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## **Passive Solar in China: Traditional and New**

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PASSIVE SOLAR IN CHINA:  
TRADITIONAL AND NEW

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ABSTRACT

The authors' observations of a tradition of passive solar architecture in northern China are described. Tendencies for modern buildings to depart from this tradition are noted. Major passive solar research programs are discussed and experimental buildings are illustrated. It is concluded that the Chinese could realize a major advantage by combining their strong tradition of passive solar architecture with modern insulation methods and improved glazing systems.

INTRODUCTION

More than any other country we have visited, China has a strong tradition of passive solar architecture. This is particularly true in the north which has a continental climate with harsh, dry winters and hot summers. Most traditional residences are constructed along an east-west axis with the principle openings along the long south side. Courtyards are on the south and enclosed by high walls or secondary buildings. We did not sense a conscious appreciation of the thermal benefits of this design approach but rather that the design was driven by the customs of a long cultural tradition. In most contemporary buildings, these patterns are followed although in some new multistory apartment blocks there is no apparent sense of orientation. Research into passive solar buildings is being carried out at universities and solar institutes, principally in Beijing and Lanzhou. The building typology is very similar to the traditional forms described above with some embellishments, notably Trombe walls and sunspaces. The sunspace approach would seem to be particularly relevant since a winter growing area could be of great benefit. The principle problem is not one

of passive design so much as the lack of adequate conservation measures. The use of insulation is not at all normal and thus there is no established industry and costs are high. Glass is expensive, is not tempered, and is virtually never used as double glazing. Thus the performance is low, countered only by the fact that expectations are low.

OUR EXPERIENCE

We are not old China hands. We have visited twice, for a total of about five weeks, to lecture on passive solar applications. The first time was in 1980 in Lanzhou, a city in the north central region in Gansu Province. The second was in 1985 in Beijing to attend an international solar conference followed by a tour through the south and east. This paper is a report of our limited observations of architectural styles and ongoing passive solar research. Thanks to the hospitality of our Chinese hosts, we have been able to visit homes and many other buildings both old and new, and because our trips were five years apart, we have been able to see the changes and the progress made in the solar field during that time.

TRADITIONAL BUILDINGS

The great majority of traditional buildings that we observed were designed in conformance with good passive solar siting and orientation. This was so pervasive that it could not be coincidental. Figures 1 - 3 show typical rural housing. Openings on the south are glazed with glass when available or with other translucent materials. The buildings often face into courtyards surrounded by high walls or secondary buildings to provide a sheltered area which is almost an extension of the house

itself. North, east and west walls usually have few, if any, openings. Even large older buildings show this kind of climate sensitivity.

Materials of construction vary depending on locality. Around Beijing we saw primarily brick or stone. But in the more arid regions, adobe was the norm. Roofs are usually tiled and have a wooden support structure. Buildings are typically uninsulated except for a small layer of straw or earth in the roof.

We do not wish to give the impression that these buildings are comfortable in the harsh Chinese winter. Surely they are not. But they are probably 15 degrees F warmer due to the attention to passive solar principles than they would otherwise have been.

#### MODERN BUILDINGS

China has a major housing problem. In response to this, there is an enormous rate of new construction. Most new housing in the cities of China is in the form of mid-rise apartment buildings of the internationally familiar reinforced concrete and hollow tile type with cored slab floors. The majority of these buildings maintain the traditional solar orientation and east-west elongation, but there is a trend toward a standardized apartment plan which is the same on all facades. Many large residential buildings have balconies on the south side and an extra glassed-in area on the north. This same type of construction is beginning to be used in the countryside as well as the cities - a space saving technique - but most rural construction is still of the traditional types.

#### PASSIVE SOLAR RESEARCH

The Chinese are very interested in passive solar recognizing that it is an appropriate technology for the cold, northern areas of the country. Passive solar research activities are centered at the Beijing Solar Energy Research Institute and at the new Gansu Natural Energy Research Institute. Strong architectural interest in passive solar is evidenced by work at the Tsinghua University in Beijing and at Tianjin University.

In addition to experimental buildings at the institutes in Beijing and Gansu, there are major complexes of experimental passive solar buildings at Daxing, southeast of Beijing, and at the experimental village northeast

of Beijing. These are illustrated in Figures 6 - 13. In these passive buildings, good solar orientation and direct gain are taken for granted; the research concentrates on Trombe walls, water walls, sunspaces and movable insulation. Little research was in evidence on insulation, ventilation, shading, improved glazing systems (compared to single glazing), or thermal analysis. The best current survey of passive solar research activities can be found in the papers of the International Conference on Solar and Wind Energy held in Beijing in August 1985.

#### CONCLUSIONS

There is clearly a very strong interest in passive solar in China. The Chinese have an advantage over most of the rest of the world in having such a strongly solar-oriented building tradition. Acceptance of passive solar should not encounter some of the resistance which has been experienced in other countries.

We are concerned by a tendency to depart from some of these traditions in modern buildings. We believe that it is possible for the Chinese people to carry the best of these traditional features into new buildings which are modern, comfortable, and place a minimum strain on their economy and environment.

The greatest needs which we could identify are for improved systems of building insulation and improved glazings with high transmission and low heat loss. These are clearly areas which China can develop with its vast resources and clear sense of purpose.

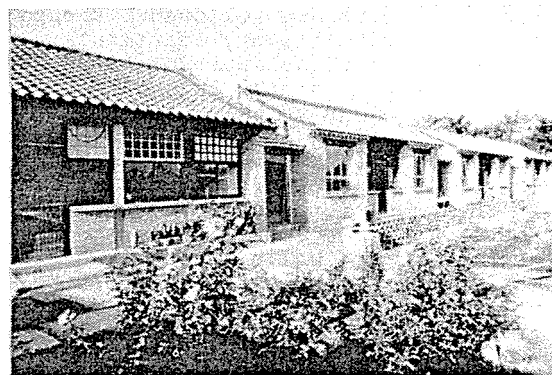


Fig. 1. Typical farmer's houses near Beijing. South facade.

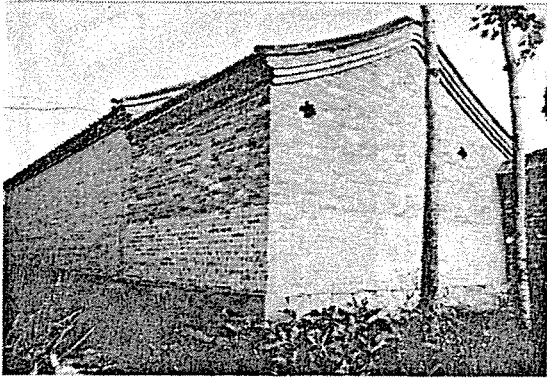


Fig. 2. View of the same house from the northwest.

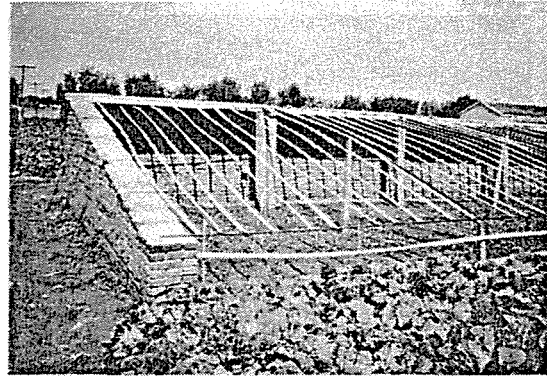


Fig. 5. Typical agricultural greenhouse construction. This view from the SSE shows massive north and end walls and slats used to support polyethelene.

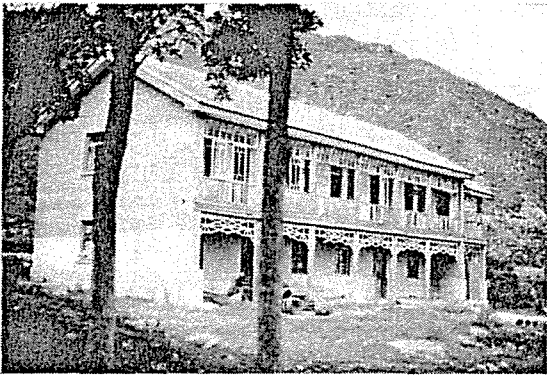


Fig. 3. Two story building north of Beijing.

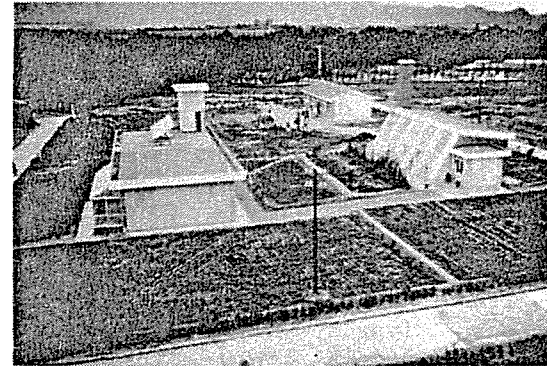


Fig. 4. New apartment construction in Beijing showing the south side.

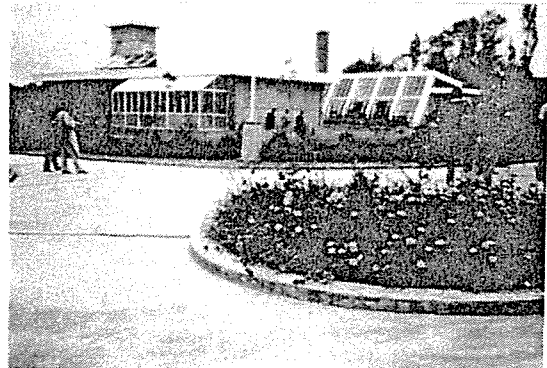


Fig. 6. Two views showing experimental buildings at the Gansu Natural Energy Research Institute. (photos by Neeper).

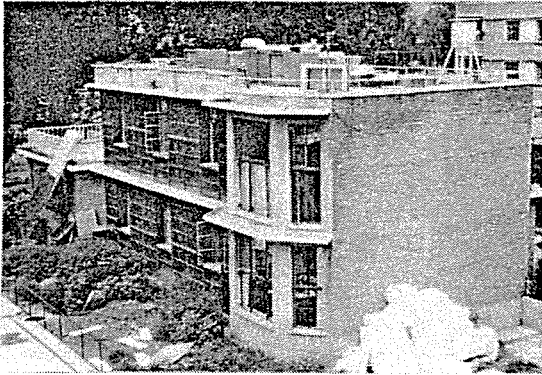


Fig. 7. Trombe wall building at the Beijing Solar Energy Research Institute.

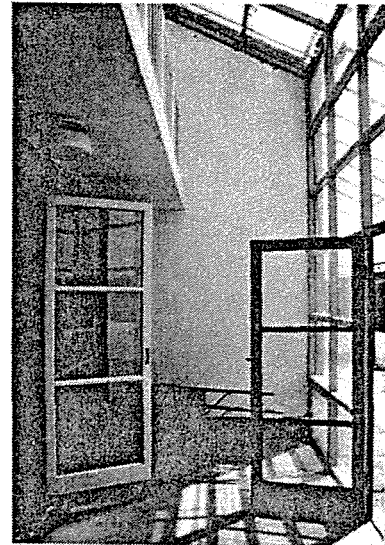


Fig. 8. Typical Chinese thermosyphon passive solar water heaters.

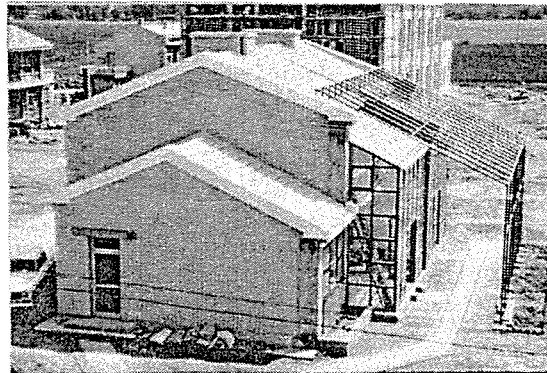


Fig. 10. Outside and inside views of large sunspace on passive solar residence, Daxing. Pipe frame is support for summer shading.

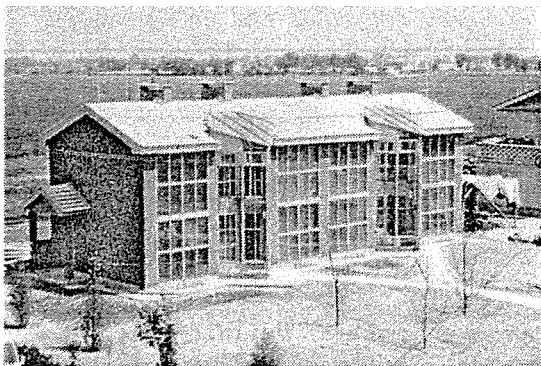


Fig. 9. A residential building at Daxing features Trombe walls and sunspace entries.

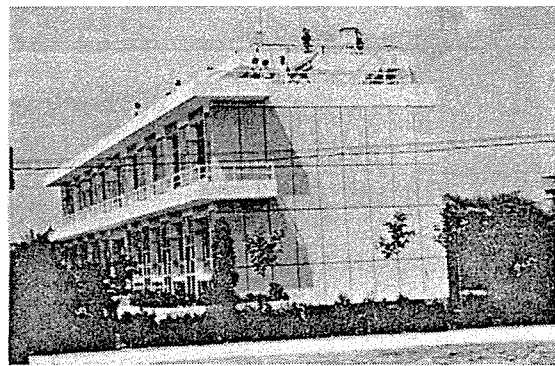


Fig. 11. Direct gain office and laboratory building, Daxing.



Fig. 12. Movable insulation system for skylights, Daxing.

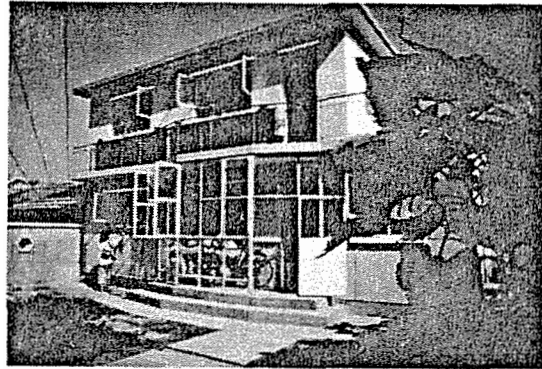


Fig. 13. A passive solar house in the experimental village NE of Beijing features sunspaces and Trombe walls.