

Chapter 57

Energy Efficient Residential Block Design: The Case of Ankara

Hakan Hisarligil
Erciyes University, Turkey

Sule Karaaslan
Gazi University, Turkey

ABSTRACT

This chapter presents a methodological approach to residential block design for sustainable urban development for hot-summer and cold-winter climates. Taking Ankara as a case, its focus is on developing an energy efficient design process as regards residential block geometry with optimum performance for both climate and energy use. The numerous variables analyzed are orientation, building geometry and envelope, heating and cooling loads of buildings, and microclimatic conditions including solar radiation, air, and wall temperature, and wind speed. It is also important in this study to demonstrate the potential use of “free and user-friendly” simulation tools for such analysis in the early design phase for those who are not experts but have moderate knowledge of urban microclimate and energy. For this aim Weather Tool v2.00 for climate and passive design analysis, CASAnova 3.0 for building energy analysis, and ENVI-met 3.0 for microclimatic analysis are used.

INTRODUCTION

The relation between climate and energy use in the built-environment is globally recognized as a key issue for sustainable urban development. Numerous studies (Kalma & Newcombe, 1976; Landsberg, 1981; Aida & Gotoh, 1982; Oke,

1988; Elnahas & Williamson, 1997; Santamouris et al., 2001) have shown that building and urban environment significantly modify climate and energy use for heating and cooling. Urban form, in this context, mainly relates to both the design and planning approach taking utilization or prevention of climatic conditions into consideration. Urban design is essential for improving people's indoor and outdoor thermal comfort conditions,

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which directly affect the heating and cooling load of buildings. A design that does not consider the climatic gains and losses of buildings in the early design phase may cause lower indoor and outdoor thermal comfort and higher energy use for heating and cooling.

In the case of Turkey, where energy requirements for residential areas have until now been supplied mainly by oil products, a source with environmentally negative impacts and which depends economically on foreign resources, measures for energy savings have been taken according to “TS-825 Heat Insulation Regulations” based on the climatic conditions of regional differences determined by the heating degree days (HDD) throughout the country. However, when the findings of a number of theoretical studies (Oke, 1987; Swaid, 1991; Ratti et al., 2005) on climate and energy at urban level were compared to “TS-825 Heat Insulation Regulations,” which are limited to calculations of the heating loads of buildings based on S/V ratio alone, it was suggested that beside heating, the cooling loads of buildings and microclimatic conditions at urban scale should both be taken into account to be effective in an urban area. Therefore, it is not difficult to see that there is an urgent need for a comprehensive approach and teamwork to provide a firm foundation on which design and planning decisions on the physical environment can be based. What is important is to develop the necessary techniques to establish balance, continuity and the implementation of decisions to achieve the desired results. Moreover, since urban planning and design affect the urban microclimate and energy use, we aimed to provide results derived from an integrated analysis which would help in setting in motion the steps necessary for establishing satisfactory indoor and outdoor thermal comfort conditions.

The main focus of this research, which is a revised version of the Ph.D. dissertation of the first author (Hisarligil, 2009), was to develop an energy efficient planning and design process on the scale of the residential block, through ana-

lyzing the microclimatic conditions of generic residential blocks with energy efficient buildings in residential areas, where energy demand is low but supply is of high quality. Ankara, with a temperate-dry climate featuring both hot and cold climatic conditions together at the regional scale, was chosen as the case area. We used Weather Tool v2.00 for climate and passive design analysis, CASAnova 3.0 for building energy analysis and ENVI-met 3.0 for microclimatic analysis as the simulation software for this work. In this study, besides the theoretical background, the use of such simulation tools in an integrated manner is also proposed for the planning and design process of residential areas. In brief, “efficient” energy saving in settlements can be achieved through taking the mutual interaction between microclimate and energy gains into consideration in the case of residential block design.

BACKGROUND

The idea of climatically responsive design, dating presumably back to the beginning of the history of human dwelling, can be defined simply as modulating thermal conditions such that they are always within, or as close as possible to, the comfort zone. The ideal climatic design is, thus, successive modulation of ambient conditions so as to bring internal conditions within the comfort zone. Climate, briefly, is the statistics of meteorological data over long periods for solar radiation, temperature, humidity, wind, rainfall, and other conditions in a given region. A microclimate, on the other hand, is the local weather which differs from these statistical data since any modification, natural or man-made, in an area creates its own ambient weather. The building envelope, which behaves as an interface between the indoor and outdoor environment, in this context is like the outermost skin of the body and absorbs thermal shock to facilitate human thermal comfort. Any heat gain or loss beyond this level requires an

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