An Introduction to Passive Solar Buildings

An Online Continuing Education Course for Engineers

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An Introduction to Passive Solar Buildings

J. Paul Guyer, P.E., R.A.

Paul Guyer is a registered mechanical engineer, civil engineer, fire protection engineer and architect with over 35 years experience in the design of buildings and related infrastructure. For an additional 9 years he was a senior-level advisor to the California Legislature on infrastructure and capital outlay issues. He is a graduate of Stanford University and has held numerous national, state and local positions with the American Society of Civil Engineers and National Society of Professional Engineers and is a former President of the Board of Governors of the Architectural Engineering Institute.

CONTENTS

1. INTRODUCTION

This course is intended as an introduction to principles and concepts underlying the design of buildings to *passively* utilize solar energy for heating. Here are some points for you to keep in mind as you go through the course material:

- This is an introduction to the *passive* solar technology that may be used to heat buildings. It is not about *active* technologies. Usually an optimal solution for a specific building and locale involves *passive* technology supplemented by *active* technologies. Active technologies are not part of this course. Passive technologies are. This will be discussed further.

- Utilization of passive solar energy to heat buildings is fundamentally an exercise requiring an understanding of (a) the fact that heat is transferred from outside to inside a building by conduction, convection and radiation, and (b) the concept of heat sinks as a reservoir for heat storage.

- Procedures for design of buildings to passively use solar energy for heating buildings may typically involve (a) use of shading devices to reduce heating by radiant (solar) energy in the summer and allow it in winter, (b) utilize thermal convection (i.e. hot air rises) to maximize heating by convection in winter, and (c) utilize thermal storage (mass-effect) to transfer excess heating capacity from daylight to nighttime hours.

- This is an introductory course intended to tell you about basic systems and climate considerations underlying the passive utilization of solar energy to heat buildings. It is not intended to be a definitive design manual that can be used for feasibility studies, design analyses and building design.

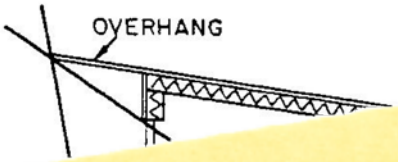
2. SYSTEMS

2.1 Direct Gain Heating. Direct gain buildings are passive solar heating systems in which sunlight is introduced directly to the living space through windows or other glazed apertures as indicated schematically in Figure 1. As with all passive solar systems, it is important that the apertures face south or near south in order to achieve high solar gains during the winter heating season and low solar gains during the summer cooling season.

Thermal storage mass is essential to the performance and comfort of direct gain buildings. A building that has inadequate mass will overheat and require ventilation, which entails a loss of heat that might otherwise have been stored for night time use. Generally, it is desirable to employ structural mass as a storage medium in order to take advantage of the improved economics associated with multiple use. Insulation should always be placed on the outside of massive elements of the building shell rather than on the inside in order to reduce heat Losses without isolating the mass from the living space. Concrete floor slabs can contribute to the heat capacity of a building provided they are not isolated by carpets and cushioning pads. Heat losses from the slab can be limited by placing perimeter insulation on the outside of the foundation walls. If the structure is fairly light, the heat capacity can be effectively increased by placing water containers in the interior. A variety of attractive containers are available commercially.

An overhang, illustrated in Figure 1, is used to shade the solar aperture from the high summer sun while permitting rays from the low winter sun to penetrate and warn the inside of the building. In climates having particularly warm and sunny summers, an overhang may not be sufficient to prevent significant aggravation of the summer cooling load. Sky diffuse and ground reflected radiation enter the living space despite the presence of an overhang and must be blocked by external covers or internal shades. Using movable insulation on direct gain apertures has the advantage of reducing night time heat losses during the winter-as well as eliminating unwanted solar gains during the summer.

FIGURE 1
DIRECT GAIN HEATING SYSTEM



Direct gai… …n other types of p… …epted by most occu… degradatio… …uting the sunligh… window pla… properly de… …s of reducing en… …mfort or aesthetic values.

2.2 Daylighting. The daylight delivered to the interior of direct gain buildings is an additional resource that is available year-round. Pleasing uniform illumination can be achieved by using blinds that reflect sunlight toward white diffusive ceilings. The artificial lighting system in many buildings imposes a significant load on the cooling

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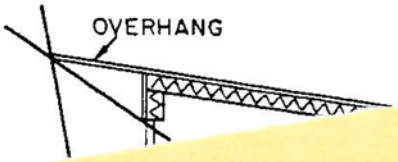

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