
Sustainable Design

Introduction

During the lifetime of a building, it affects both the local and global environments:

- site development and construction affect the local ecology
- the construction process :
 - produces noise causing local disturbance
 - can produce local air and water pollution
- the extraction, processing, manufacture and transportation of materials causes pollution of both the local and global environment
- when completed the building has long term effects on the environment:
 - through the energy it consumes
 - through the water it uses
 - through the sewage and other wastes it produces

When studying the concept of '**sustainable design**' basic considerations include:

- **the economical use of resources** - reduction, reuse and recycling

There are finite supplies of nearly all construction materials. It makes economic and environmental sense, therefore, to maximise the reuse of components and recycling of materials wherever possible.

By doing this, the availability of these finite resources will be extended. In addition, energy will be conserved which would have been used to produce new materials.

- **life cycle design** - design for the whole life of the building

Another important consideration, however, should be the design of modern buildings. They should be designed to be flexible allowing different usage by a variety of owners.

This will maximise their useful life and avoid the need for demolition for a longer period. In addition, the design should allow for disassembly rather than demolition at the end of the building's useful life.

- **environmental quality** - in and around the built environment

The two factors described above deal with economy of resources and efficient use of the built environment.

The third consideration is the effect of human construction on the natural landscape and the plants and animals that live in it. This includes existing urban landscapes as well as rural areas.

The economical use of resources

There are three elements to ensuring the economical use of resources:

1. Energy conservation

When the building is complete it consumes energy during its use for heating, cooling, lighting and equipment operation. In addition to the energy required in the extraction, processing, manufacture and transportation of construction materials, the construction process itself also requires large amounts of energy for earth moving, lifting, welding etc.

The environmental impact of most energy consumption generally takes place at some distance from the building at a power generation plant.

▪ Urban planning

Urban planning has its part to play in energy conservation. Cities and neighbourhoods should be designed not around the car, but rather around public transport systems, cycle paths and pedestrian walkways.

People should be able to live closer to their work places to reduce the need for transport. Urban sprawl can be reduced by redeveloping existing inner city sites and / or adapting old buildings for modern usage.

▪ Site planning

Considerations include : orientation of buildings to maximise solar gain; the use of deciduous trees to the south of a building to provide shade in summer and planting evergreen trees to the north of a building to provide protection from the wind in winter.

The use of passive heating and cooling reduces the need for heating in winter and air conditioning in summer.

▪ Building envelope

Reducing heat transfer through the building envelope by means of well insulated walls, floors and roofs, together with high performance windows and doors will reduce the energy requirements of a building.

Building design that maximises the use of natural light will also help to conserve electrical energy. The use of natural rather than artificial lighting also has beneficial health effects on the occupants of the building.

▪ Embodied energy

The embodied energy of a material is a measure of the energy that goes into its entire life cycle. This includes extraction, processing, manufacture and transport. Selection of materials with low embodied energy reduces the environmental impact of a building.

▪ Energy efficient equipment

The next highest cost of a building after the construction cost is the operating cost. Over the lifetime of the building these may in fact exceed the construction cost. The use of high efficiency heating, cooling and ventilation systems is important.

The economical use of resources

2. Water conservation

Buildings require varying quantities of water depending on their function for drinking, washing, cleaning, cooking and flushing toilets. All this water will have been treated and delivered to the building. This also consumes energy. The water that leaves the building as sewage will also require treatment. Therefore, a reduction in water use also produces a reduction in waste.

- **Greywater**

Greywater is produced by activities such as hand washing. This does not require the same treatment as sewage. Well designed plumbing systems can reuse this greywater to flush toilets or for irrigation.

- **Rainwater**

Rainwater could be used in the same way as greywater for irrigation and flushing toilets.

- **Consumption**

Water consumption can be reduced by the use of low flush or composting toilets. Where possible the smaller volume of sewage should be treated on site rather than at municipal sewage treatment plants.

3. Material conservation

The greatest quantity of materials are usually brought into the building during its construction. There is a significant amount of waste generated during the construction, installation and commissioning processes. After completion, there will be a smaller amount of materials being consumed and producing waste during the life of the building.

- **Reuse existing buildings**

Convert old buildings to new uses rather than demolishing them and building new ones. New buildings should be designed with future change of use in mind and for disassembly rather than demolition.

- **Reuse and recycle materials**

Many building materials such as wood, steel and glass can be easily recycled into new materials. Others like bricks & tiles can be reused in a new structure.

- **Standardise building dimensions**

Standardising dimensions can reduce the amount of construction waste. For example most sheet materials such as plywood come in standard sized sheets. Room sizes should be set to allow whole sheets to be used.

Life cycle design

The conventional model of a building's life cycle has 4 stages:

design / construction / operation / demolition

Analysing the building processes involved in each of these stages helps to identify how a building affects the environment throughout its life.

An alternative way of looking at the life cycle of a building splits it into 3 stages:

- **pre building** - this includes building design, impact on the landscape, building orientation and selection of materials.

During the pre building stage the design of the building and the materials used for its construction should be examined for their environmental impact. The materials used should:

- be from renewable resources
 - extracted without causing ecological damage
 - recycled or recyclable
 - durable and require low maintenance
 - be from local sources wherever possible to reduce transport
-
- **building** - this includes site clearance, building construction, building operation and disposal of waste.

This stage is concerned with the environmental impact of the actual construction of the building and its operation when complete. The construction work should be planned to:

- minimise the impact on the local environment
 - minimise waste materials and allow for their recycling
 - use non toxic materials in construction and maintenance
-
- **post building** - this includes demolition / disassembly, reuse of materials, recycling of materials and disposal of waste.

In this stage the effect of the building on the environment at the end of its useful life is considered. Wherever possible the building should be adapted and reused. Where complete reuse is not possible, individual components should be reused.

Environmental quality

In modern industrialised societies, people spend more than 70% of their lives inside buildings. An essential part of sustainable design is to provide built environments that ensure the occupants' health, safety, physical comfort and psychological well being.

Elements of environmental quality include:

- **preservation of the natural environment**

This involves minimising the impact of a building on the natural environment including the topography, plant and animal life. Considerations include:

- an understanding of the impact of the building on nature
- minimising the change in the natural surface contours
- not changing surface and subsoil water drainage
- preservation of existing local plants and animals

- **consideration of existing urban environments**

This involves co-operative planning of neighbourhoods, towns and cities to reduce energy, water and waste disposal demands. This should result in an improvement of many urban environments. Considerations include:

- promotion of public transport systems
- construction of walkways and cycle paths
- reduction of pollution in urban environment

- **human comfort**

As described above, human comfort, health and safety is an essential part of sustainable design. Considerations include:

- provision of thermal and acoustic comfort
- provision of natural ventilation systems
- accommodation of people with various disabilities
- use on non toxic materials inside the building

Assessment

Sustainable Construction

Questions 1 to 5 - Select the correct response for the following questions :

1. Which of the following does **not** have a long term effect on the environment?
 - A energy consumed during the lifetime of the building
 - B noise produced during the construction process
 - C water consumed for washing, cleaning, cooking and flushing toilets
 - D sewage and other waste materials

2. Which of the following is **not** a basic consideration of sustainable design?
 - A the economical use of resources
 - B life cycle design
 - C political instability
 - D environmental policy

3. Which of the following is **not** one of the three elements ensuring economical use of resources?
 - A energy conservation
 - B water conservation
 - C material conservation
 - D labour conservation

4. An alternative way of looking at the life cycle of a building splits it into 3 stages. Which of the following is **not** one of these stages ?
 - A design
 - B prebuilding
 - C building
 - D post building

5. What percentage of their lives do people spend inside buildings in modern industrialised societies?
 - A approximately 40%
 - B approximately 50%
 - C approximately 60%
 - D approximately 70%

Questions 6 to 10 - Decide whether each statement is True (T) or False (F).

6. i) During the lifetime of a building, it affects both local and global environments.
ii) The environmental impact of most energy consumption generally takes place at some distance from the building at a power generation plant.

Which option best describes the two statements?

- | | | | | |
|---|-----|---|-----|---|
| A | i) | T | ii) | T |
| B | i) | T | ii) | F |
| C | ii) | F | ii) | T |
| D | ii) | F | ii) | F |

7. i) The use of passive heating and cooling reduces the need for heating in winter and air conditioning in summer.
ii) Selection of materials with high embodied energy reduces the environmental impact of a building.

Which option best describes the two statements?

- | | | | | |
|---|----|---|-----|---|
| A | i) | T | ii) | T |
| B | i) | T | ii) | F |
| C | i) | F | ii) | T |
| D | i) | F | ii) | F |

8. i) Greywater is produced in industrial plants and requires more treatment than normal sewage.
ii) New buildings should be designed with future change of use in mind and for disassembly rather than demolition.

Which option best describes the two statements?

- | | | | | |
|---|----|---|-----|---|
| A | i) | T | ii) | T |
| B | i) | T | ii) | F |
| C | i) | F | ii) | T |
| D | i) | F | ii) | F |

9. i) During the pre building stage the design of the building and the materials used for its construction should be examined for their environmental impact.
ii) The post building stage includes demolition / disassembly, reuse of materials, recycling of materials and disposal of waste.

Which option best describes the two statements?

- | | | | | |
|---|----|---|-----|---|
| A | i) | T | ii) | T |
| B | i) | T | ii) | F |
| C | i) | F | ii) | T |
| D | i) | F | ii) | F |

10. i) Consideration of health, safety & comfort are not part of sustainable design.
ii) Urban environments aren't included when considering environmental quality.

Which option best describes the two statements?

- | | | | | |
|---|----|---|-----|---|
| A | i) | T | ii) | T |
| B | i) | T | ii) | F |
| C | i) | F | ii) | T |
| D | i) | F | ii) | F |