**Principles to improve the energy efficiency - sitting and vernacular design, shade, ventilation, earth shelter, thermal inertia and air lock entrances.**

Environmental planning and management allow conservation of both the environment and developed facilities and long range risk control. Effective site design accommodates methods (1.) through (6.).  Sustainable design can limit the scale of the building and recognizes traditional, vernacular and cultural values and art.

(1.) Sitting and vernacular design.
For effective passive solar heating, a building should face within 25 degrees of south (in the northern hemisphere), and be well integrated with the landscape and topography of the site.

(2.) Shade
Site topography, vegetation and awnings are the simplest forms of shading. Technological shading devices for both the exterior and interior of dwellings are available. These were developed by the building industry since most commercial structures suffer from unwanted heat gain.

(3.) Ventilation
In the tropics houses are raised and open toward prevailing breezes. Windows, ventilators, and vents ensure air exchange.

(4.) Earth shelter
Earth sheltered design is one method of building a house (passive heating design) that will need no other heating or cooling energy input to remain comfortable year round.

(5.) Thermal inertia
Thermal inertia in the form of an on grade floor slab can be heated by sunlight passing through south (in the northern hemisphere) facing windows. This middle of the day heat gain (passive solar heating) is then retained by the mass of the concrete and warms the house continuously. This heating, with normal insulation and construction, is adequate without any other energy input for most temperate climates.

(6.) Air lock entrance

This principle simply relies on a double door system, where only one is opened at a time, to reduce heat loss or gain as from an open single door.

New principles (technologies and methodologies of effectiveness), environmental design and planning complete the methods list.  These six principles, (7.) – (12.), follow from recent developments in standards, technology, and design methods. Integrated dwelling systems can be synthesized combining historical principles, modern aesthetics, and new technologies, into artifacts of environmental design.

The following are also listed, in expanded detail, in the Architecture and Resource Conservation (ARCtm) checklist in items:  3.c. (7.); 4.a. (9. and 10.); 4.b. (12.); 4.c. (8. and 11.); and 4.d. (12.).

(7.) Scale (footprint), insulation, design of future alternatives, percentage of daily use time

Aesthetic principles, cultural footprint (Wang 2003)

“The most significant determinant of building energy use- size,” (Addington, Energy, Body, Building, 2003)

What size of dwelling is enough? Conservation of all resources is well served by limiting the size or scale of house design. Many traditional designs are of compact, functional and pleasing forms. Perhaps a standard range from 60 sqm to 120 sqm is enough for most families.

Insulation installed in the walls and roof can, with earth shelter or thermal inertia, produce a house that needs no other energy input to heat or cool it.

(8.) On site water catchment and waste disposal

Catchment water collection is adequate in many tropical and temperate areas. New developments in filters insure freedom from contamination.

The Clivis Multrum composting toilet very handily takes care of human waste without water. Most wash water can be directed into grey water systems and used for irrigation.

(9.) Solar water heating panels

There are many types of solar water heating systems ranging from simple pre-water heater boosters (passive heating system) to high technology panels with fuzzy logic controlled heat pump systems (active heating system).

(10.) Photovoltaic electricity

Continuous gains in photovoltaic electricity generation technology and use are making these applications usually more attractive than grid electric power. Two recent developments are the panel with an AC inverter and pushing excess power back into the grid.

(11.) Recycling and use of local materials

Many fine recycled building materials are available. Local materials from river rock to timber are often available. Use of indigenous materials saves on processing, storage, wholesaling and transporting costs.

(12.) On site growth of food, fuel and building materials

A significant amount of food for a family can be grown in a small intensive vegetable garden and many fruit trees do well at the homestead scale. Wood for cooking and heating is easy to grow. Weeds and brush can be used for heating or biomass generation. Growing trees for timber requires some planning and special attention. Coppicing can fairly easily produce a variety of sticks and poles for use or sale.

\*\*\* Bioregionalism is the belief that social organization and environmental policies should be based on the bioregion rather than on a region determined by political or economic boundaries.

Eco friendly & sustainable building materials

**Goals**

* **Waste nothing**
* **Use Free resources**
* **Optimize rather than maximize**
* **Create a livable environment**

Sustainable Materials

* **Balance environmental performance goals with performance requirements**
* **Limit the use of materials that have hazardous content** (during construction, cleaning after use)
* **Opportunities to use salvaged materials**
* **Locally available material** (cost & performance are equal)
* **Products with recycled & renewable content**

Life cycle assessment

* Addresses environmental & health factors over a product’s full life cycle from resource extraction, manufacturing, transport, on site construction, occupancy/ maintenance, to recycling / reuse / disposal
* Issues to be considered when evaluating product – raw materials, production processes, packaging & shipping , installation & use, resource recovery.

Raw materials (pre building phase)

* Raw material - **Non toxic**?
* Raw material - **Renewable source**?
* Raw material - **Sustainable source**?
* Raw material - **Agricultural or industrial by product**?
* Product - **Salvaged source**?
* Product - **Recycled content**?

 

**Production** **processes**

* Use of energy, water in manufacturing?
* Manufacturing plant – energy efficient or does it use alternative or renewable resource? / conserve or reuse water?
* Amount of solid, aqueous & gaseous waste associated with manufacture?
* Toxic emissions & effluents eliminated from production process?
* Ozone depleting materials been depleted from production process?



**Packaging & shipping**

* Is product or material locally manufactured
* Does the product or material use minimal, reusable or recycled packaging?
* Does the manufacturer use energy efficient transportation mode???

**Installation & use**

* How durable is the product?
* Does the product emit harmful chemical installations?
* Does the product contain mineral fibers?
* Is the product an installation hazard for workers?
* Is the product low maintenance?
* Are non toxic, low VOC adhesives, finishes, sealants & maintenance products available for the product?

**Resource recovery**

* Are the product or material salvageable / bio degradable / recyclable?
* Does the manufacturer provide a take back option for the product?

**Environmental impact of building materials**

* Embodied energy Ozone depletion Freight transport
* Human toxicity Waste disposal
* Water extraction Acid deposition Ecotoxicity
* Eutrophication Summer smog Minerals extraction

Use of Natural Materials

* Natural materials are generally lower in embodied energy and toxicity than man-made materials.
* Require less processing and are less damaging to the environment.
* theoretically renewable.
* When natural materials are incorporated into building products, the products become more sustainable.

Local Materials

* Shortens transport distances, thus reducing air pollution produced by vehicles.
* better suited to climatic conditions
* Purchases support area economies.
* if materials must be imported they should be used selectively and in as small a volume as possible

***Building Phase***

* Refers to a building material’s useful life.
* This phase begins at the point of the material’s assembly into

 - A structure, includes the maintenance and repair of the material,

 - extends throughout the life of the material within or as part of the building.

COST EFFECTIVENESS

**Filler slab: Advantages:**

 Filler slab using earthen pots

20-35% less materialsDecorative, Economical & Reduced self-load

Almost maintenance free 25-30% Cost Reduction

**Jack Arch: Advantages:**

Energy saving & Eco-Friendly compressive roofing.

Decorative & Highly Economical Maintenance free

**Masonry Dome, Advantages :**

Energy saving eco-friendly compressive roof.

Decorative & Highly Economical for larges spans. Maintenance free

**Funnicular shell, Advantages:**

 Funnicular shell roof

Energy saving eco-friendly compressive roof.

Decorative & Economical Maintenance free

**Masonry Arches, Advantages:**

 Masonry arches in Baker’s home

Traditional spanning system. Highly decorative & economical Less energy requirement.

CONSTRUCTION TECHNIQUES

**Use of Rat-trap Bond for masonry**

The hollow nature of such walls improves its thermal properties.

Electrical conduits can be accommodated in the hollows, which avoid chasing of walls as is normally practiced.

Can be used for load bearing structures up to 2 storeys’ high.

Proves to be very economical.

**Use of nets (perforations in a wall)**

Created for allowing light and ventilation (the most common being a wall with its header blocks removed).

Modifying the proportions of perforations, according to solar angle can help control the influx of radiations to quite an extent.

Brick nets sealed with pieces of glass can economically provide pleasing, diffused light.

**Foundation**

Lime concrete can effectively substitute the cement concrete in the conventional method of laying foundation where brick and cement mortar are adopted over a bed of cement concrete.

For soils with normal load bearing capacity, foundation masonry can be started directly over a bed of rammed and leveled brick-bats.

Economy can be achieved by doing foundations in random stone masonry without mortar.

**Roofs – Use of filler slabs**

It implies, “filling up” of unnecessary parts of concrete slab with light weight material.

It improves its insulating properties.

The resulting light-weight slab reduces the requirement of steel reinforcement.

Bricks, Mangalore pattern tiles, coconut shells, inverted earthen pots, etc. can be used as filler materials.

**Masonry Domes**

Can be built on any room, irrespective of its shape.

Though for maximum economy, room shape should conform to that of the kime’s.

Domes are specifically economical for large spans as this helps in cutting down substantially on the steel, concrete and shuttering used otherwise.

**Finishes**

Finishing takes up a major chunk of the overall building cost.

This may be saved by minimizing applied finishes like plastering, painting, polishing, etc. These are not only initial expenses, but also recurring.

Most of the building blocks, viz. country burnt bricks, stone, and concrete blocks, etc. have pleasing color and texture and are quite capable of resisting adverse weather.

Therefore, plaster can be completely avoided without affecting the strength of the structure.

In case brighter surfaces are required; a few coast of lime wash can be applied directly on the masonry surface.

Site Planning