The Journal of SUSTAINABLE BUILDING DESIGNS

ISSUE NO. 3

Multi-dwelling housing

UN-HABITAT
FOR A BETTER URBAN FUTURE

The Journal of Sustainable Building Design

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DISCLAIMER:

This publication was made possible through the financial support of the Global Environment Facility (GEF).

ACKNOWLEDGEMENTS:

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1 Introduction

Buildings have a strong potential to impact positively or negatively two important elements of everyday life: our environment and energy bills. Their contribution to climate change mitigation on greenhouse gas emission and higher or lower energy bills are directly related to the way buildings are designed in relation to the local climate and site-specific characteristics.

This journal calls for change in the way we build. It promotes creative ways to produce buildings which achieve optimum conditions for their inhabitants whilst making minimum demands on fossil-based energy. The first step in creating comfort and thermal delight in buildings is to understand the relationship between the local climate and our need for shelter. Buildings should vary with climate and thus with location.

The design of energy efficient buildings and homes depends on, solar path and solar radiation, rainfall, humidity, prevailing wind, and ambient temperature of a particular place among others. Design parameters of buildings and homes, therefore, vary with different climatic zones. Therefore, to achieve sustainable housing, it is important to build conssidering the prevailing climatic conditions.

Poor climatic design of buildings, all too often seen in 'modern' architecture, causes many buildings to overheat, even in temperate or cold climates where such problems were never faced before the advent of modern architecture. The influence of the sun should be understood and respected by designers of passive solar buildings in which the sun's free energy is used for natural lighting, heating and drying out but will not interfere with the occupants' comfort. Well-designed buildings with environmentally friendly solutions use less energy. They require lower maintenance compared to ordinary buildings and are more comfortable spaces to live in.

Designing an energy efficient built environment involves minimising the wastage of energy resources while maximising the use of passive design options and renewable energy sources. The green building (or sustainable building) is a result of a holistic approach. It is designed, constructed, and operated in an environmentally responsible way; it is resource efficient (land, water, energy, material, waste) throughout the building's life-cycle.

This journal acts as a guideline in providing applicable passive design principles for different climatic conditions that should be taken into consideration when designing in the different climates. These include:

- Site analysis
- Building orientation
- Natural ventilation
- Day lighting
- Solar shading
- Building materials
- Window sizes
- Window location
- Location of building services

Whereas sustainable buildings are directly related to local climate and site conditions, this journal is not intended to provide generic templates replicable in any part of the East African region. It aims to discuss examples and guide the user on how best to explore local climatic conditions.

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2

Prevailing Wind Analysis

Wind is the movement of air masses caused by the difference in atmospheric pressure related to land, water and air temperature gradients. They can be:

- Regional winds: occur at macro-territorial level (between one geographical region and another
- Local winds: occur at a local scale (waterfront, lakeside area, valleys)

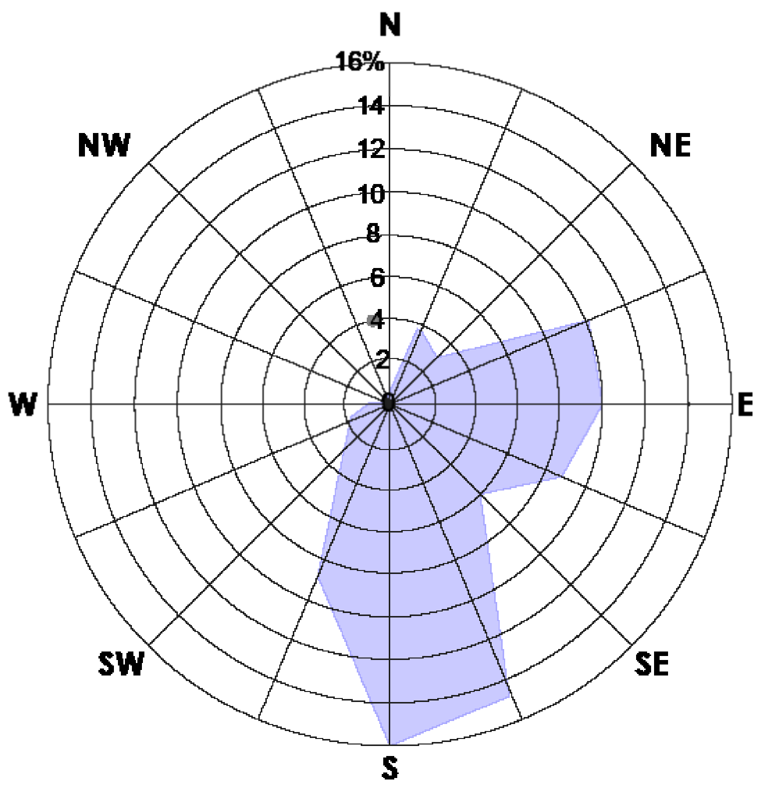
Winds are characterized by the following parameters:

- Speed
- Direction from which it flows
- Frequency

Understanding the prevailing wind patterns of a site can be useful in designing ways to take advantage of natural ventilation or to protect the occupants from uncomfortable windy conditions.

Wind Rose: It is a diagram that shows wind speed and direction for a particular location and analyses the wind characteristics by indicating its strength and frequency over a specified period of time (month, season and year).

Figure 1: Average wind speed wind rose for Mombasa, Latitute 4° South



The longest spoke on the wind rose represents the greatest frequency of winds blowing from that particular direction.

Reading different types of wind rose diagrams:

The wind rose is divided into a number of spokes. The length of each 'spoke' around the circle represents the wind frequency and direction from which it blows while each concentric circle represents different frequencies, starting from zero at the centre to increasing frequencies at the outer circles as illustrated in Fig. 1 above.

1. Determine the location the wind rose represents. A wind rose will indicate statistics for only one location or region.
2. Note the time period represented by the wind rose – month, years etc.
3. The typical orientation of a wind rose is due North at the top.
4. Relate the colours/thickness of the bars/spokes to the legend. They usually represent wind speed in Knots, Meters/Sec, or Km/Hr.
5. Labels on the concentric circles denote frequency in percentages.

3 Natural Ventilation

Thermal comfort of the built environment is affected by air temperature and air movement. Ventilation, which is simply the removal of stale indoor air from a building and its replacement with fresh outside air, has an impact on the thermal comfort.

Adequate ventilation provision is vital in providing pleasant, comfortable internal conditions with suitable air quality in both domestic and non-domestic buildings and also for the provision of cooling in buildings which are overheating. This is essential for the well-being of the occupants and the fabric of the building itself.

Natural Ventilation is used to describe ventilation systems which make use of existing thermodynamic forces within a building to draw in fresh air and discharge waste air without the assistance of energy powered equipment. Air movement is a major factor that influences the indoor climate and should be considered when planning, designing and constructing buildings. It should be incorporated in the design concept. Properly designed and installed natural ventilation systems are considered to be the most energy efficient and healthy solution. They are economic, efficient and require minimum maintenance to provide ventilation at low or zero running costs.

Given the increased awareness of the cost and environmental impact associated with mechanical ventilation, natural ventilation is the best method for reducing energy use and cost in addition, it provides a comfortable, healthy and productive indoor environmental quality. It saves significant amounts of fossil fuel-based energy by reducing the need for mechanical ventilation and air conditioning which in turn reduces greenhouse gases released into the atmosphere from electricity generating plants that produce the energy used for cooling buildings and from air conditioning plants.

Figure 2: Section showing cross and stack effect ventilation

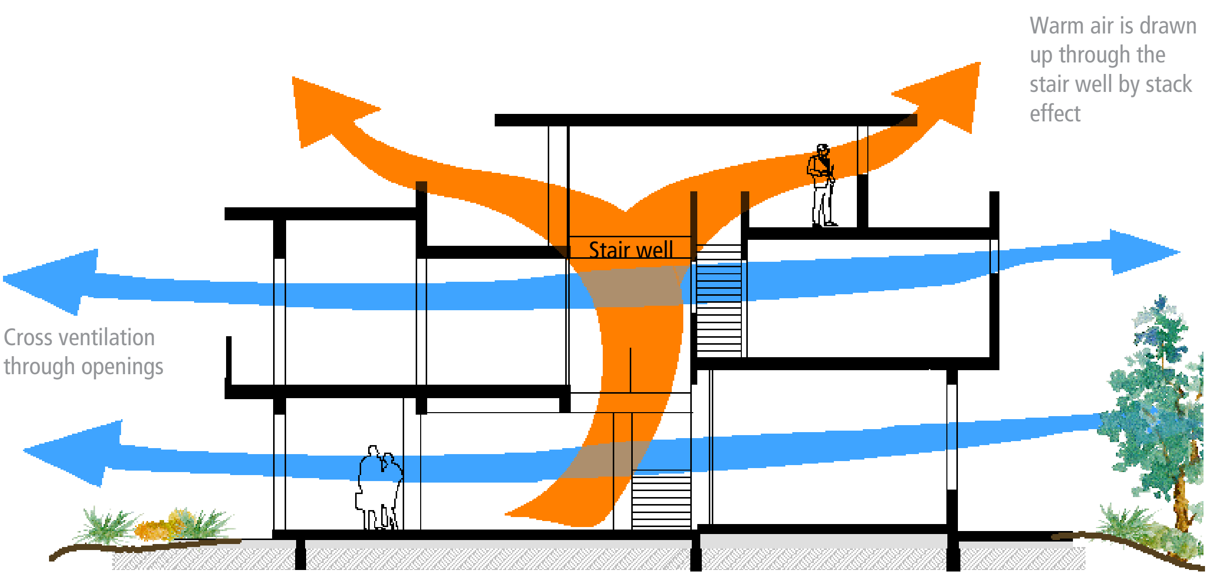
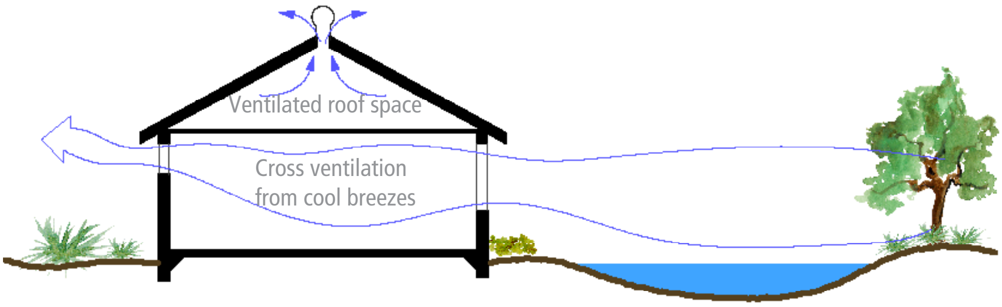


Figure 3: Evaporative cooling ventilation



Use of ponds, pools and water features immediately outside windows or in courtyards pre-cools the air entering the house.

Categories of natural ventilation

Cross ventilation:

In order to achieve reliable air circulation, buildings must be designed for cross-ventilation. Incorrectly designed interior partitions impede cross ventilation by changing the air direction and speed.

Stack Effect:

The stack effect occurs when there is a difference between the inside and outside temperatures. It is brought about by warm through high-level outlets and drawing in colder, heavier air from outside at the lower levels.

- The "stack effect" can also be induced by placing openings near the floor and near the ceiling. It can be regulated by window shutters to obtain the desired cooling effect.

Evaporative cooling ventilation:

This is an effective method of controlling the internal temperatures, especially in hot arid climates. It can be direct passed over water, and cooled by evaporation then supplied directly into the building (e.g. use of pools, fountains etc.) or indirect where evaporation is separated from the air which is delivered into the space (e.g. use of water spray over external walls, roof pools etc.).