CHAPTER (1)

INTRODUCTION

Passive systems are fundamentally different from active space-heating systems in that most passive system components are part of the building itself. Therefore the design of passive systems takes place earlier in the architectural design process than does the design of active systems. Active systems can be added on to buildings when loads and energy requirements are identified, therefore their design is focused in the design development architectural phase. However, passive systems, with their intimate association with the building and its structure, are front-loaded in the design process. Most of the passive design work is included in the programming and schematic design phases, with somewhat reduced emphasis required in design development relative to that for active system.

There is also a fundamental difference between residential and commercial passive systems. Most passive systems built in the 1970s were applied to relatively small residences and methodology for residential passive design appears to be relatively mature.

During the same period, a handful of commercial passive systems were built which used in office buildings, institutional buildings, hospitals, and so on. The differences between residential and commercial buildings are basically twofold. Firstly, it is much more difficult to distribute heat in a large commercial building when the heat is produced along a southern zone or in the roof area than in relatively small residences. Therefore temperature

control by zones is more complex for the commercial applications. Secondly, internal loads due to business machines, lighting, and people frequently dominate the energy performance of commercial buildings. In some applications very little heating is required. Therefore the heating season during which a passive system investment must be paid off in fuel saving may be relatively shorter in a commercial than in a residential building, which has substantially smaller internal loads per square foot of floor area [1].

1.1 Basic Types of Passive Solar Building Design

While passive solar energy systems can be grouped in various ways, the approach used here is to describe them according to five physically identifiable methods of operation, [20]:

1-Direct-Gain Systems.

2-Thermo siphoning Systems.

3-Thermal Storage Walls.

4-Thermal Storage Roofs.

5-Attached Sunspaces.

The following brief descriptions simply introduce the basic components of these five system types.

1.1.1 Direct –Gain Systems:

Direct-gain systems use solar radiation that enters through glass or plastic glazing directly into the space that is to be heated. See Fig. 1.1. Nearly all of the solar radiation entering the room is immediately converted into heat. Thermal mass for storing excess solar heat is most effective when located so that it receives direct exposure to sunlight, as in a concrete floor, [20].

To reduce heat loss and thereby to increase overall thermal performance, insulation may be applied at night to the glass-either inside or outside. During the heating season, south-facing glass takes advantages of the sun's low position in the sky; in the summer, when the sun is high in the sky, the glass is shaded by overhangs or trees.

1.1.2 Thermo-siphoning Systems:

Fig. 1.2 illustrates the simplest form of a thermo-siphoning air collector. As the air in the space between the glass and the blackened absorber surface is heated, it expands and becomes lighter, then it rises through the collector, and flows into the room through a vent at the top.

Cooled room air, drawn into the collector through another vent at the base of the wall, replaces the warmed air leaving the collector. It is heated and subsequently expelled from the top of the collector into the room. This process continues as long as there is enough solar radiation to raise the temperature of the collector above the temperature of the room.

1.1.3 Thermal Storage Walls:

In many applications of passive solar heating, thermal energy storage is located between a wall of glass or plastic and the space to be heated. See Fig. 1.3. There are two general types of thermal storage walls. The first type uses heavy masonry materials, one foot or so thick. The outside surface of the wall, which is painted a dark color, heats up as the sun irradiates it; the heat is conducted through the wall and is then transmitted to the interior spaces several hours after the sun's energy strikes the wall. The second type uses water instead of masonry. Tubes, 55 gallon drums, and specially fabricated water walls are commonly used for thermal storage.