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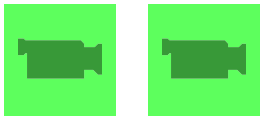
Sustainable Building Design

OBJECTIVES & DEFINITIONS



Objectives for sustainable buildings

Resource efficiency

Energy efficiency

Pollution prevention (including indoor air quality and noisy abatement)

Harmonization with the environment (including environmental assessment)

Integration and systematic approaches (including environmental systems)

Lifecycle of a Building

Ways in which materials are used can optimized through the lifecycle of a building

- Manufacture: waste reduction, pollution prevention, use of recycling materials, embodied energy reduction (the quantity of energy required with all the activities associated with the production process, for example energy to quarry, transport, and manufacture building materials plus energy used in construction), natural materials

Lifecycle of a Building

Operation: energy efficiency, water treatment and conservation, non-toxic, renewable energy resources, longer life

Disposable: biodegradable, recyclable, reuseable

Waste Management

Strategies appropriate for sustainable buildings

- Waste prevention, recycling construction and demolition materials
- Architectural reuse (adaptive reuse, conservative disassembly, reuse of salvaged materials)
- Design for material recovery

Definitions & Terminology

Intelligent building

Living building

Grey water

Black water

Building envelope

U value

Passive solar design

Daylighting

Active solar collection

Intelligent buildings

The benefits if this approach to a sustainable building design are for example:

- Effective energy management system
  - Provides lowest cost energy
  - Avoids waste of energy by managing occupied space
  - Makes efficient use of staff through centralized control and integration of information from different sources

Living Buildings

Key features include:

- Harvest their own water and energy needs on site
- Adapt specifically to site and climate and evolve as conditions change
- Operate pollution-free and generate no waste that is not useful for some other process in the building or the immediate environment
- Promote the health and well-being of all inhabitants
- Comprise integrated systems that maximize efficiency and comfort
- Improve the health and diversity of the local ecosystem rather than degrade it

Outdoor Environments

Landscaping can contribute to reductions in energy consumption for building

- Careful landscape planning can reduce cooling and/or heating costs by 30%
- Trees, grass and shrubs will also reduce air temperatures near the house and provide evaporative cooling
- Trees provide shade, reduce the surface temperature of buildings and prevent direct heat gain through windows.
- Deciduous trees can provide shade in summer and admit light in winter when the leaves fall
- Evergreen trees provide year-round Sun and Wind protection
- Windbreaks can reduce wind within a distance of three times their height

Grey Water

Non industrial waste water

Also known as Sullage

Domestic waste water

Residential waste water

- The remaining water after used in the washing process, i.e. dishes, clothes, baths & showers
- Easier to recycle, through sewerage treatment plants

Black Water

Waste water including human waste which requires sewage treatment to remove dangerous and harmful toxins

Also known as ‘foul water’, ‘brown water’ and ‘sewage’

Does not mean industrial waste water

Water

Water consumption in buildings can be optimized through reduction of water consumption and recycling, for example:

- Toilets (low flush, cistern displacement, waterless (composing, incinerating), urinals (controls, waterless)
- Wash-hand basins (push taps, flow controls)
- Showers (water-saving showerheads or systems
- Water control in gardens and outside spaces
- Water-saving washing machines
- Water supply (auto shut-off and pressure regulators)
- Rain water and grey water recycling

Building Envelope

Building envelope contributes to the amount of energy a building uses during operation

- Building envelope design is a major factor in determining the amount of energy a building will use in its operation
- The building envelope must balance requirements for ventilation and daylight while providing thermal and moisture protection appropriate to prevailing climate
- Consider climate and activities inside the building

U Value

A U value is a measure of heat loss. It is expressed in W/m2k, and shows the amount of heat lost in watts (W) per square metre of material when the temperature (k) is one degree lower outside

For example wall, roof, glazing, and so on

The lower the u value, the better the insulation provided by the material.

What are the building regulations for the U value in Hong Kong, and are they comparable with the UK (Europe), USA and Australia?

U Value

Building materials conduct heat at different rates

Components of the envelope such as foundation walls, sills studs, joists and connectors can create paths for the transfer of thermal energy

Area, thickness, temperature difference and thermal conductivity all determine the heat flow through a material

U Values

Calculating heat loss or gain through a building material envelope comprising different materials

Heat flow = wall area x temperature difference x U value

Passive Solar Design

Passive solar design refers to the use of the sun's energy for the heating and cooling of living spaces

In this approach, the building itself or some element of it takes advantage of natural energy characteristics in materials and air created by exposure to the sun

Passive systems are simple, have few moving parts, and require minimal maintenance and require no mechanical systems

Passive Solar Design

Passive solar design can contribute to passive solar heating and/or cooling and reduce energy consumption:

- When sunlight strikes a building, the building can reflect, transmit or absorb the solar radiation
- Heat from the Sun causes air movement that can be predictable in designed spaces
- Therefore the design elements, material choices and location can provide heating and cooling effects in a building

Passive Solar Design

Ways in which passive solar deign can be achieved:

- Appropriate solar orientation (for example elongate the east-west axis of the building, interior spaces requiring the most light and heating and or cooling should face the Sun, less used spaces should be away from the Sun)
- Use of thermal mass; appropriate ventilation
- Window placements and roof overhangs

Daylighting

Daylighting is the controlled admission of natural light into a space through windows to reduce or eliminate electric lighting

By providing a direct link to the dynamic and perpetually evolving patterns of outdoor illumination, daylighting helps create a visually stimulating and productive environment for building occupants, while reducing as much as one-third of total building energy costs.

Daylighting

Daylighting can contribute to reductions in energy consumption for buildings:

- Daylighting significantly reduces energy consumption and operating costs
- Energy used for lighting in buildings can account for 40-50% of total energy consumption
- The cooling required to counter waste heat generated by lights can amount to 3-5% of total energy use
- Daylighting reduces the need for electrical light sources, cutting down on electricity use and its associated costs and pollution

Indoor Environments

Optimizing the indoor environment of buildings they must be designed to meet basic human requirements for a healthy and comfortable indoor environment whilst at the same time ensuring low energy consumption

- Indoor air quality
- Visual quality
- Acoustic quality
- Noise control
- Systems controllability

Active Solar Collection

Active solar collector systems take advantage of the Sun

- They provide energy for domestic water heating, pool heating, ventilation air pre-heat and space heating
- Water heating for domestic use is generally the most economical application of active solar systems
- The demand for hot water is fairly constant throughout the year, so the solar system provides energy savings year-round
- Major components of a system include collectors, a circulation system that moves fluid between the collectors and storage, the storage tank, a control system, and a back-up heating system

Links and Bibliography

http://www.syec.co.uk/factsheets/U_value_factsheet.pdf

http://www.greenbuilder.com/sourcebook/PassiveSol.html

http://www.wbdg.org/design/daylighting.php