Passive Solar Retrofitting of the University of Ioannina New School of Philosophy Building, Greece

GR2

1 Photos

Figure 1: *Left:* View of the building from the South-West
Above: View of the atrium space
Below: View of a model showing the solar roof from the South

2 Project summary

Building description

The school of Philosophy complex is located in the University of Ioannina's new campus, in the N.W. part of Greece. It has been in use since 1987, and it comprises of mostly classrooms, office spaces and services organised around medium-sized courtyards. The building was designed before the "energy crisis" and provision had initially been made for air-conditioning the majority of the spaces – something that was subsequently dropped, as too expensive to achieve due to operation and maintenance costs. The section of the building being affected by this project has a total covered surface area of 4,100m^2 of office and classroom spaces organised around a central courtyard of approximately 900m^2.

Project objectives

The aim of this project has been to show that a combination of passive solar energy collection and storage systems can cover most year-round heating and cooling problems of this University building, while presenting quite attractive prospects of low maintenance costs, durability and simplicity of operation. These advantages, combined with the high livability of covered courtyard spaces in the winter, should render this system appropriate to a Higher Education setting in this part of the country.

The solar system
The solar system is composed of:
a) a centrally located, covered atrium, formed by a solar roof specially designed to meet both heating and cooling needs of the building around it, and
b) a low temperature, long-term heat storage system, using earth as the storage medium and comprising an array of 27cm diameter PVC pipes placed at a depth of 1.5m under the atrium ground surface.
A short-term storage system was planned to be combined with a system of air collectors integrated to the solar roof, but this was subsequently dropped as too complicated and costly to construct and maintain. The covered atrium has a surface area of approximately 900m^2 and an average height of 13m, while the underground heat storage pipes have a length of 40m.

3 Site
Ioannina, latitude: 39°42' N, longitude: 20°48' E
Mean annual temperature: 14.7°C
Mean winter temperature: 9.4°C

4 Building description /typology

4.1 Typology / Age

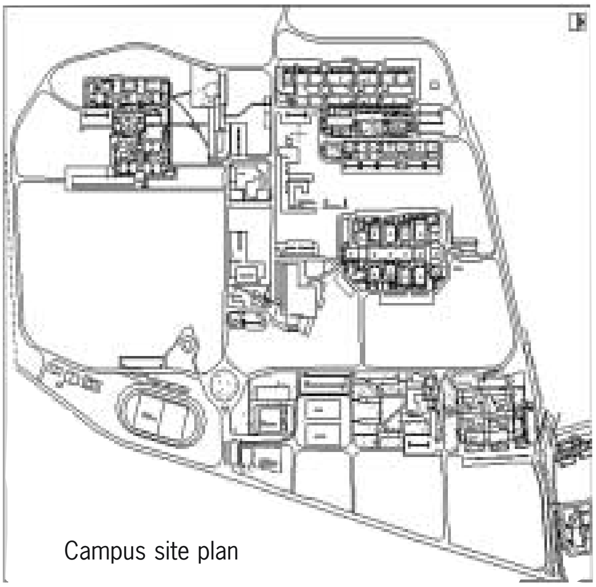
Typology/Age	Pre 1910	1910-30	1930-50	1950-70	1970-
Atrium building					●

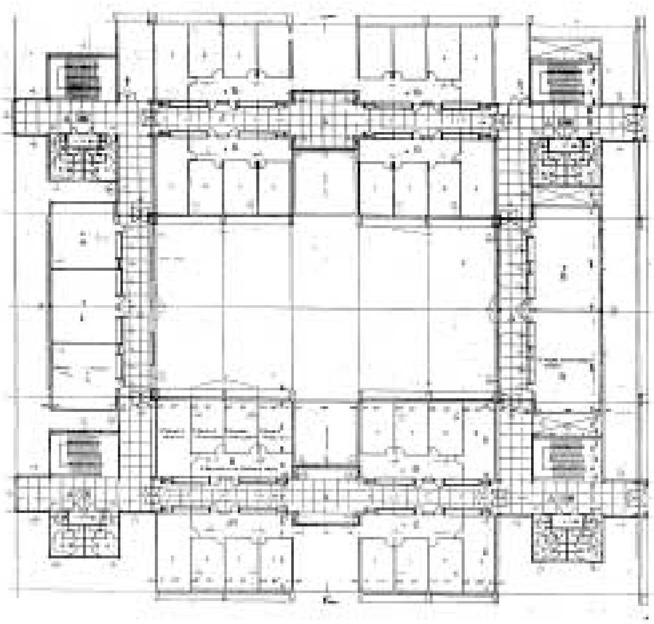
Megastructure university building, atrium type (1987).

4.2 General information
Year of construction: 1987
Year of renovation (as described here): 1993
Total floor area (m^2): 4,100m^2 (this section)
Number of students: 1600
Number of classrooms: 60
Typical classroom size (m^2): 120m^2

4.3 Architectural drawings

Figure 2: Campus site plan


Campus site plan



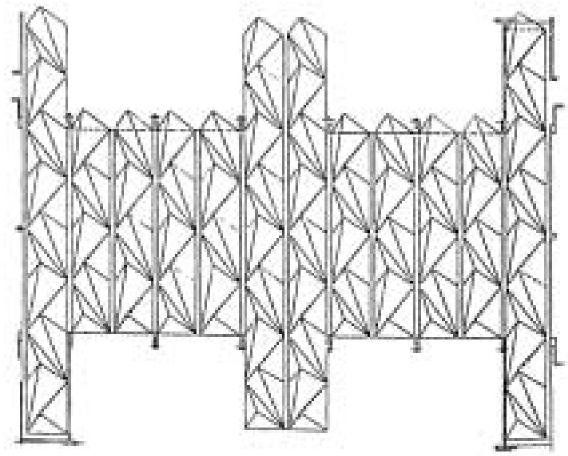


Figure 3: *Left:* Typical floor plan
above: Solar roof axonometry

5 Previous heating, ventilation, cooling and lighting systems

- *Heating system:* One boiler room; Fuel: Oil
- *Ventilation:* Natural ventilation
- *Cooling:* Local split type heat pumps (for offices and laboratories)
- *Lighting:* Fluorescent centrally or locally controlled (~17W/m^2)

6 Retrofit energy saving features

6.1 Energy saving concept

The retrofitted energy saving features comprise of:
a) a centrally located, covered atrium, formed by a solar roof specially designed to meet both heating and cooling needs of the building around it, and
b) a low temperature, long-term heat storage system, using earth as the storage medium and comprising an array of 27cm diameter PVC pipes placed at a depth of 1.5m under the atrium ground surface.
A short-term storage system was planned to be combined with a system of air collectors integrated to the solar roof but this was subsequently dropped as too complicated and costly to construct and maintain. The covered atrium has a surface of approximately 900m^2 and an average height of 13m, while the underground heat storage pipes have a length of 40m.

6.2 Building

- Use of shading devices
- Use of simple passive solar systems
- Use of daylighting components

6.3 Ventilation

- Natural ventilation
- Night ventilation
- Solar chimneys
- Ground cooling
- Thermal mass

6.5 Lighting
• Increased levels of daylight from the atrium space

6.6 Other environmental design elements
• Microclimate improvement

7 Resulting Energy Savings
Present energy consumption for heating: 104.6 kWh/m^2
Energy consumption for lighting: 17 W/m^2
Energy gains from the project are estimated at 33 kWh/m^2 for this section of the building or 31% of its yearly energy requirements.

8 User evaluation
Indoor air quality: O.K.
Quality of daylight / artificial light: Sufficient daylight for most offices and classrooms around the atrium
Sound quality: Some noise from earth pipe fans
General feeling: In general users were very happy with the existence of the covered atrium, which can be used both as a relaxation space and as a passage, joining two parts of the building, throughout the year. No major problems have been encountered.

9 Renovation costs
The cost of the retrofitting was approximately €190,000. The operating costs related to the overall system are estimated at €600 per year and the payback time is estimated at 18.5 years.

10 Experiences/Lessons learned

10.1 Impact on indoor climate
The impact of the atrium space on the indoor climate of the surrounding spaces has been quite positive, because of the improvement of thermal and lighting comfort and the creation of a sheltered space from rain and drafts between different parts of the building.

10.2 Practical experiences of interest for a broader audience
The thermal comfort as well as the lighting efficiency inside the space is excellent. Due to the use of the buried pipes, the atrium space is also comfortable during the summer. It is believed that the use of additional plants and a fountain inside the atrium will further improve thermal comfort during the summer.

10.3 Resulting design guidance
The overall conclusions drawn from this project are positive. The designed components have operated successfully with an overall satisfactory performance. The replication potential of the systems is excellent and a drastic reduction of cost is expected in cases of repeated application.

11 General data

11.1 Address of project
University of Ioannina Campus, Ioannina, Greece.

11.2 Date of report / revision no.
July 2002 / revision 4

12 Acknowledgements

Architects: The passive solar atrium was designed by Euphrosyne S. Triantis.
Building Physics: Mat Santamouris
Monitoring: A. Argyriou, M. Vallindras
Project co-ordination: Euphrosyne S. Triantis
Construction: Ergotechniki S.A.
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Author: Euphrosyne S. Triantis

13 References

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