15 A Bio-Climatic Approach to Desert Architecture

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Desert architecture may be characterized as “Architecture of the Extremes,” being basically similar to “regular” architecture but differentiated from it by its obligation to address needs and problems of an extreme character. The problem of thermal comfort in buildings is perceived as one of the more characteristic and difficult problems that desert architecture must address, even though this is not the only problem nor necessarily the most difficult one. A typical way of addressing the thermal comfort issue in buildings is by intensive use of expendable energies, but this, of course, is not an ideal approach: it leads to waste of energy, it is expensive, and not everyone is comfortable with the thermal conditions it creates (witness the number of people who do not like air-conditioning). Various characteristics of design and construction enable the improvement of thermal comfort to be integrated into a building without the use of artificial means and expendable energy. Now, when it seems that even the drowsy Negev (the southern half of the Israeli land area, which houses only about 7 percent of the country’s population) is awakening to a building surge, it is desirable to clarify these methods, and even to try to apply them in new building projects. What’s more, as an ever increasing worldwide need for housing construction is evident, much of it in hot arid lands, the “right” type of building technology should be used to improve standards of living and decrease the use of purchased energies.

This article demonstrates a number of climatic and energy characteristics of building in the desert. It takes as its subject an examination of a recently completed house in the new Neve-Zin neighborhood of the Sede-Boker Campus of Ben-Gurion University of the Negev, the first real “solar” or “bio-climatic” neighborhood in Israel. The house chosen is the Etzion House (Fig. 15.1), which was designed by and built for the author of this article. It was chosen for examination here because of the author’s first-hand familiarity with its design considerations and characteristics.

15.1 The Climate of the Negev

It is necessary, first of all, to introduce the Negev and its environmental conditions, and also to correct several misconceptions and false “truths” concerning the

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climate in most of its regions. The relatively high Negev regions (300 m and above) are not areas as hot, for example, as the Arava or the Beit-Shean Valley (both along the Jordan Rift). The higher regions of the Negev may be characterized as having cold, uncomfortable winters and summers that are hot during the day but usually pleasant at night. The Sede-Boker Campus is located at 30.8° latitude north, 500 m above sea level. Average annual rainfall is 80 mm, but there is a considerable deviation from year to year.

The climate is considered hot and dry during the summer, with an average maximum temperature of 32°C and an average daytime temperature of 24°C. Solar radiation is very strong, and may reach 7.7 kWh/m² x day on a horizontal surface (during June and July). In the summer, ambient relative humidity is very low, between 20 percent and 40 percent during most of the day, but it rises considerably during the night, when the ambient temperature drops sharply, to reach 90 percent. Summer daily temperature fluctuation is about 18°C, and the average temperature is within the range of thermal comfort. Winter is cold, sometimes rainy, and uncomfortable. The average temperature in January is 10°C and the average minimum daily temperature is 3°C. The temperature at night often drops below freezing (0°C). The intensity of solar radiation during the winter is relatively high and reaches 3.3 kWh/m² x day on a horizontal surface, and about 4.6 kWh/m² x day on a south-facing vertical surface (Fig. 15.2). These conditions make Sede-Boker an almost ideal location for buildings that achieve thermal comfort in the winter by employing solar energy. Thermal comfort generated by the sun adds to the quality of life and is definitely economical.

15.2 Building Design: Sealing the Envelope

The concept guiding building design in this climate is the creation of an envelope, sealed as far as possible against the passage of energy. In this envelope should be openings, allowing desirable - but controlled, both in time and in quantity - passage of natural energy from the house outwards and vice versa. The house should be massive, with a relatively high thermal capacity. The first “truth” that should be refuted regarding building design is that the directional orientation of the building is the key to achieving thermal comfort. A house built according to the concept guiding the design of the Etzion House is largely insensitive to its orientation. If the envelope is really well insulated and has a significant thermal capacity, there is not much difference in the thermal performance of a house facing south compared to houses facing other directions, because the envelope is, practically speaking, almost sealed to the passage of energy. Orienting the openings, though, is very important, as will be explained further on. Thus the popular opinion that the bio-climatic house must have a long southern exposure is not necessarily correct: a long south-facing elevation is needed only for positioning the south-facing windows, and it should be large enough to enable just that.