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Application of night cooling concept to social housing design in dry hot climate

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Abstract

A passive night cooling system was developed and implemented for a new project of social housing. The passive cooling system incorporates a solar chimney in combination with high thermal mass in the building construction. The natural ventilation is enhanced with the help of the solar chimney and night fresh air cools the building structure. The design of this concept was calculated by balancing energy using basic thermal equations for a summer reference day and evaluated using two simulation tools, TRNSYS and TAS. The building has been constructed and actually in process of monitoring.

Keywords: Night cooling; Solar chimney; Optimisation solar gains

1. Introduction

During the last years more and more households have installed decentralized cooling devices, to cut the summer peak and ensure a good comfort inside their flats. This development leads to new load peaks in the electrical network during the summer. On the other hand, it seems to be a status symbol as well in social housing projects, to have such a cooling device or not. In the year 2003 more than 3 millions of homes have an electric cooling system.

This building is the result of the wish of the EMV (Empresa Municipal de la Vivienda, Madrid Municipal Public Housing Company) to progress toward higher energy efficiency in their social housing promotions. This 49-dwelling Public Protection building, with shop premises, storerooms and garages, is located on Plot 15 of ''OESTE DE SAN FERMÍN'' in Madrid.

This project is part of the Integrated High Efficiency and Environmental Modification Plan for plots 5, 12 and 15 of the ''Oeste de S. Fermín'' API included in the group project ''ALTENER HOUSES'' within the framework of the European Union ALTENER II programme.

The concept for the ''parcela No15'' aims to ensure a certain comfort for the flats during the summer months by applying a passive solar cooling concept. The climate in Madrid with relative cold nights makes it feasible to use this natural cooling source for increasing the building comfort. By introducing an accessible high thermal mass in the building construction and activating it during the night with increased ventilation, the concept tries to limit the indoor temperature below an operative temperature of 28 °C. Instead of using fan forced ventilation for the night ventilation, the developed design aims to implement solar driven night ventilation by solar storage chimneys.

These chimneys, oriented to the west, collect solar gains during the afternoon in their concrete walls, reaching temperatures up to 50 °C. While they are collecting, the chimneys are closed. During the night when the ambient temperatures are down to around 20 °C, the flaps at the top of the chimneys are opened and the chimney effect of the collected heat sucks the exhaust air out of the apartments. The fresh cold night air enters through the east facade and runs through the flat, cooling down the thermal masses of the walls and ceilings. To comply with fire regulations, every flat has its own chimney, without a connection to the other flats.

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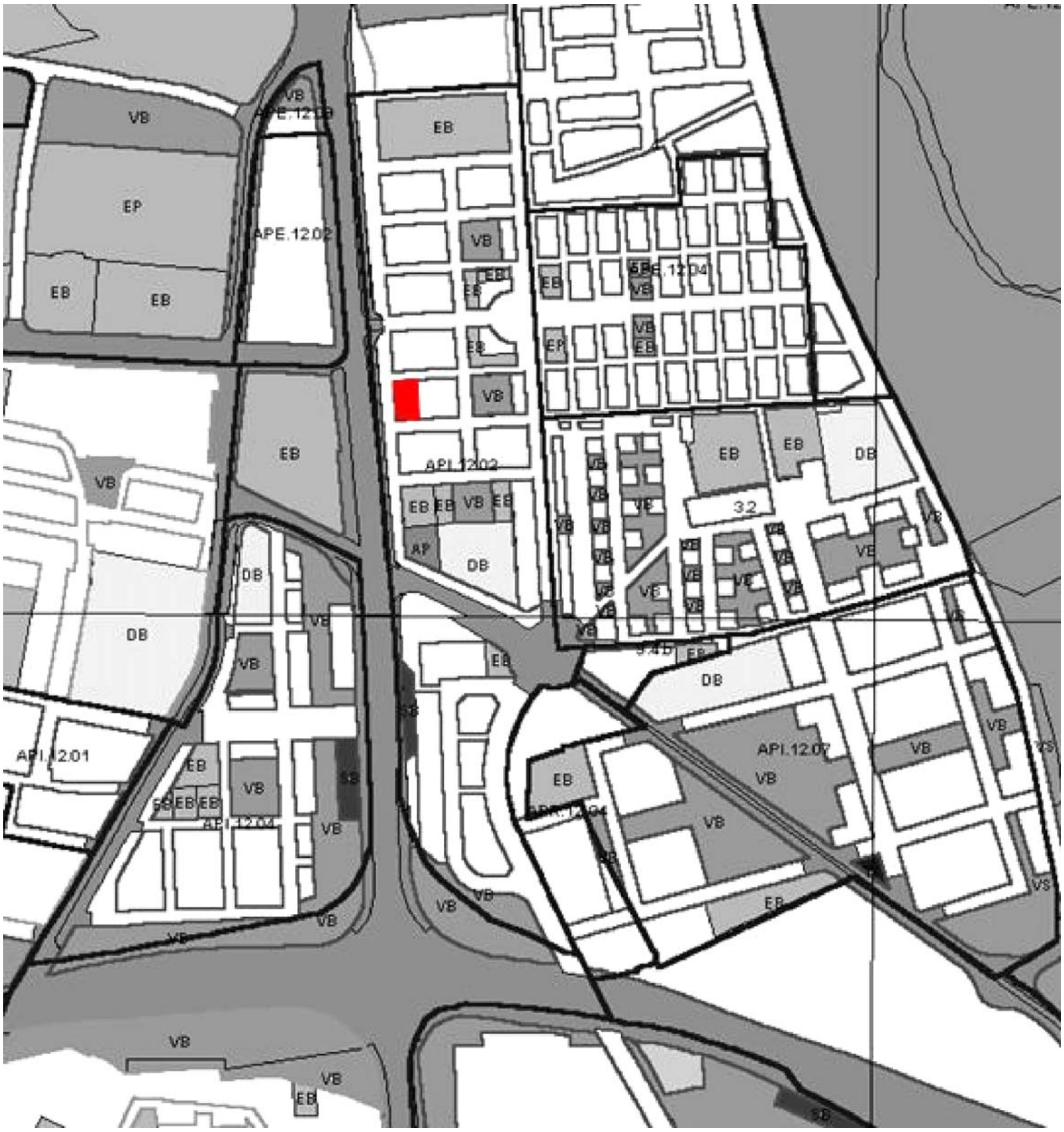

Fig. 1. Plot of land.

For the proper use of the system, an operation and maintenance manual detailing the operating methods instructions and standard control settings for passive cooling service equipment has been developed.

2. Urban and site context

A good focus on energy efficiency and environmental concepts should be presented from the beginning in the definition of our habitat. It should be part of the objectives of urban planning to define the basic characteristics of buildings. In this case, this has not been done.

Usually, the location characteristics of this type of social promotions present some difficulties in terms of orientation. This is our case. The shape, dimensions and orientation of the plot seem to predetermine a rectangular-type of block with a double corridor and interior patio whose longitudinal axis has a north–south

Fig. 2. Picture of the site.