4.4 Sustainable Building

Over the past decade, sustainable development has emerged as the favoured way of responding to the continuing degradation of the global environment. The approach was launched into the international political arena by the World Commission on Environment and Development (WCED), chaired by Norwegian premier Gro Harlem Brundtland in 1987, which defined it as *'Development that meets the needs of the present without compromising the ability of future generations to meet their own needs'* (Brundtland, 1987). For the WCED, sustainable development includes two key concepts. First, the concept of needs, in particular the essential needs of the world's poor, 'to which overriding priority should be given' and second, the idea of 'limits' to the environment's ability to meet present and future needs, imposed by the state of technology and social organisation.

To translate Brundtland's report into action the United Nations Conference on Environment and Development (UNCED) organised an Earth Summit in Rio de Janeiro in 1992. One result was the Agenda 21 action plan, which provided for the first time an international agreement on the practical implications of sustainable development for cross-cutting issues such as trade, consumption and population growth, and sectoral issues among which architecture was included. In 2002 the next United Nations World Summit on Sustainable Development (Rio+10) Earth Summit will be organized. This ten-year review of the Earth Summit Agreements in 2002 will be a major impetus to catalyse collaborative action to implement sustainable development more effectively (see National Councils for Sustainable Development NCSD website).

Since 1992, an array of local and national strategies have been designed to tailor these recommendations to specific conditions facing different communities across the world. One particular aspect has to be pointed out in this context: the steadily increasing energy consumption, and building designs or architecture, urban design and planning not adapted to local climatic circumstances,.

Too often climatic factors are neglected in construction because they are not of immediate interest and concern to the building industry, builders, designers, developers and owners. This is true not only for structures in hot climate zones, but also for those in temperate and cold climate zones. With the input of sufficient energy almost everything seems possible but present construction trends in tropical and subtropical regions still show little awareness about energy conservation. The widely applied international concrete box and iron sheet style of ubiquitous buildings is not adapted to local climatic conditions and hence its worldwide influence is questionable (Gut et al., 1993).

Building cannot escape the far-reaching consequences of this concept in a society that is moving gradually towards sustainability. This is proven by the fact that the Royal Institute of British Architects (RIBA) has included ecological sustainability on the curriculum for all the RIBA recognised courses (Smith, 2001). One of the new publications that outlines the future of the sustainability debate in architecture is *Taking Shape* by Susannah Hagan. By focusing on the impact of the new theories of sustainable technology and new materials in architecture, Hagan moves the discourse and practice of environmental sustainability within architecture towards a greater degree of awareness of both its cultural significance and cultural potential (Hagan, 2001).

Hans-Peter Jost and Jutta Schwarz discuss how to go about constructing archive buildings in line with the main principles of ecologically sound construction (Jost et al., 1996). Considerations include the choice of the site, external arrangements, optimum use of energy, choice of materials, ensuring a long life for a building, ease of maintenance, and stabilisation of building waste. However, the article only deals with building in the West.

Recently an interesting study was published in the well-known Butterworth's Series in Conservation and Museology on the ecology of building materials. It gives a comprehensive understanding of ecology in building and provides vital technological information that allows the architect to put ideas of sustainability into practice (Berge, 2000). In the same series an ecological and environmentally responsible guide to the preservation of historic timber structures has also appeared, founded on respect for traditional crafts and building techniques. It illustrates the new, universally applicable approach to preservation based on the Principles for the Preservation of Historic Timber Structures, adopted by the International Wood Committee of ICOMOS (The International Council on Monuments and Sites). Considerations of appropriate technology, preservation of old-growth forests, and redevelopment of traditional craft skills are central to its arguments (Larsen et al., 2000, see also Schreckenbach, 1982; Sierig, 1991c).

The green awareness became especially popular when the cost for archive building rose (Rombauts, 1996). In Australia today there is a much greater understanding of a building's total structural integrity than ever before. Archivists now think in terms of a building's capacity for sustaining environmental conditions, not just creating them. They think of the entire building structure e.g. wall, roof, and floor as a means of aiding this process (Ling, 1998). Archivists in charge of planning new buildings do not generally accept the concept of achieving a stable climate in the stacks by means of construction without energy consuming electric devices.

Somehow the idea of sustainable archive building did not really catch on in the USA (Banks, 1999).

The study by Paul Gut and Dieter Ackerknecht: *Climate responsive building* is a very comprehensive approach, dealing particularly with building in tropical climate zones, published by the Swiss Centre for Development Cooperation in Technology and Management (SKAT). Climate responsive building is a possible alternative to climatic non-adapted building. It involves the application of soft measures and natural means to reduce energy consumption by design, construction and materials appropriate for a specific climate. This also has positive consequences in terms of economy as well as in terms of proper use of local resources. Improvements can be achieved when buildings are conceived in an integrated approach. This includes the settlement pattern and urban forms and the selection of the site according to microclimatic criteria. The shape and type of buildings and their orientation, the integration of suitable vegetation and the arrangement of the external and internal space require careful consideration. The correct use of building materials, designs of openings and their shading, natural cooling, passive solar heating and the well-aimed utilisation of prevailing winds for ventilation are important supporting elements.

In general, the SKAT publication provides the necessary information for the planning and construction of buildings in tropical and subtropical regions with respect to natural climate control by passive methods (i.e. without energy consuming appliances). In the main, low-cost and appropriate concepts are envisaged. A major part of the book is dedicated to the nine experiments and simulations Gut and Ackerknecht conducted in diverse climatic zones. The Appendix contains the physical data required to assess the properties of the main building materials and other useful lists such as an extensive bibliography (166 titles), solar ecliptic charts for tropical and subtropical regions and conversion factors.

According to Gut the main points to take into consideration when designing a climate responsive building are (Gut et al., 1993):

- minimise heat gain during daytime and maximise heat loss at night in hot seasons, and reverse in cold seasons;
- minimise internal heat gain in the hot seasons;
- select the site according to microclimatic criteria;
- optimise the building structure (especially regarding thermal storage and time lag);
- control solar radiation;
- regulate air circulation.

4.4.1 Passive Climate Control

The concept of passive climate control is completely in line with the notion of sustainable building. It is an alternative to a mechanical air-conditioning system and as such is an essential part of sustainable building. Passive climate control implies that the repository is built and arranged in such a way that the thermal and hygroscopic properties of the building and its contents create a good stable indoor climate. It concentrates on building physics and ensures that the temperature and relative humidity stay within acceptable ranges. For most, passive climate control is a design principle where it is important for the engineer to be aware of how the building is used. At the same time it is important for the user to be aware of any activities that could possibly have an unintended and inappropriate effect on the indoor climate (Christoffersen, 1995).

It is clear from the recent history of the construction of repositories in tropical climate zones, whether archive, library or museum that the repositories play a major part in passive climate control. It is especially important in tropical climates that buildings are designed or retrofitted to minimise moisture problems (Daniel et al., 2000). It is regrettable that still too little research work has been undertaken to develop passive climate control where the design of the building ensures a stable environment (Lyall, 1997).

Lars Christofferson conducted a remarkable Ph.D. research and development project on passive climate controlled repositories. He developed a resource saving concept for the establishment of a suitable climate and introduced ZEPHYR Climate Controlled Repositories together with the idea of sustainable storage. Although he based his study on storage facilities in Northern Europe it is still worthwhile reading for those building in the tropics (Christofferson, 1995).

The first archive building in Africa is an interesting early example of passive climate control. In the design of the new building of the National Archives of Nigeria in 1958 many practical and cheap solutions were found to control heat and humidity. Complete ventilation is provided on all floors with standard adjustable grain-glassed louvered windows with steel bars on the inside for protection against burglars. For the same reason the wings of the building have been made long and narrow with many doors and windows placed opposite each other. Sun protection for the external walls is provided by the vertical fins between each window and by horizontal sun-breakers immediately above the windows (Gwam, 1966).

Channelling the wind can also provide ventilation. For this purpose windscoops or special screens are installed on roofs to divert the wind to channels which reach the rooms. This technique has been used in certain very hot and dry parts of India for centuries. Normally one windscoop is provided for each room and in multi-storeyed buildings the channels reach all the way down. This type of ventilation is only possible if the wind blows regularly in the same direction (Agrawal, 1974).

A particular method of preventing solar gain has been employed in the 1982 archive building of Botswana, Africa. Here, earth berms are constructed to the underside of windows encasing the first and second floors. The berms have a roof structure that forms a vented air space between itself and the building fabric, thus preventing direct solar and radiant heat gain (Lekaukau et al., 1986).

In Cologne, Germany the system of 'natural air-conditioning', a form of passive building, is applied to about 10,000 square meters. It has proven to be an effective method for stabilising temperature and humidity within a range acceptable for paper records. The whole strong-room is surrounded by air above ground; the air can pass up under the facade and through the space between the roof and the ceiling. With this construction the room is insulated as much as possible against the outdoor climate and its changes (Buchmann, 1998; Stehkämper, 1988). In South Africa the box within a box-idea is explored in a subterranean construction (Harris, 1993; Rowoldt, 1993 and 1994). An up-date on this topic appeared in 1992. The author is surprised by the lack of serious discussion on this 'Kölner-model' and discusses other experiences in the German-speaking countries (Stein, 1992). International comparisons show that builders generally use structures having a small surface area with heavily insulated walls to achieve a stable internal environment (Thomas, 1988).

That sustainable architecture can be established with very little means, including financial, is proven by Laurie Baker who, during the course of 30 years, built over 26 buildings. Among others he was responsible for the construction of the Library of the Centre for Development Studies at Trivandrum, Kerala. The eight-story building was built with exposed brick without cement. It is a cool building using natural ventilation and light (Hochschild, 2000; Kremp, 2001).

For more details on construction materials see the section on C*onstruction* below and for an older state of the art study on passive cooling see *King, 1984*, for a later case study see *Rosenlund, 1993.* For further reading on passive climate control see *Adamson et al., 1993a and 1993b; Allard, 1998; Anonymous, 1982a, 1982b, 1985b and 1997; Ayres et al., 1988; Bahadori, 1979; Baker, 1987; Bansal et al., 1994; Cofaigh Eoin et al., 1996; Dodd et al., 1986; Doswald, 1977; Edwards, 1994; Fischer, 1984; Fitzgerald, E. et al., 1999; Holm, 1983; Padfield et al., 1990; Roaf, 2001; Rosenlund, 1989; Rosenlund et al., 1997; Sacré et al., 1992; Swartzburg et al., 1991; Slessor et al., 1997; Yang et al., 2000.*

On sustainable building in general see *Clark, 1990; Edwards, 1999; King, 1993; Kokusen, 1998; Melet, 1999; Piano, 1998; Ray-Jones et al., 2000; Steele, 1997; Vale et al., 1991; Yeang, 1999.*

For a bibliography on passive solar systems see *Anonymous, 1989a*, see also *Rosalund, 1989 and Stulz, 1980.* Also check the SKAT website.