

Stack ventilation is a passive cooling strategy that takes advantage of temperature stratification.

BASIC PRINCIPLES -- AIR BOUYANCY

- (1) As air warms, it becomes less dense and rises;
- (2) Ambient (hopefully cooler) air replaces the air that has risen.

TEMPERATURE

In order to function effectively (i.e. generate a substantial airflow), the difference between ambient indoor and outdoor air temperatures needs to be at least 3°F [17°C]. A greater temperature difference can provide more effective air circulation and cooling.

TWO WAYS TO CHIEVE A GREATER TEMPERATURE DIFFERENCE

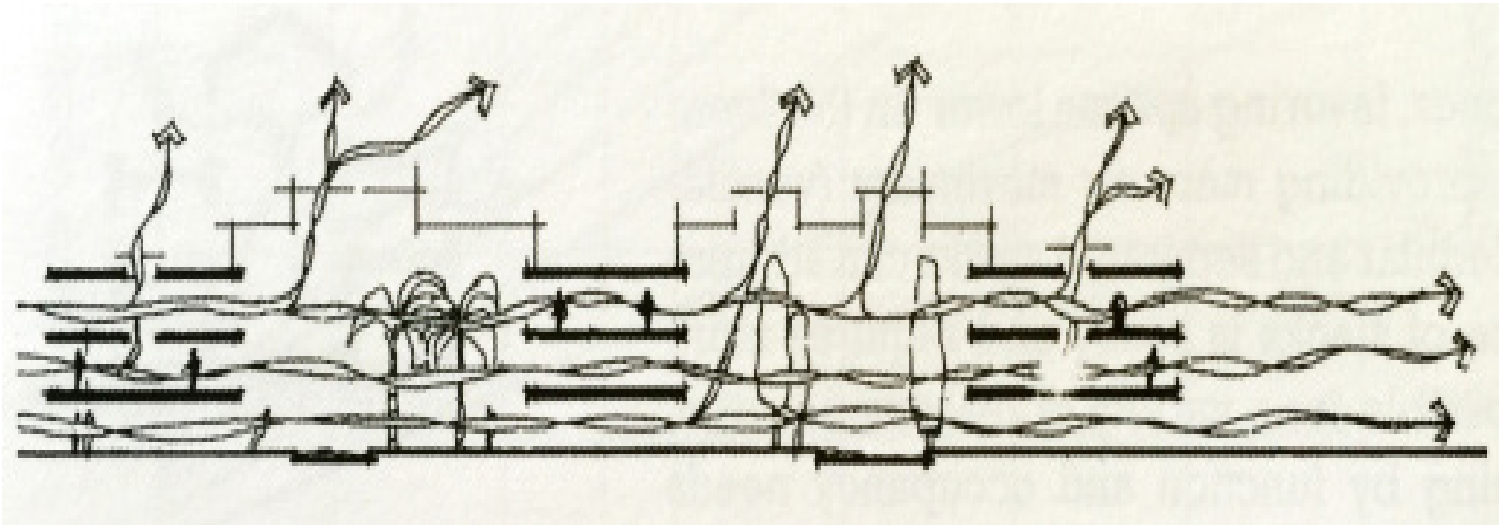
- (1) To increase the height of a stack-- the higher the stack, the greater the vertical stratification of temperatures.
- (2) To use solar energy to heat the air. In the BRE building (Figure 02) in the UK, ventilation stack are located along the southern face of the building. These stacks are glazed with a translucent material so that radiation heats the air in the stack, causing an increase in airflow within the building.

KEY ARCHITECTURAL ISSUESW

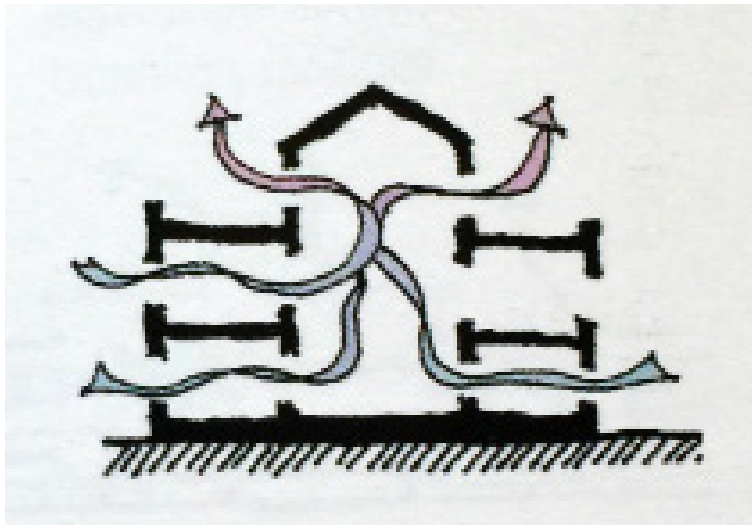
- (1) To work well, stack needs to be double the height of the building if they are to serve all floors of a building, or that they only serve a portion of the total floor area.
- (2) Inlet (and outlet) sizing is critical to system performance. Inlet location, quantity, and size can affect building security, building fasade appearance, and the quality of the incoming air.



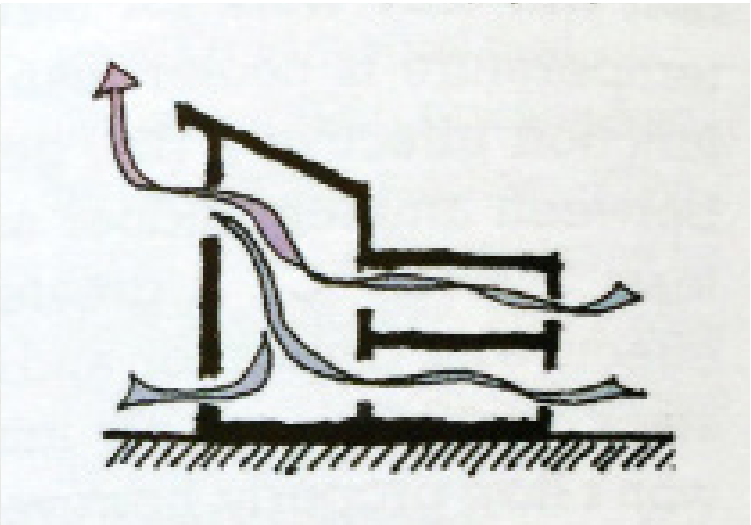
02 Solar chimneys at the Building Research Establishment office, Garston, Hertfordshire, UK. THERESE PEFFER

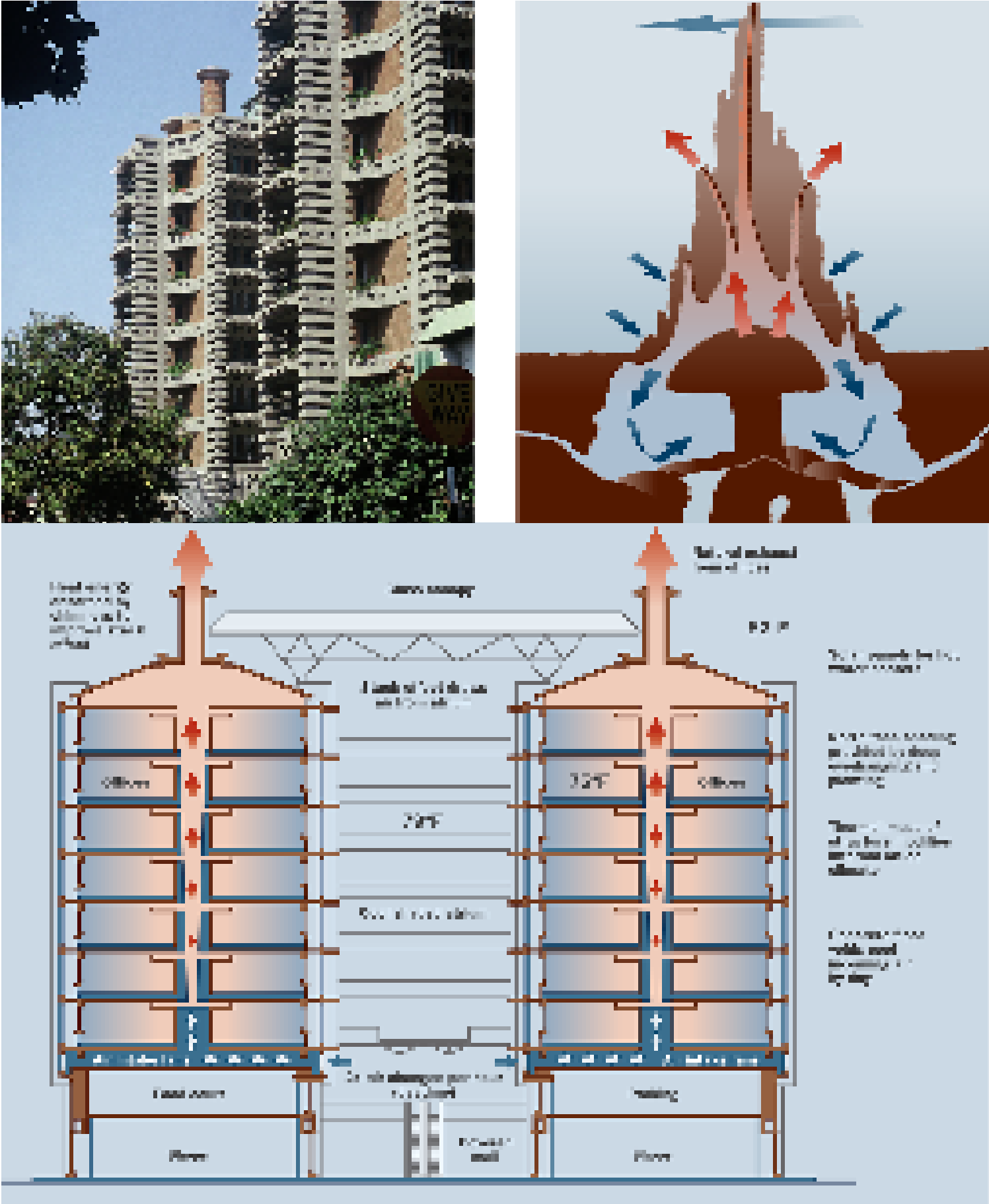


01 Schematic competition entry for the IBN-DLO Institute for Forestry and Nature Research in Wageningen, The Netherlands. BROOK MULLER



03 Various stack ventilation configurations. KATE BECKLEY





The Eastgate Centre in Harare – A Termite Mound In Disguise (Left)

Termites use dense materials that store heat in the day. They then use specific methods of ventilation to remove heat at night. Architect Mick Pearce studied the termites’ movement and use of space, mapping the structure of their tunnels and galleries .

Stack ventilation towers exhaust warm air at Lanchester Library at Coventry University, Coventry, UK. (Above)

Stacking effect providing more air movement (ventilation) at lower levels of a stack, while modular and separated stacks can address this problem. But on the other hand, we also need to consider about cost, opening requirement, etc.



Night ventilation of thermal mass takes advantage of the capacitive properties of massive materials to maintain comfortable space temperatures.

BASIC PRINCIPLES -- MATERIAL

The mass materials moderate air temperature, reducing extreme swings of alternating hot and cold temperatures.

DAY & NIGHT

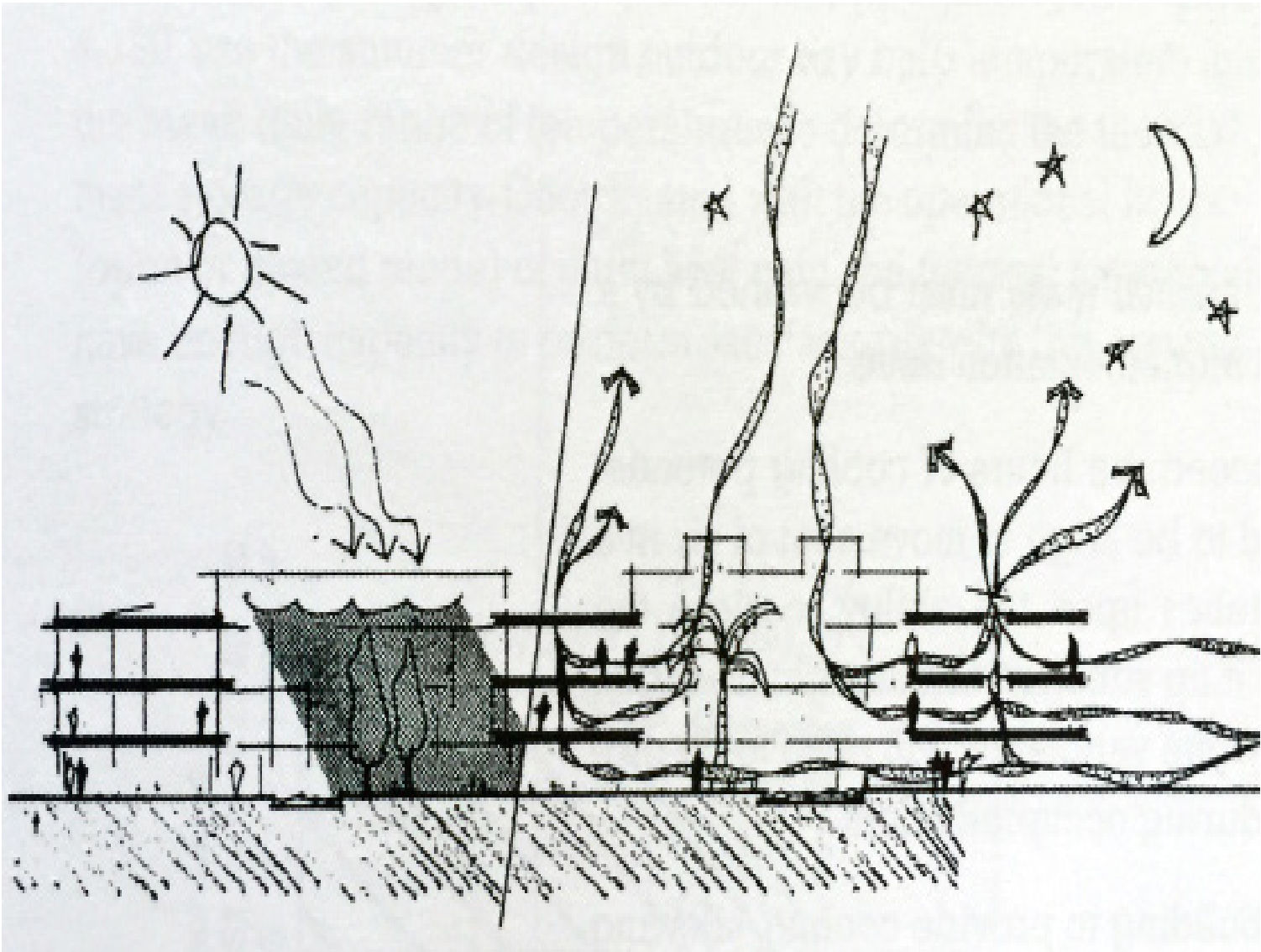
- (1) During the day, the building mass absorbs and stores heat since the temperatures are warmer.
- (2) At night, when outdoor air temperatures are cooler, the heat that was absorbed during the day is released from the mass to the cooler air circulated through the space and then discharged outdoors.

CLIMATE

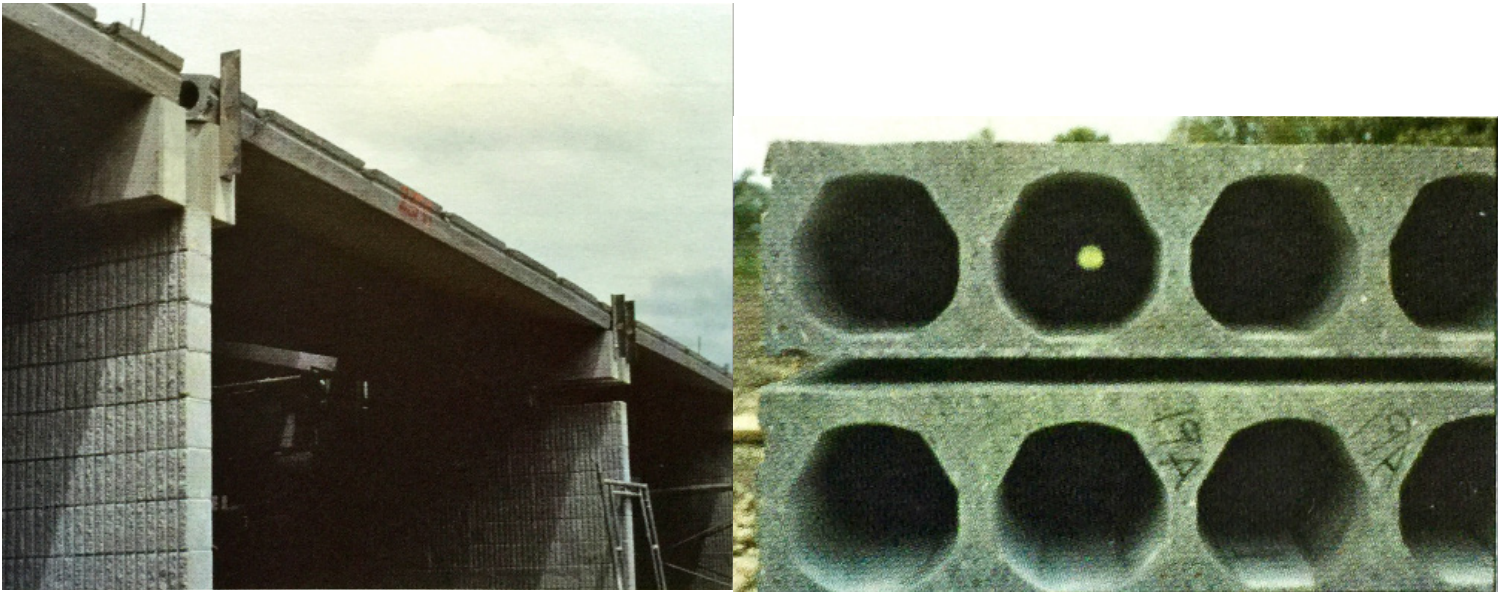
The success of this strategy is highly dependent upon the local climate. The diurnal temperature difference must be large (around 20°F [11°C]).

KEY ARCHITECTURAL ISSUES

- (1) The use of stack ventilation as the airflow driver is encouraged (Figure 04);
- (2) Concrete is often used to provide mass for better spacing and sizing of load-bearing members, as well as the structural strength to overcome the added loads. However, any material with substantial mass will work as thermal storage, including masonry units and water containers.
- (3) The surface area of exposed thermal mass is usually 1 to 3 times that of the conditioned (passive cooled) floor area to make this strategy work effectively.



04 Schematic competition entry for the IBN-DLO Institute for Forestry and Nature Research in Wageningen, The Netherlands. BROOK MULLER.



EXAMPLES (Left)

The Emerald People's Utility District office building in Eugene, Oregon uses mass in the floor, roof/ceiling, and partition walls coupled with cross and mechanical ventilation to cool the building during the overheated season. JOHN REYNOLDS  
Cored concrete slabs used as thermal storage and air circulation channels in a night ventilation system. JOHN REYNOLDS