leading to doubling the number of buildings in 50 years. If energy used for destruction is included, energy saving will even be increased.

Table 1. Embodied energy of typical Korean apartment buildings for the life of 25 years and 5 years

	25 Years	50 Years
Initial Embodied Energy	1,571	1,571
R&M Embodied Energy	393	944
Total Embodied Energy	1,964	2,515
Total / Year	79	50

CONCLUSION

The paper investigates the significance of embodied energy of building materials, which include e: ;y use for the construction of buildings and for their subsequent maintenance and refurbishment, as an :ample of energy-efficient building design. Although it is difficult to calculate the embodied energy va! ;, careful selection of building materials can save energy both during the initial construction and maintenanc :ocedure. For high-rise apartment buildings, it is especially important to select building materials in tern of energy saving, since embodied energy of building materials is significant for high-rise and high-tech buil :s.

Looking for alternatives for energy-intense materials such as insulation materials contributes to a :stainable global environment. Life-cycle energy costing approach, which involves consideration of regular intenance and periodical material and component replacement, will lead to real energy saving in the long :rm. This includes the consideration of the different life-spans of each building component and easy rep ement of shorter-life one. The importance of maximise the life of buildings is also pointed out, through the i :cation of values for the energy saving.

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PASSIVE EVAPORATIVE COOLING BY MEANS OF WIND TOWER FOR SUMMER COMFORT IN ALGERIA (CONSTANTINE)

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ABSTRACT

Primary energy consumption in Algeria continues to grow, and this is associated with the growth in sale on conventional air conditioning systems. This was a major impact on electricity demand specially for summer cooling purpose for north and south regions of Algeria.
This investigation demonstrates that the combination of passively driven air movement and evaporative cooling through wind tower system can be used with success and fulfil comfort requirements of hotel accommodation under constantine climate. © 1998 Published by Elsevier Science Ltd. All rights reserved.

KEYWORDS

Passive cooling ; Evaporative cooling ; Hotel accommodation ; Wind tower ; New design.

INTRODUCTION

Summary of previous work

Now days, it has become a common tendency to rely entirely on engineers and their equipment to achieve comfortable climatic conditions in building. Whereas, an important number of passive cooling techniques offer considerable potential in reducing demand for fossil fuel energy in cooling the building.

One of the passive cooling systems being used in hot and dry climates relies on evaporative cooling. This approach can be accomplished by wind tower. The combination of passively driven air movement evaporative cooling has precedents in the middle eastern wind towers described by Bahadori (1978) or the malqaf designed by Hassen Fathy (1986). Experimental building in Tucson Arizona in 1986, Cunningham and Thompson (W.A. Cunningham *et al.*, 1986) demonstrated the effectiveness of a down draught tower incorporating wetted cellulose pads Fig. 1. The project of Givoni (1994) confirms the effectiveness of this strategy and from the published results ; it is interesting to note that the exit air temperature from the cooling tower was measured at 23.9°C, when the out door dry bulb temperature reached 40.6°C and wet bulbs temperature was 21.6°C. The drop in temperature through the cool tower coupled with high air change rates indicates the significant cooling potential of this technique.

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THE NATURE OF CLIMATE

Constantine, is located at 36.17°N and 6.37°L east of Greenwich, the altitude is about 687 m above sea level. Constantine is characterised by a semi-arid climate, hot and dry in summer. The temperature may reach 44°C with a humidity of about 18%. Where the winter is cold and humid, the temperature can be as low as 2.5°C with 90% as humidity (Meteorological station, 1994).

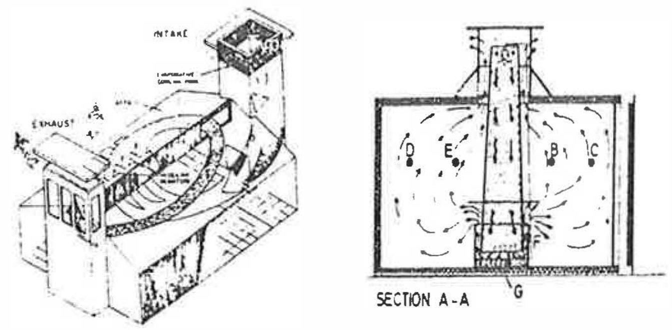


Fig. 1. Cunningham and Thompson's cool tower and experimental building - Inertial/convective cooling experiment (shower tower)

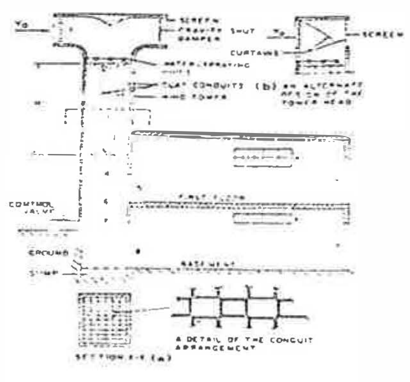
CASE STUDY

This study provides a thermal performance analysis of a typical modern 40 bedroom hotel commonly found in Algeria and particularly in Constantine. The thermal assessment of bedroom model taken into account the cyclical thermal behaviour, examining the heat flow through the building envelope under constantine climate conditions. A micro-computer is used to predict the equivalent external temperature profile representing the thermal time long and damping effects due to capacitance. Internally, the temperature effect of incidental or causal gain together with useful solar input is represented by 'the base temperature' concept related to demand temperature at the upper and lower limits of a comfort band.

Results show that a small winter heating load can be met with an intermittently operated traditional heating system, where as a significant residual cooling load is left taking into account maximum available shading measures. In order to meet this load passively when external temperature are above maximum internal comfort limits. A method of introducing cooled ventilation air via wind tower in confirmation with atria spaces appears to have potential.

HOTEL DESIGN

To improve comfort conditions and meet the cooling load, a new design of the hotel where the improved wind tower described by Bahadori (1985) are proposed in conjunction with an atrium rather than the initial 'T shaped 40 bedroom hotel'. Three distinct improvements :



A cross-section of the improved proposed design of the wind-tower.
(a) Section x-x, cross-section of the clay conduit column.
(b) An alternative design of the tower head.

Fig. 2.

1. A tower head which accepts wind blowing in any direction, and presents the air flow learning the other tower openings, this has been taken in the analysed hotel since there is confusion over wind direction in Constantine.

2. An energy storing system on column with a substantial increase in the heat transfer area.

3. Full utilisation of the potential of evaporative cooling of air by wetting the wall areas of the column, this latter features cooled be further entrained by passing air from the towers through an atrium distribution chamber containing fountains / pools to surrounding bedrooms.

Hence, with this strategy a significant reduction of the internal air temperature : when t_e = 35° C, Q = 18% humidity (Y. Benamara, 1987), the temperature of the delivered air is t_A = 20° C Q = 85%.

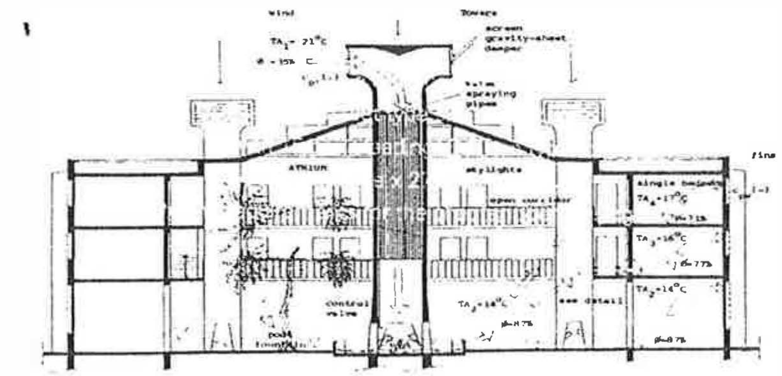


Fig. 3. The pattern of the cooled air with corresponding temperature 'TA' and R. Humidity (night with open window and shutters) section AA.

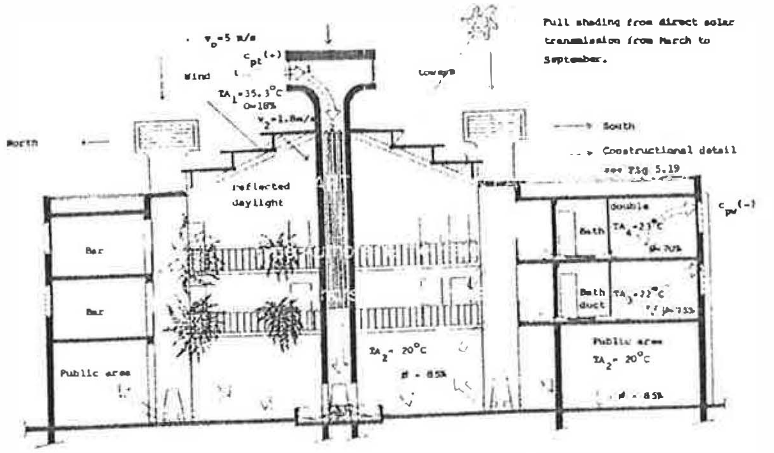


Fig. 4. The pattern of the cooled air decharged by the wind towers into the atrium with correspondin temperature and relative humidity. (day period with open window/close shutters) section BB

CONCLUSION

The strategies resistance, capacitance balance, shading, colour and window sizing, in conjunction with wind-tower induced evaporatively cooled cross ventilation, have been shown to provide an effective means of displacing auxiliary energy loads and improving comfort in hotel.

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PASSIVE SOLAR ENERGY-EFFICIENT BUILDING DESIGN IN KENYA

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ABSTRACT

In this work analysis has been done on the climatic data to obtain physical buildings design specifications for Kenya. The aim is to provide appropriate information at strategic design stages to make better use of energy in urban planning and building design for better indoor "comfort" climate. It utilizes a computer program, ARCHIPAK (Szokolay, 1985), together with climatic data (for 8 year period) to get "comfort zones", and "control potential zones", for nine stations representing the country fairly well by virtue of their geographical locations (Mito, 1997). Here we present pre-design guidelines for passive solar architecture for the capital city of Nairobi.

KEYWORDS

Climatic design, Solar energy, Passive solar architecture, Thermal comfort, Human comfort

INTRODUCTION

Very few buildings are built appropriately for the climate, and hence, are either unnecessarily cold or hot, due mainly to poor orientation of the building with respect to the sun, or simply because the right kind of materials have not been used, in relation to the local climatic conditions of a particular region. In fact, thermal performance of a building can be predicted with reasonable accuracy, and the building itself can control the indoor conditions depending on how efficiently it can adjust to the external environmental conditions – mainly the utilization of the solar energy. Today there exist a considerable amount of knowledge about the design of such buildings and many thousands of built examples, both modern and ancient in developed countries. Some of these were designed intentionally that way while others were purely accidental. The research work currently being undertaken in many countries today involves continuing investigation, analysis and definition of the many complex thermal processes that can take place in a building structure (Butti *et al.*, 1981; Watson *et al.*, 1983; Page, 1958; Milne *et al.*, 1979; and; ASHRAE, 1981). Even with these great wealth of knowledge about passive solar design, much of the detailed thermal performance and interactions of our buildings are not clearly understood. Moreover, most of the thermal comfort standards accepted in the past for conditioned buildings have been found to be inappropriate for passive solar buildings. This is also the case in Kenya and most of developing countries where modern designers or builders have lost touch with the local environment, and so design with no regard for climate.

PASSIVE SOLAR ARCHITECTURE

A passive solar architectural system is one which uses the materials of the building fabric as the collector, storage

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