ProEcoPolyNet
Technology Profile
Wall temperisation

Background

Buildings belonging to cultural and architectural heritage nowadays serve different purposes than in the past. They can be used as exhibition premises and depots, for various cultural events, and other periodic events. Microclimatic conditions in such buildings, resulting from above stated and similar patterns of use can sometimes be inappropriate or even harmful for the exhibited items, building fabric, and frescoes. They can also be found unsuitable for the needs of visitors and other users. Lack of available financial sources often restrains regular maintenance of such buildings, obstructs new investments, and makes it difficult to cover operational costs, usually for heating.

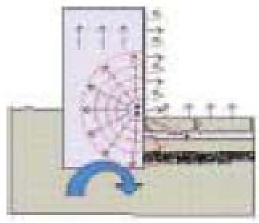
Boundary conditions

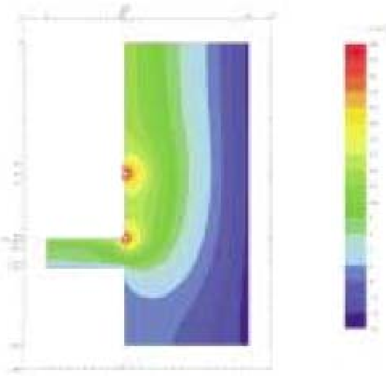
Most of the buildings representing cultural heritage are not equipped with technology for temperature or humidity conditioning according to modern standards. Churches, with its high space, big mass of the walls, and intermittent use represent a special case regarding the heating system characteristics. Visitors require heating of the churches during rituals. Minimum indoor temperatures should not be lower that 8 to 12°C. Sensitive objects of art inside churches require minimum temperature and humidity oscillations, low air velocity and low dust circulation. Relative humidity must not exceed 60-65%.

Heat is needed in the lowest two meters of the space. Hot air, which tends to move under the ceiling, causes higher energy losses, so the pattern of energy transport from the source to the visitors is very essential. Warm air with higher relative humidity often causes condensation on the cold walls and other colder objects, causing damage.

Description

The system for temperature control of walls, columns and other parts of the building structure was developed in Germany in the 1980s, where it was called "Temperierung". In English spoken circles it is referred to as wall temperisation, wall tempering, or wall warming. It was intended for protection of the walls against rising ground water, and at the same time for maintaining constant temperatures and humidity in the room as much as possible. The system should be simple for installation, cost effective and energy efficient. It is composed of one or two levels of soft copper pipes built in just bellow the inner wall surface, main pipes, connecting single heating loops, heat generator, safety appliances, and regulation.





The principle of connecting massive building fabric and heating installation into one unit is known from the Roman times as hypocaust heating. Temperisation is a modern equivalent to this principle. It represents an alternative system for heating of massive buildings with a direct low temperature heating of the walls instead of the indoor air. Heat distributed to the wall from the pipes raises the temperature of the wall, providing radiative heating of the objects in the room without air as a medium of heat transfer. In this way the circulation of the air and dust is reduced.

The wall temperature is in the same range as the air temperature, preventing water vapour condensation on the wall surfaces. The temperature of the walls is kept on a constant higher level during the whole year, reducing the capillary transport of the moisture in the wall and causing the walls to dry out.

Benefits and advantages

Wall temperisation offers several significant benefits: moderate heating of the building, good level of thermal comfort for occasional visitors, efficient use of energy, stable indoor microclimate, warmer wall and its surface, prevention of raising dampness, and prevention of surface condensation. On the other hand, since this is a non-destructive method, there is no decrease of earthquake resistance of the structure as opposed to provisions like wall cutting, and there is much less restoration work needed due to less particles' deposition on walls and exhibits.

Warmer walls emit heat into the indoor space by radiation. In this way an appropriate level of thermal comfort can be achieved at lower indoor air temperatures, which directly results in lower energy demand and lower running costs.

In-situ verification

In the framework of Eureka EU 1383 Prevent, various national research projects co-financed by the Ministry of Science and Technology of Slovenia, and other research work, Building and Civil Engineering Institute ZRMK and Faculty of Civil Engineering from Ljubljana performed design, installation and field tests of operating temperisation systems in several historic buildings in Slovenia.

Example: The Parish Church of St. Martin in Teharje, Slovenia

The Parish Church of St. Martin in Teharje, Slovenia, was constructed between 1906 and 1907, above a village on the spot of an older church from the 17th century. The heated volume of the church is 7700 m^3. The walls inside are painted with ornaments and fresco paintings. The heating capacity of the boiler is 60 kW. The boiler house with two boilers is located in the church and is designed for heating the church and the priest's house with classrooms. The boilers are fired by oil, and operating at 90/70 °C. The regulation unit reduces temperatures for the church heating to 50/43 °C. A standard heat meter is installed to measure the heat distributed to the church.

In three different levels 1254 m of coated copper pipes were installed. The most important level is at the ground level, built-in with the purpose of wall drying and also heating. The other two levels suit the heating purposes.

Measurements were done in the church to get information about the system and about the response of the building fabric and interior. The temperature was measured at over 20 locations, along with moisture measurements in the wall and humidity of indoor air. Already the first results of temperatures, humidity and moisture in the walls showed that the indoor temperatures were always above 10 °C, and that they oscillated very slowly in comparison to the variations of outdoor temperature.

The surface temperature of the wall was in the range of the indoor air temperature, and in the region where the pipes were built-in it increased up to 25 °C. The relative air humidity in the wall cavity at the height of approx. 50 cm was reduced from 88% to 76% after the first heating season, while at the ground level it remained at 100%. A progressive reduction of these parameters was expected during consecutive heating seasons.

Velocity of the air movement inside the church caused by the heating system is under 0,5 m/s, so there are practically no problems with dust deposit and unpleasant microclimatic conditions, like drought. The energy use is significantly lower compared to buildings of a similar type and size equipped with radiators or convective heating systems.

Obstacles

There are no special technical obstacles regarding the design and use of the wall temperisation system. There exist of course some limitations connected to available free wall surfaces in order not to destroy eventual valuable frescoes or wall ornamentation.

Cost/Benefit

It is not easy to predict in advance the actual costs of a wall temperisation system. The price is closely linked to the characteristics and type of a particular building, to its intended use, and to the amount of eventual other planned restoration works. However, practical analyses have shown that this is an energy efficient system, which solves many problems at once: wall dampness, surface condensation, microclimatic conditions for the indoor space and indoor apparel, and thermal comfort for visitors.

Market situation

There are no specific market restrictions. The system has so far been installed and tested in various countries, and has given the expected results. Probably the technology is at the moment still not known enough in the wider circles, and a tendency for application of standard (not necessarily better or more efficient) solutions is still strongly present.

Contact and further information

Name and contact details

Dr. Marjana Sijanec Zavrl
Building and Civil Engineering Institute ZRMK
marjana.sijanec@gi-zrmk.si
+386 1 2808 342

Date of release of this Best Practice Sheet

March 2007

:

ProEcoPolyNet is a **Net**work for the **Pro**motion of RTD results in the field of **Eco**-building technologies, small **Poly**generation and renewable heating and cooling technologies for buildings.
The Consortium consists of the following partners.

The ProEcoPolyNet project is supported by

SIXTH FRAMEWORK PROGRAMME