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# Performance evaluation of a passive solar building in Western Himalayas

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**Abstract**

Under the Passive Solar Building Programme, more than 100 buildings have been constructed in the high altitude region of the Indian State of Himachal Pradesh. A policy decision has been taken by the State that all government/semi-government buildings are to be designed and constructed as per passive solar housing technology. The evaluation studies of some of these buildings have been carried out by our group. In the present study, the thermal performance of a passive solar bank building at Shimla, has been evaluated. This solar building incorporates a heat-collecting wall and a roof-top solar air heater with an electric heating backup, sunspaces and double-glazed windows. The monitoring of the building shows that the solar passive features in the building results in comfortable living conditions. The study shows that the high cost central electric/gas/wood-fired heating systems can be replaced by a low cost solar heating system with backup heaters. This will result not only in reducing higher installation costs of these systems but also the annual running and maintenance costs. It is shown that the solar passive features save electricity required for space heating and reduce the heat losses in the building by about 35%. The strategy to be followed for the propagation of passive solar technology on large scale in this Himalayan State or in any other cold hilly region is also presented.


*Keywords:* Solar energy; Passive solar housing technology; Passive solar building; Space heating; Cold climates

## 1. Introduction

A Passive Solar Building Programme is being implemented in the Western Himalayan State of Himachal Pradesh in India. A large number of passive solar buildings have been designed and constructed in the State under a Solar House Action Plan [1,2]. The constructed buildings are monitored to study the efficacy of solar passive features incorporated in these buildings.

In the present study, the steady state method is used to evaluate the thermal performance of a passive solar building [3]. The passive solar H.P. Co-operative Bank building is located on the Mall Road in Shimla, in the Western Himalayan State of Himachal Pradesh, India (latitude 31.1°N, longitude 77.1°E and altitude 2202 m (above mean sea level)) (Fig. 1). The layout and location plan of the building is given in Fig. 2. The eastern longer face of the building has no access to light and air as it adjoins the State Bank of Patiala solar passive building. The narrow front of the building which is exposed to the southern sun incorporates a solar heat collecting wall (Fig. 3), two sunspaces, double-glazed windows. A solar air heating collector is installed on the southern side of the roof (Fig. 4). The western face has access to light and air from adjacent lane but no sunshine is available. The natural light from the valley side is available to the north side of the building as there are no buildings on that side. The schematic diagram of the roof-top solar air heating system with a 45 kW electric backup heating system with three units of 15 kW each is shown in Fig. 5. The system which is thermostatically controlled to maintain the inside

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Fig. 1. Passive solar State Co-operative Bank building at Shimla.

temperature at 19 °C, heats the air which is circulated by a fan through ducts into the banking hall and conference room.

## 2. Passive solar features of the building

The passive solar features of the bank building at Shimla are as follows:

- orientation of building is 10° west of south;
- air-lock lobby at the main entrance to reduce heat losses;
- external walls (north, south, west) are 9-in.-thick brick walls;
- eastern wall is 18-in.-thick brick wall as it adjoins another solar passive State Bank of Patiala building;
- two sunspaces, each of size 1.8 $m^2$, are provided on the south face on the first and second floors;
- a 36-$m^2$ heat collecting solar wall on southern face;
- roof-top solar air heating system with a 45-kW electric backup heating system;
- double-glazed sealed windows with wooden frame shutters on west and north sides;
- buffer zone has been created on the north face of building to reduce heat losses;
- west wall of the officer rooms are insulated with wooden panels and
- the exposed roof is thermally insulated by 50-mm-thick resin-bonded mineral wool.

The climatic data of Shimla and building data are summarized in Tables 1 and 2, respectively.

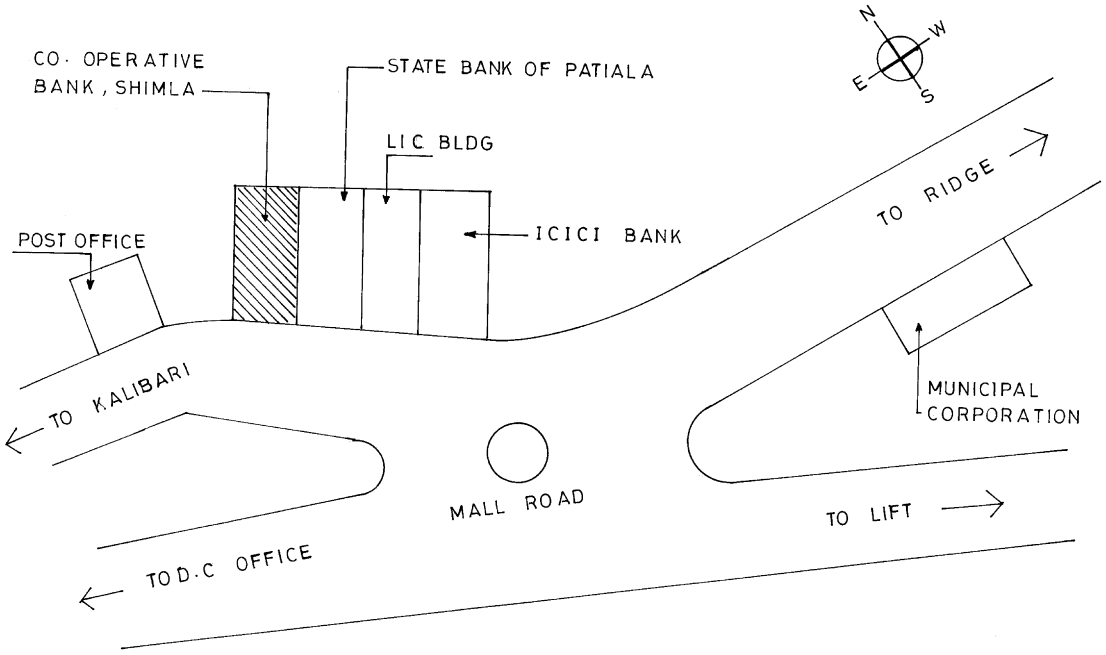


Fig. 2. Location of passive solar bank building at Shimla.