

### **3.5 Ecology of the building**

Sustainable building design is not about creating a style that appears to be 'natural' and therefore environmentally friendly. It is a response to the conditions of habitation in a particular location rather than an aesthetic. A sustainable design can take on any style without compromising the essential principles.

#### **Building as organism**

The building envelope is often considered the third skin. The building should operate similar to the human body, a coherent system involving water movement, air movement, energy production and use. Just as with humans, if the building organism is not working effectively it is prone to decay and infection, leading us to the concept of the sick building<sup>3</sup>.

Hugo Vanderstadt describes (1996:61) the effect of modern living environments as modern comfort that is not risk free. Sometimes there are consequent side effects such as: unnatural light, too little negative ionisation of the air, cold radiation from the surrounding walls, too little warmth comfort, disturbance of natural magnetism, artificial electromagnetic fields, stressful interior decoration, toxic surfaces and so on. He also identifies the "sick-building-syndrome" as a logical consequence of modern habitation.

The Gaia house charter states that in order to design in harmony with the planet we should: "Use 'green' materials and products - non toxic non-polluting, sustainable, and renewable, produced with low energy and low environmental and social costs, and bio-degradable or easily used and recycled...Design systems to prevent export of pollution to the air, water and soil" (Pearson 1989: 40).

#### **3.5.1 Relationship of building to site**

The ideal situation is where the building acknowledges the site and the surrounding area. The design of the sustainable building is a response to the specific location and site<sup>4</sup>. It is not a theoretical abstract artificially implanted on a cleared piece of ground, devoid of any reference.

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<sup>3</sup> vide 3.1:26

<sup>4</sup> vide 3.4:33

A low percentage of coverage allows for a substantial garden and a maximum retention of natural features around the building. The influence of neighbouring buildings on the generic climate of the building is minimised.

use of mechanical climate control.

### **3.5.2 Orientation of the building**

Traditionally houses and stands in South Africa acknowledge the benefits of the north facing aspect. The length of the building should be north facing to make maximum use of the sun for passive and active warmth, natural daylight and potential to make use of passive solar design.

It is influenced by the geographic location, orientation, as well as the weather's temperature.

Hugo Vanderstadt makes the following remarks about the optimal use of natural light and sunrays, "where the sun does not enter the doctor will visit" (1996:61). A good design makes maximum use of the sun for light and warmth. It can avoid the necessity for artificial lighting during the day and electric heating on colder days. Medical studies have proved that sunlight is needed for the production of Vitamin D in the human body. A shortage of vitamin D can result in lowered immunity, rickets, low blood pressure and so on. Thurnell-Read (1995:15) writes: "...during winter months some people suffer from depression and lack of energy, which has now become known as Seasonal Affective Disorder (SAD). Treatment with full spectrum light has been shown to be beneficial." Ultra violet (UV) light has an anti-bacterial working but unfortunately UV radiation does not penetrate normal glass.

Vanderstadt (1996:61) suggests that at least one window in the house allows UV penetration such as quartz glass, acrylic or perspex. Considering sustainability quartz glass is preferred. His suggestions are for the central European climate. While achieving UV penetration in the interior spaces, in Gauteng consideration must be given to avoid glare. In South Africa and specifically Gauteng the climate is mild and use can be made of a sliding door which is kept open for a few hours of sunshine to penetrate the interior spaces.

Thermal comfort

Orientation must occur so that an abundance of daylight can penetrate the depth of the home and the warmth of the sun can be utilised to warm the interior spaces in winter, yet that there is adequate shading in the summer, that the interior remains cool. A balance between sun shading and sun trapping should be achieved.

It is recommended by the body's metabolism without the excessive use of energy to keep the body temperature in equilibrium. The available energy can be used for daily activity as well as rejuvenation through sleep. The range within which the body is comfortable is called the "comfort zone".

### 3.5.3 Generic climate of the building

Sustainable building design makes use of the natural climatic forces of the site for natural climate control. Energy and economic savings are a result of eliminating the use of mechanical climate control.

The design and building materials used - colour and type, give the opportunity to reduce absorption of heat, use rainwater for cooling and ventilate naturally.

The internal air quality is also of importance. It is influenced by the occupants' breathing, sweating, germs, smoking as well as the emissions from the surrounding building materials and household equipment. The space must be well ventilated allowing an exchange of air. The opening sections (when opened) are adequate to ventilate as well as cool the rooms by natural air circulation.

The quality of the oxygen in the air affects one's well-being. The quality of the air is measured by the number of negative and positive ions per cubic centimetre.

2 000 ions with 60% negative and 40% positive ions is considered healthy for human functioning. Vanderstadt cites the following problems in the situation where there are too few negative ions in the air: less vitality, drowsiness, problematic breathing, headaches, irritated eyes, stress, reduced immunity and degeneration of the blood. The oxygen quality is therefore not a small problem to be ignored. Air circulation is largely determined by the layout of the rooms and relative positioning of opening sections. Ventilation must be planned so that the air circulates and there is an exchange between internal and external air supply without resulting in draughts. The SABS gives a minimum requirement for air circulation in these spaces, but direct connection to natural air circulation is always better than artificial climate control. Ventilation is promoted through the use of air bricks and positioning of the opening sections.

#### **Thermal comfort**

Comfort is the absence of discomfort. A thermal comfort zone is defined as the temperature and humidity at which a range of people feel comfortable, neither too hot nor cold. The human body responds to climatic factors. Our comfort involves the ability of the body to work optimally when the climatic factors can be accommodated by the body's metabolism without the excessive use of energy to keep the body temperature in equilibrium. The available energy can be used for daily activity as well as rejuvenation through sleep. The range within which the body is comfortable is called the "comfort zone".

The quality of the indoor climate depends greatly on the ventilation of the building. The comfort zone for relative humidity is between 40%-60%. Moisture regulated fans and natural ventilation can achieve this. Opening sections should close well to prevent air infiltration when not required so that the effects of wind and air movement can be controlled.

### **The building shell**

The daily life cycle of the building includes the absorption and release of heat. The thermal capacity of materials is affected by the humidity and should be considered. The thermal dynamics of the building are also influenced by the wind. The wind affects the thermal performance of the materials and can cause heat loss, but can be used to moderate summer temperatures by assisting ventilation of the building<sup>5</sup>. The strength of the wind is not substantial enough to influence the construction of buildings greatly in Gauteng, as it does not cause substantial stresses on the structures.

Leaking plumbing, roof leaks, defective gutters, condensation, defective water proofing, defective drainage, rising damp, ground moisture and spillage can lead to a build-up of unhealthy moisture in a building that leads to decay and the growth of fungi. Natural air movement is important in preventing a moisture build-up.

Recommendations to control the effect of all the natural climatic fluctuations on the internal climate are:

- i) Plan for independent control by providing well positioned opening sections for ventilation and shading devices. Air rises externally upward against the building- known as buoyancy, affecting the air change rate. The size of windows and the rate of rise affect the air change rate.
- ii) Plant quick growing deciduous trees carefully positioned relative to the house that in the future provide shade in summer.
- iii) A broader roof overhang would provide shade in the summer when the sun is higher.
- iv) Provide insulation in the roof space
- v) A generous floor to ceiling height aids air movement.
- vi) Considering the wind directions when positioning the house on the stand

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<sup>5</sup> vide 3.5.4:53

vii) External weather conditions affect the internal air movement. Air bricks, ventilators, open windows, roof ventilators can improve the airflow. The airflow in a room should be encouraged to mix and change direction and not just pass on a direct path through (Singh 1994).

The various climatic constraints can give rise to an architectural style that is unique to climatic region while responding appropriately, giving a richer fabric to the built environment. The average temperature and sunlight hours of Gauteng are conducive to outdoor living. When designing consider appropriate spaces to living both inside and outside, rooms that open up to the outside, courtyards, patios and pergolas. The optimal relationship of orientation and layout results in a comfort zone that requires no additional artificial control. When the design is initially set out the living spaces such as the lounge, dining and bedrooms should be positioned to gain maximum benefit from natural light, temperature control and ventilation.

#### **3.5.4 Energy efficiency**

The sun, wind, methane gas and waste wood are all natural sources of renewable energy that should be harnessed by a sustainable building to lessen the pressure on non-renewable fossil fuels. Use renewable energy whenever possible. Use of biomass, solar energy, wind-power and photovoltaics.

Grid electricity is an expensive resource on finite minerals such as coal. Special care must be taken not to waste it. Energy efficient installations and machines must be used (refrigerator, freezers, washing machines, drying machines, dishwashers, cookers, lighting) and general saving of electrical use. Simple techniques can be used to reduce energy requirements such as:

- i) Use landscaping to conserve energy<sup>6</sup>.
- ii) Wind and sun can be used for drying
- iii) Heating and cooling using natural forces completed by pumps and fans
- iv) Use renewable resources such as wood for heating
- v) Use standardised quality fixtures with replaceable components. The fixtures will last longer and if necessary components to fix faults will be available.

Materials with a high thermal mass reduce energy use, as less is required to heat and cool the interior spaces. Thermal fluctuations should be avoided by using

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<sup>6</sup> vide 3.4.8:46

materials that display good thermal performance. Heat efficiency is achieved by good insulation of walls, windows, doors, floors and roofs. All openings should insulate well to avoid leakage when closed. The plan and form should be efficient with the control of airflow and orientation for use of passive solar power.

Energy can also be harmful to human beings. The placement of electrical lines and transformers in relation to a building is very important. Electromagnetic fields should be avoided where possible.

The glasshouse or sunroom attached to the building provides a place to cultivate food without artificial fertiliser (a place to use grey-water and compost), reduces energy use to heat the space (winter) or cool the interior spaces by pulling out cool air from shaded interior rooms and adds an area to occupy on cooler days, it can form a sound barrier. (Baggs 1996:92-93)

### **Materials and energy<sup>7</sup>**

Energy is also an essential component in the manufacturing of building materials and products, known as embodied energy. Sustainable buildings make use of materials that do not require large amounts of energy to produce or alternatively have recycle or reuse potential that mitigates the initial production cost long term. Examples of these types of materials are timber and loam or mud bricks.

#### **3.5.5 Water conservation**

Domestic water supply requires purification due to the pollution of our natural water supply. Our water characteristically is filled with unnatural chemicals and bacteria that are harmful to us. It is possible to install a natural water purification system. Ponds, septic tanks, sand filters and percolation are a few of the techniques that can be used to purify water on site. To install a water purification system for one household is expensive but in a larger development a system could be installed for a number of houses, making it cost effective and viable.

Water can be conserved in the building and by changing wasteful habits. The following measures can be employed to increase water conservation:

- i) Use water efficient equipment. Select toilets with lower flush options. Low flush for liquids and standard flush for solids. Use low flow fixtures (toilets, water

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<sup>7</sup> vide 3.5.7:57

taps and shower heads). An option to save water usage is to install a composting toilet.

- ii) Household appliances (dishwashers, clothes washing machines) should be selected for their energy and water efficiency.
- iii) Consider greywater as a source that can be used to irrigate the garden or flush toilets<sup>8</sup>.
- iv) Avoid using municipal black water removal as this wastes large quantities of water<sup>9</sup>.
- v) Water use habits should be adjusted for minimum wastage. Some age old advice still counts in modern sustainable building use. Don't let the tap run while shaving or brushing teeth etc. Rather shower than bath. Avoid small washing loads if machine does not have a cycle for small loads. Avoid washing dishes in dishwasher if it is not full. Do not wash dishes under running tap. Do not use toilet to dispose of waste. Use nutrients from kitchen waste through composting.
- vi) The optimal position should be selected for the water heater (geyser). Avoid long distances where water is wasted while waiting for hot water. If unavoidable, divert or capture the water normally lost for use in garden or to flush toilets.
- vii) Rainwater can be collected from roofs and can be used for garden irrigation. Note that the quality of rainwater can vary according to levels of air pollution depending on the area the building is located. Barrels of all sizes and formats are available that can be linked to the gutters around the house.

### 3.5.6 Waste management

There are different types of waste arising from habitation. Waste water (grey water and offal water), material waste and organic waste. Waste arising from household consumables and waste from the building itself all form part of what can be considered wastage arising from habitation. The increased need for landfill areas verifies that there are too few people motivated to recycle and re-use their household waste. People must be taught why it is important to sort their waste and minimise non-degradable, non-recyclable materials or otherwise we will all be living on a giant landfill one day. Municipal waste collection should not be used as an excuse to avoid bringing the relevant waste to the recycle depot.

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<sup>8</sup> vide 3.5.6:55

<sup>9</sup> vide 3.5.6:56,vi

Waste can be managed in the following ways

- i) The waste arising from packaging - consider refills and bio-degradable packaging when shopping for consumables.
- ii) Organic waste from the kitchen is bio-degradable can be used in a composting system for use in the garden.
- iii) Recyclable materials should be sorted and brought to the relevant depots. The household must aim to produce reusable materials not garbage. Separate rubbish at its source into glass, paper, plastic, textiles, bio-degradable, and re-usable materials.
- iv) Environmentally dangerous garbage must be eliminated in an appropriate way. Dangerous waste, such as batteries, chemical cleaning substances, fats, medicines etc. should when purchased, used conservatively.
- v) Greywater can be defined as the wastewater produced from baths and showers and washing machines. Blackwater is the wastewater from toilets, kitchen sinks and dishwashers. Grey- and blackwater must be separated for use. Greywater is usually used for irrigation in sub-surface systems in line with health regulations. The separation of black and grey waters can be problematic in existing buildings; it should be included at the design stage.
- vi) An option to save water usage and deal with human waste is to install a composting toilet. Ironically the complex sewerage system halts decomposition as the human waste enters water. Composting toilets only use a small amount of water. Human waste breaks down naturally in the presence of oxygen and other biological materials. If possible, recycle the nutrients in sewerage, kill the pathogens and bring down the biological oxygen demand. Use settlement tanks, percolation or sand filters, in combination with irrigation, re-absorption and aquaculture<sup>10</sup>.
- vii) The building itself should be designed for re-use or re-cycle at the end of its life cycle<sup>11</sup>.

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<sup>10</sup> vide Appendix 3:138

<sup>11</sup> vide 3.6:62

### 3.5.7 Materials and construction methods

#### **General introduction to sustainable building materials**

The physical materials that all buildings are made of are generally sourced from our planet earth and are essentially either renewable or non-renewable in character. The material has at some stage been taken from the earth and through a manufacturing process rendered useful to the building industry.

Nine parameters for sustainable building materials were deduced from data in Pearson (1989), Vanderstadt (1996) and Baggs (1996). Each of the parameters for listed below are discussed on the following pages.

Sustainable building materials must comply with the following parameters:

- i) Come from a renewable resource – source of materials
- ii) Require a minimum of energy to manufacture, transport, place and demolish
- iii) Minimum impact on the natural eco-systems in the area
- iv) Non-toxic to humans and the environment i.e. environmentally friendly
- v) Acts as a third skin, i.e. it can breathe
- vi) Electrostatically, magnetically neutral and avoid geopathic stress and electromagnetic pollution
- vii) Absorptive acoustic properties
- viii) Minimal moisture content once the building is complete
- ix) Can be re-used or are bio-degradable and have a maximal life-span<sup>12</sup>

#### **i, ii & iii) Source and manufacturing of materials**

If a building is to be sustainable and address the effect it has on the environment from the outset sustainability must be a consideration in the design stage, material specification and ordering and site works. The responsibility does not lie with one member of the team but from the designer through to the site worker. The economics of a building work are paramount but not a reason to ignore the importance of sustainability.

There are different categories resources can be divided into. Non-critical zone renewable resources such as solar energy, tides, wind, waves, water and air

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<sup>12</sup> vide 3.6:62

remain renewable irrespective of human activity. Critical zone renewable resources such as fauna and flora, soil and aquifers depend on the rate at which they are used in relation to their production. The critical zone is reached when recovery is slower than supply. To ensure these resources are not exhausted they must be managed carefully. A sustainable building industry is one that does not squander materials or energy. Construction that makes maximum use of materials that can be found in the immediate environment. Materials that don't require a sophisticated manufacturing process, such as mud, sand, clay, lime, wood and organic materials that are renewable such as wood, sisal, straw and cellulose products.

Non-renewable resources are those that once consumed are irreplaceable. These are the fossil fuels - oil, natural gas and coal. In terms of human life-span they are non-renewable as they have taken millions of years to form. There are also recoverable non-renewable resources which are the metals such as aluminium, chromium, copper, gold, iron, lead, magnesium, manganese, mercury, nickel, platinum, silver, sulphur, tin and zinc, which can be recovered by re-cycling.

The building trade and the components used in buildings tend towards being non-renewable. In respect of their finite character, they are often squandered without thought. Although the availability, cost and actual physical properties are of primary importance, the sustainability of the material may not be ignored. Generally building materials fall into eight main groups, these are stone, timber, brick, iron and steel, concrete, glass, plastics and natural fibres.

**Stone** – The “rocky Highveld” with its characteristic scattered rocks gives the opportunity to tie the building to the site in terms of using natural materials occurring on site. Features and walls can make use of the rocks recovered during site clearing. Stone requires no manufacturing related energy. Although it is critical zone non-renewable resource, if it is found on site and would be removed to accommodate the building footprint, it can be considered a sustainable building material. However it should not be removed from natural sites for use in a building somewhere else far away.

**Timber** is a non-critical zone renewable resource. The hardwood and softwood should both originate from a sustainable forest i.e. regulated plantation. During the manufactured process the timber must be well seasoned and non-toxic preservation techniques should be used. Effective preservatives are borax, sodium carbonate, potash, linseed oil and beeswax. (Pearson 1989:153) The exotic bluegum (eucalyptus) trees found on site that need to be removed to make way for

an indigenous garden, can be used in the structural framework of the building. Cork, linoleum, rubber, paper and composite boards are all members of the timber group. These materials if sourced from a sustainable forest are appropriate materials for use in a healthy home.

**Brick** – Earth is an abundant material that is moulded into bricks and tiles either naturally dried or baked in a kiln. Bricks perform well thermally and are generally the preferred wall surface for homes. Generally brick manufacturers are expected to set their own environmentally friendly standards, however there is also the option for on site brick production. Fired bricks require energy using fossil fuels while mud-bricks (raw-earth) are an on site material. Mud-bricks in turn have greater waterproofing requirements.

**Iron, metal and steel** - The extensive use of iron and steel in buildings should not go without special consideration for alternatives that do not make use of non-renewable resources and high embodied energy requirements. Where there is no alternative the quantity and type of steel used must be a consideration. The utilitarian pipes, plumbing fixtures, ironmongery, nails, screws, electrical cabling, etc. should be specified keeping sustainability and re-cycle possibilities in mind. Aluminium and iron have greater energy requirements to manufacture and should be used minimally. Firstly only use iron, metal and steel when there are no other alternatives and secondly choose according to the manufacturing process. Metal is highly recyclable and efforts must be made to use components that can be re-used or recycled.

**Concrete** is an essential part of the entire built work but the cement it contains is aggressive to the skin and contains harmful substances. Cement furthermore requires large amounts of energy to be produced. Cement is essential to reinforced concrete and the only alternative is to use ingredients concrete is composed of, the cement, sand, stone and water, from a sustainable resource. The quantities required must be calculated that there is minimum wastage. The other option is where no reinforced concrete is required to find an alternative to using cement.

**Glass** is produced from natural renewable resources. It is important that the process by which glass is manufactured should be sustainable with minimum impact on the environment and lowered energy requirements for production and recycle potential. Additionally the quality of the spectrum of light-waves the glass allows through is an important consideration for the well-being of the occupants<sup>13</sup>. Other criteria when selecting glass are the consideration that ordinary glass has

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<sup>13</sup> vide 3.5.2:50

very low insulation, thermal and strength properties. In terms of thermal insulation double glass may be considered. Safety glass and tinted glass are other options to consider.

**Plastics** are unique in being an entirely manmade material that has become an integral part of the building structure. This is a total artificial product as is not in-line with what would be considered a healthy building. Many plastics including acrylics, PVC, polystyrene, polyurethane foam and other synthetic man-made materials are harmful to the health, among the effects are eye, nose, and skin irritation. In case of fire the fumes from most plastics are highly toxic. The use of plastics is almost inevitable in modern construction and therefore products should then be selected according to the manufacturing process that supports sustainability as a principle.

**Natural fibres**, linen, cotton, wool, silk, kapok, jute, hemp, sisal, coir, rayon, feathers and down, skins and hairs are all natural from an abundant renewable resource. They can be widely used in the building. Their production as an annual crop or manufacture as animal by-product must be done in a sustainable way with non-toxic preservatives or additives. (*ibid*: 160-161)

#### iv) Non-toxic materials

Many glues, paints, preservatives and synthetic materials have toxic effects on humans and the living environment. The toxic fumes and particles are taken up through the skin and air passages and lead to ill health. Firstly such materials should be avoided and replaced with non-toxic, environmentally friendly alternatives, such as natural plant dyes, water-based paint and natural varnishes. Good ventilation also supports the removal of unwanted components in the air that have been released from toxic materials.

Rotting, insect infestation, and fire are not welcome even in a sustainable building, therefore preparation and preservation of the materials and soil are essential.

All such work undertaken must be in an environmentally friendly way with non-toxic preparations.

#### v) Acts as a third skin, i.e. it can breathe

The human skin supports a healthy body by breathing, transpiration and absorption. People clad themselves in clothes as a second skin that protects and insulates while allowing the body balancing processes to continue. The building forms the third skin of human protection. The building must not harm the human occupant, but assist in maintaining well-being. So too, the building structure must maintain a

balance between dry and moist, warm and cold, protection and absorption, air exchange and so on. Just as the skin regenerates and new clothes are bought the building shell must also have the potential to regenerate. The comparison of building to a third skin is a study in itself. It is sufficient to use the metaphor as a reminder when considering which materials and finishes to specify for a building.

vi) **Electrostatically and magnetically neutral and avoid geopathic stress and electromagnetic pollution**

Static disturbs the natural electro-chemical system of the body. Synthetic materials characteristically carry a higher static charge compared to natural materials that naturally balance their static charge. Static affects the ion percentage of the air as discussed earlier. Vanderstadt (1996) recommends the following practical measures to reduce excess static – avoid synthetic carpets, wall coverings and furniture. Cover concrete and metal with solid wood. Replace synthetic material with cork, coconut fibre, felt, sisal, straw, reeds, seagrass, hennop, jute, natural paints, natural linoleum, beeswax and oils.

The general term geopathic stress refers to the discomfort and illness that occurs when the earth's natural magnetic field is disturbed by natural or man-made energy fields. Just as the body has an electro-chemical balance so too the human body has its own unique magnetic charge. Magnetical fields around equipment and arising from materials should be prevented from adversely affect the health of the body. The accepted safe level of exposure to electromagnetic fields is constantly being revised by scientists. Currently there is a great debate as to the effect of cell-phone magnetism on the brain. Electromagnetic pollution is the negative effects of electric and magnetic fields arising from for example microwaves that are used for satellite communication and microwave ovens. Modern technological devices must be recognised for both their positive and negative effects<sup>14</sup>.

The hazardous gasses ozone and radon also contribute to poisoning the home environment. Ozone is an unstable poisonous gas present in small amounts in the air, and it is responsible for the protective atmospheric layer shielding the earth from ultraviolet radiation. Smog is a result of high ozone levels. Radon is an invisible, odourless, colourless, radioactive gas found naturally in the earth's crust and in certain building materials. When radon decays it forms a harmful radioactive

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<sup>14</sup> vide 3.4.5:42

substance (*ibid*: 49-101). Radon occurs in higher concentrations in certain locations according to the ground composition. These areas are not suitable for building houses on.

vii) **Absorptive acoustic properties**

Noise pollution is a common phenomenon in the urban setting. An excess of noise is not conducive to human health. Where possible, noise pollution should be brought to minimum acceptable level. Simply stated, solid hard materials reflect, while soft materials absorb sound waves. Solid materials are concrete, metal, bricks, glass surfaces and stone. Organic materials such as straw, reeds, wood, and cork absorb sound due to their cellular structure. Internally soft furnishings aid the internal absorption of sound while externally vegetation works as a buffer and absorber of noise from the broader environment.

viii) **Minimal moisture content once the building is complete**

A moisture problem in buildings is recognised by experts as one of the main contributors of the 'sick building syndrome'. Water is a major component of the building construction process and materials. It is used in the mortar, concrete, forms part of bricks, is an essential part of timber and so on. The building may take several years to dry out completely. A moist third skin results in a moist cold space. Compare the physical response to wearing wet clothing, transfer this to the building shell, excess moisture contributes to ill health. Moist walls also cause heat loss when spaces are heated. The best solution is to use dry rather than wet building construction. Use mortar and other materials that dry quickly and allow for good ventilation of the new building structure.

ix) **Can be re-used or are bio-degradable and have a maximal life-span**<sup>15</sup>

### 3.6 **Life cycle of the building**

"To choose healthy materials is quite difficult. We are also concerned with the life-cycle of the materials, how much energy and environmental damages it takes to produce them, how the production influences nature and people working with the material, and what you can do with the material when you don't need it any more, and how the ecosystems are influenced by the use of the material" (Berström & Steinwell 1992:3).

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<sup>15</sup> *vide* 3.5.2:50

Large amounts of landfill may be attributed to building rubble. Re-use and recycling of building materials would greatly reduce these amounts. The modular co-ordination of components reduces waste. The more artificial and processed a building material becomes the more difficult it becomes to recycle or re-use. Asbestos is one such product greatly used in the seventies and now a problem during demolition. It is expensive to destroy and toxic as landfill. Timber painted with toxic paints can not be burnt due to the toxic fumes that would be emitted during such a process.

### **3.6.1 Life-cycle of building materials**

The quality of the materials is important, the better the quality the longer the building life-span. Avoid materials that are produced only to last a few years and then require replacement. Natural renewable materials are the most appropriate for use in a sustainable design.

Maintenance should be thought about from the planning phase. Maintain the building well to extend its life, for example where timber frames are used, oil these yearly to avoid rot or drying and cracking. Where materials require preservation, such as wood, use natural preservatives.

### **3.6.2 Re-use of building materials**

Materials should be used in such a way that they can be re-used if the building is demolished. Vanderstadt (1996:90) suggest using materials that can easily be disassembled and re-used, such as logs stones and stacked bricks. Use mortar sand fixtures that allow easily disassembling for re-use.

### **3.6.3 Re-cycling of building materials**

Vanderstadt (1996:90) states that sustainable building uses materials that can be re-cycled by nature herself. These are materials such as natural preserved timber, straw and organic materials such as wool. Sun-dried clay bricks (adobe type), mixed of straw and other organic materials also have a good insulation value as well as recycle value.

Where possible, use materials that can be recycled or are bio-degradable once they have reached the end of their usefulness to the building.

### 3.7 Summary

Chapter three defines and discusses sustainable building design by identification of principles that contribute towards achieving a sustainable built environment.

The need to present information clearly and avoiding alienating jargon requires the sub-division of the information into logical inter-linked topics. Berström & Steinwell (1992:47) identify the inter-linked character of sustainability when they say: "Instead of maximising the function of single elements without any interrelationship to one another, we optimise the overall result by creating the largest number of useful links". The division of the information takes the lead from the Gaia principle of the house as a micro-ecosystem that interacts with the wider ecosystem of planet earth. The exploration of the principles is divided into the various interacting ecosystems between man, nature and the building hence the headings - the ecology of user, ecology of the site and ecology of the building. Each heading explores principles that contribute towards achieving sustainability in these aspects of human habitation.

### 3.8 Conclusion

Sustainability in the context of the building environment requires a broad range of guiding principles that will assist designers, developers and users alike, how to work towards achieving a sustainable building. The dissertation written by C du Plessis (1998) lists the numerous definitions for sustainable development (see Appendix 1) and identifies the need for a broader definition than a few definitive words. Chapter three acknowledges the need to address sustainability in the built environment as broader than a single definition by analysing sustainability as a set of principles that contribute to achieving that aim.

Research into SBDP that links the ecology of user, site and building reveals that information is broad and specific data relevant to both climatic region and house type is difficult, if not possible, to find. The available scientific facts can not quickly be interpreted to solve problems in the field. The research revealed that outside of the information on the Highveld climatic zone in the *Manual for Energy Conscious Design* (Holm 1996:64-73) there is currently no other specific information available that can readily be applied to the FOURways house. If a sustainable building environment is to become a reality in the near future for the occupants of the FOURways house a real need exists for information specifically geared to address the needs of this group.