of the building. A more intelligent design would have slightly reduced shading on the north windows, while adding shading on the remaining windows in order to meet SANS 204 minimum shading requirements.

As the only means to cool the building in summer is to open the windows, added insulation does little to improve the thermal comfort in the summer months. If the building were to make use of air-conditioning, similar energy savings to those seen in winter would be achieved (provided the occupants learn to live with their windows closed).

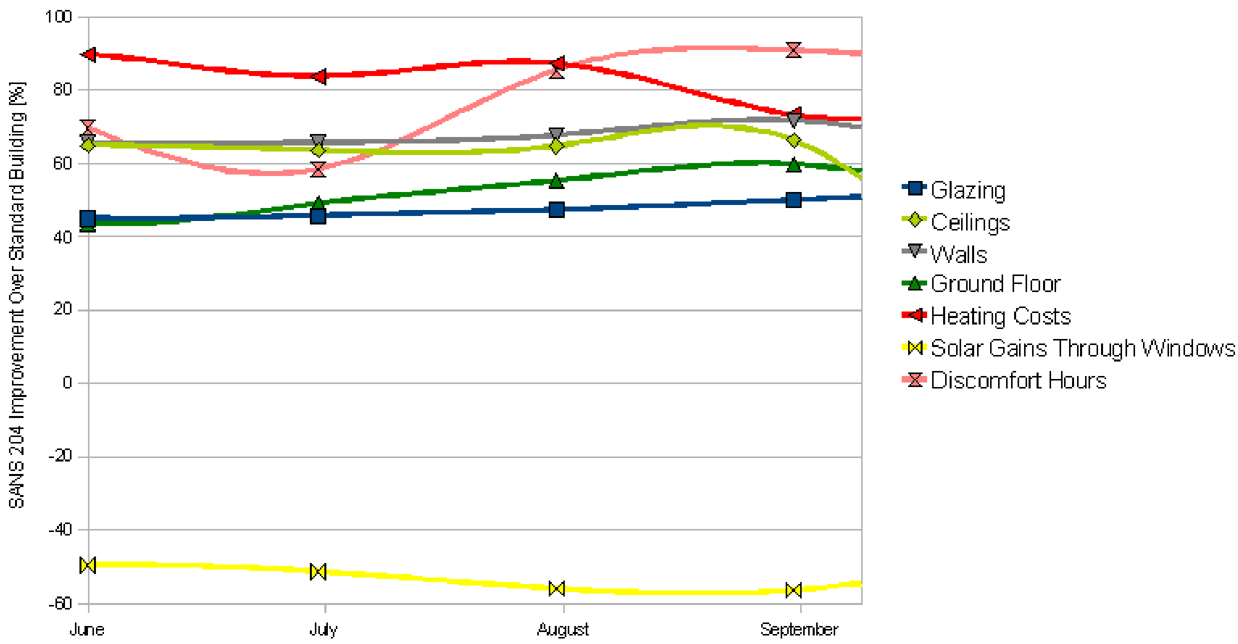

Figure 1 - The simulated performance improvements of the SANS 204 building over the standard building during the winter months. Note that the improvement for "glazing" only includes convective heat transfer, while "Solar Gains Through Windows" covers the radiant heat transfer.

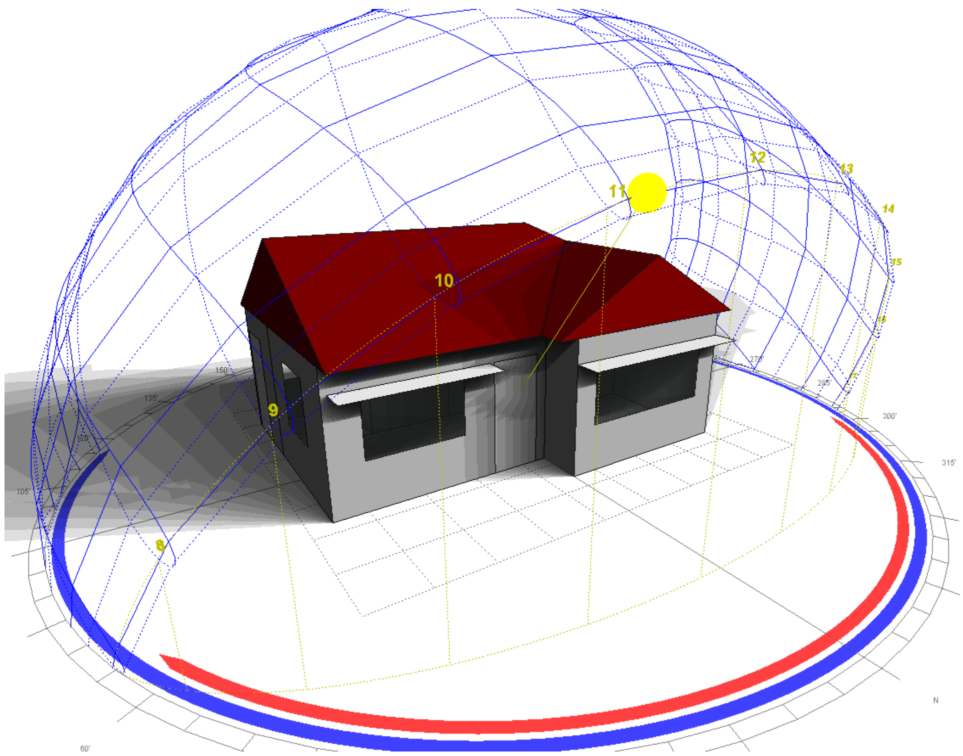

Figure 2 - SANS 204 calls for shading on the windows - this image (figures 2) shows a step in the shading design process, in this case too much shading has been added on the north windows and not enough on the remaining windows.

Daylight Factor for SANS 204 Building

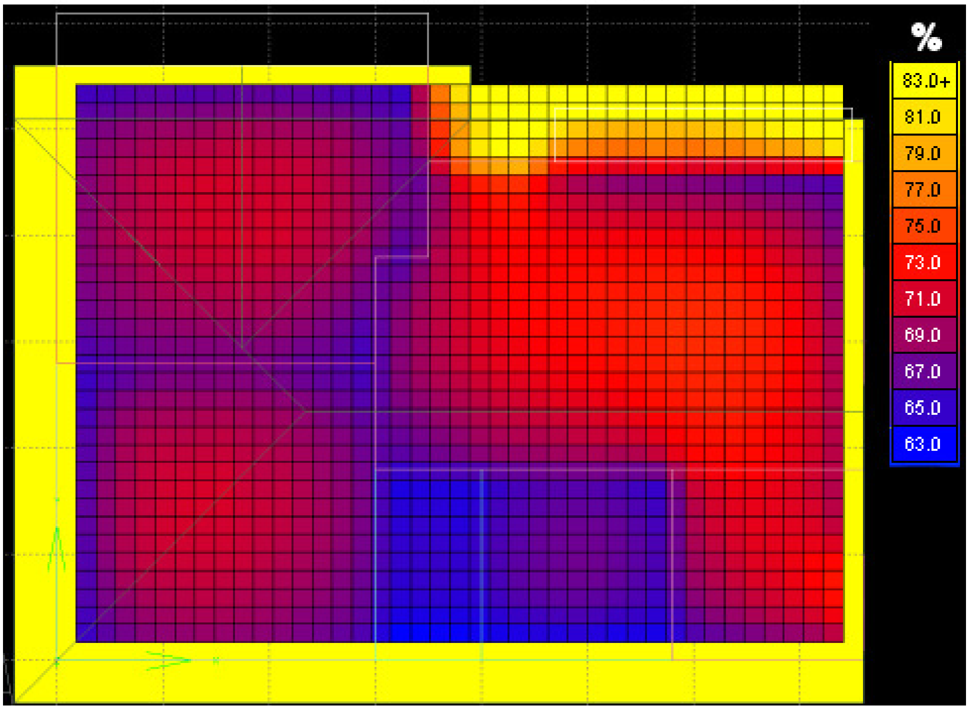

Figure 3 - A plan view showing the relative solar gains in the building throughout the year.

Figure 4 - A visual representation of the standard building, before converting it into a SANS 204 building.

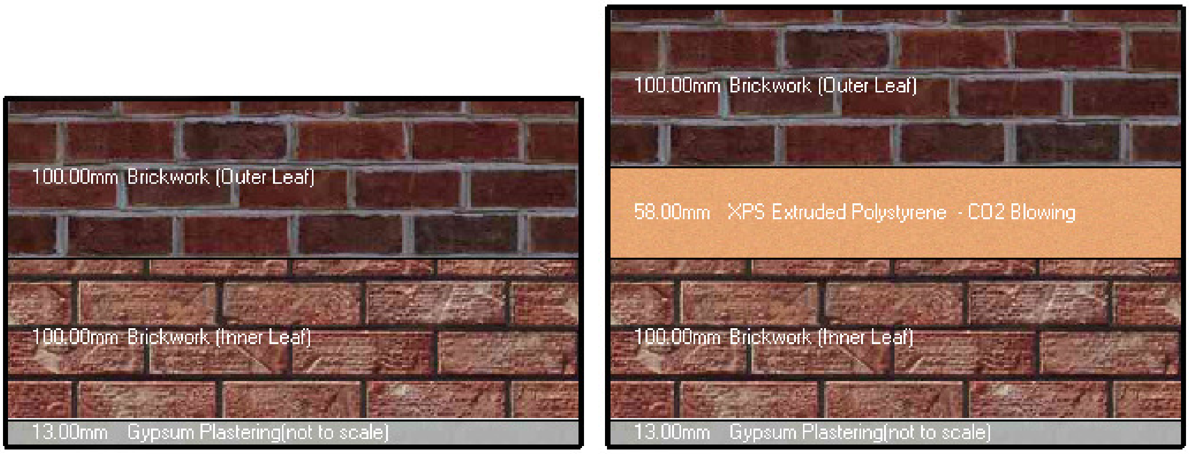

Figure 5 - An example of a standard South African outer wall (left) and one that complies with SANS 204 (right). In practice any materials can be used, as long as minimum insulation levels are achieved.