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The Green Building Handbook South Africa

The Essential Guide

Volume 2

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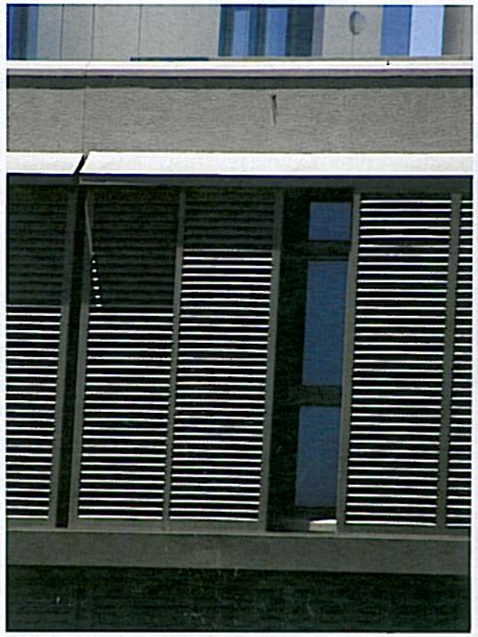

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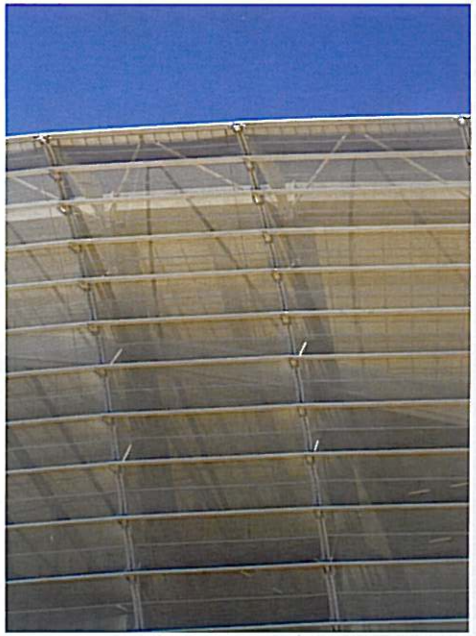

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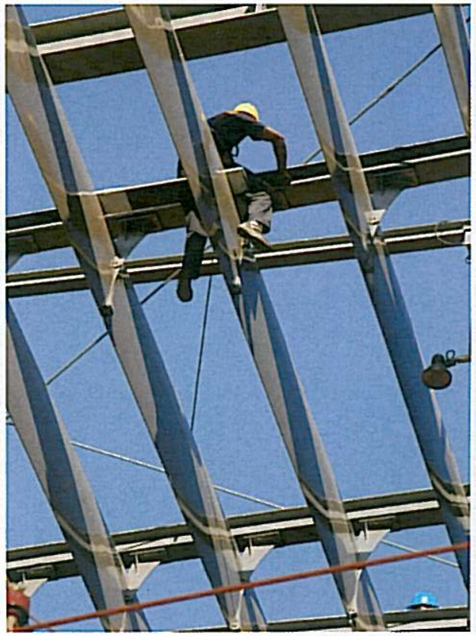

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ROOF ASSEMBLY

Dr Andre de Villiers
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Built Environment

INTRODUCTION

Walls and roofs are the two main elements of the built environment that provide shelter against the elements: sun, rain and wind, but they also need to provide comfort, safety and security for their occupants. Historically, roofs, as did walling systems, developed appropriate vernacular responses over time to their local environmental conditions and the needs of inhabitants. Later, in the search for new materials and resources following the Industrial Revolution and world population explosion, new and more materials had to be produced, giving birth to industry that is energy-intensive, high in carbon emissions and dependant on fossil fuels. A more sustainable, approach to providing shelter has to be found. In this article on roofing, such a sustainable eco-smart approach to building is described with the focus on the roofing subsystem.

The question for this article is: How can roofing for a sustainable smart eco-building be conceived, designed and built as a smart eco-subsystem.

Chevalier & Lebert published a 10 point vision statement for sustainable smart eco-building in a CIB News Article (2009). This was the final outcome of a consensus- based EU funded project to define what sustainable buildings are and to enable the building and construction sector to meet the requirements of Sustainable Development. Their work is based on the 9 general principles of sustainability, as set out in ISO 15392:2008, being applied to each of the lifecycle decision-making phases of a building project: planning, design construction, operation, renovation and end of life. It is therefore comprehensive in its coverage of sustainability and practical in its application to the built environment. Sustainability principles relevant to roofing are drawn from their "Final Vision" report to indicate aspects relevant to roofing and how smart eco-roofing can and should be designed for a holistically sustainable building project.

The objective in this article is: to provide sustainability criteria for roofing system design that can be used by planners, designers and developers as a planning, design and development guide for sustainable building projects.

The lifecycle stages of a building project considered are:

Planning, design, construction, operation, maintenance, renovation, and end of useful life.

For each of these stages, certain of the 9 general principles considered relevant are applied.

The nine principles are:

Continual improvement, equity, global thinking and local action, holistic approach, involvement of interested parties, long term consideration, precaution and risk, responsibility and transparency (ISO 15392:2008).

A sustainable smart eco-building (SSE-building) is: a building designed according to the sustainability principles as they apply to stages of its life cycle and hence meets the expressed needs of its owner and or future users for fulfilling its main functions although varying over time. (Chevalier & Lebert, 2009)

The listed criteria for consideration for roofing system design assume that the rest of the building is designed according to these criteria to render a sustainable smart eco-building as a holistic entity. They further illustrate how all subsystems to a building can and need to be similarly considered, individually and collectively, within the whole building and its surroundings. This needs to become a natural inborn language for planning, architecture and development.

While this chapter assumes the planning and design of a new facility for its full life cycle, it equally applies to the renovation or refurbishment of an existing facility for the remainder of its life-cycle.

THE 10 KEY CONSIDERATIONS OF THE VISION STATEMENT ARE:

Apply the general principles of sustainability

Sustainable roofing has to be seen in the context of the whole. It is the whole building interacting with its environment as a holistic system. Sub-structure, superstructure and roofing, etc. are seen as subsystems which, in turn and as a whole, interact with other local and regional systems. Roofing must be considered as a distinctive part of the building involving its consideration of overall environmental issues such as local context, openness, equity, involvement of interested parties, available services, orientation, passive energy, lighting and indoor environmental control, and life cycle planning from inception to end of useful life and disposal, etc. Planning is the phase in which the general direction of the project in terms of sustainable thinking as in ISO 15392:2008 is established. The roofing must be seen in terms of the environmental functions it should fulfil considering all nine vision statements below.

Involvement of interested parties

Interested parties must be consulted on all issues of relevance to them, such as the potential use of roof space for relaxation and recreation of occupants or glare from roofing that may be a hindrance to the community. This would relate to solar energy installations, passive energy installations, roof gardens or planting, *rainwater harvesting, roof finishes, etc. Occupants' needs must be obtained* collectively and individually and correlated with general community opinion.

Integrated planning

Roofing must reasonably relate to that of other local buildings and be in accordance with town planning and environmental planning schemes and infrastructure and local legislation. In South Africa SANS 204-1, 2 and 3 of 2008 regarding Energy efficiency in buildings applies: SANS 204-1 for General requirements; SANS 204-2 for Energy efficiency requirements for buildings with natural environmental control and SANS 204-3 for Energy efficiency requirements for buildings with artificial ventilation or air conditioning.

Socially and visually, the roof needs to be sensitive to the urban or sub-urban fabric of the environment. It must display integration with, and openness toward, the community environment. Roofing may be punctured by services to and from the building, mainly from below. It is often used as a low cost carrier of services for use in the building. It has a functional role but, for this article, an eco-environmental role that has distinctive sustainability implications.

Design from a Life Cycle perspective

Life cycle planning or long term consideration is seen as the cradle to grave of life of the building. The concept also applies to building materials in terms of embodied energy; the energy expended from bringing the materials into being (mining, transport and manufacture); as well as building them into the roofing sub-system.

As an external skin, roofing needs to be nurtured and maintained for the healthy operation of the building, including indoor comfort for the total life of the building, irrespective of changes in ownership and use. The roofing therefore needs to be flexible and adaptable to accommodate this. It is also important to plan for each phase taking into consideration all the other phases or stages of its existence as well. At all stages, material and resource optimisation is to be guarded and waste generation limited or preferably eliminated.

Environmental impact minimised

The building can considerably offset its environmental impact by replacing its footprint taken from the natural environment with planting on the roof for the absorption of carbon and releasing of refreshing oxygen. It also has social potential as a space for occupant relaxation and recreation. Since it is high, it can be designed to capture and harvest sun and wind energy for solar water heating and the generation of electricity.

Preference must be given to low energy materials or, when higher energy materials such as aluminium are used, then the potential for re-use of the material for similar or other applications and repeated re-use, must be considered. In general, the lighter or stronger the material the better. Materials sourced from renewable energy must be used in preference to non-renewable energy. Materials must also be chosen for their optimum utilisation. Under utilisation is wastage. Other considerations such as off-gassing, toxicity and the additional energy required for re-forming the material for re-use, are factors that must be taken into consideration.

Deliver economic value over time

Life cycle costing of the roofing system, as for the whole building development, is important to avoid high running costs in terms of services and maintenance. Durability, on site power generation, on site rain water use and or re-use of waste water are all factors contributing to economic value of the whole building over time.

Social and cultural value over time and for all

The roof can contribute to the building as a whole in providing a sense of place for its occupants (permanent or occasional) and be a means of work status improvement for workers. Local and regional cultures could also be expressed in the design of roofing.

Health, comfort, safety and accessibility

Roofing as part of the external skin is the interface between a functioning building and the outdoor environment. Thermally it acts both ways, receiving and transferring solar energy to the building and its interior and radiating heat energy from the building to a cold exterior. These processes need to be planned and designed so that roofing, as composite assembly of covering material, structure, ceiling and membranes, reacts appropriately to human comfort needs.

South African standards (SANS -1, 2 & 3) on Energy efficiency in buildings refers to the environmental requirements of a building, also singling out roofs as a specific component: Part 1 with regard to general requirements, Part 2, referring to roofs for buildings with natural environmental control and Part 3, for buildings with artificial ventilation and air-conditioning. These requirements apply for all occupants of a building.

Sufficient insulation is needed in the roof to provide and maintain indoor environment comfort. The nature of fixing and fitting the roofing system to the building should preferably be de-constructable for end-of-life re-use of components. External finishes that require no maintenance, low maintenance, or are self cleaning, should be used as far as possible.

The roof is an important component for passive energy design. Whether passive or artificially conditioned, a sealed airtight building is recommended to reduce an unnecessary burden on heating and cooling and hence to reduce cost. This applies to all interfaces of the roofing system to the rest of the building.

Other design considerations are:

- the usefulness of ventilation of the roof space
- fire safety and lightning protection as per the National Building Regulations
- the necessary vapour barriers and waterproof membranes to prevent dampness
- the thermal mass effect for solar absorption in the day and heating at night; sun angles for shading of walls and windows
- light reflective colours used on the roof rather than dark absorptive colours
- the prevention of thermal bridging for heat loss or heat gain

User friendly, simple, cost effective in operation, measurable mechanical and environmental performances over time

This applies to the building as a whole and roofing as part of its general functioning and performance.

To be adaptable throughout its service life with an end of life strategy

The roofing system must be designed to accommodate alterations and additions to the building easily and cost effectively. All 10 principles apply throughout the life cycle which include renovation and refurbishment for the initial owner or subsequent owners and for different uses. Specific planning for these stages at the outset of a project then becomes both increasingly complex and important.

CONCLUSION

Construction and building developments need not negatively impact the environment, as is currently the case. Comprehensive, holistically-planned roofing systems on the other hand, can positively impact the environment if planned, in a smart, sustainable eco-manner as part of the local community environment. A structured way of thinking, as described in this article, should aid planners to comprehensively engage with their building's environment in developing a smart sustainable eco-building environment.

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