

Passive and green building design: a residential complex for the elderly in Andria (Italy)

G.R. Dell'Osso and F. Iannone

Dipartimento di Architettura e Urbanistica, Politecnico di Bari, Italy

ABSTRACT

The architectural and technological design of buildings needs a performance-based approach that takes into account the wider needs of the sustainability-oriented approach.

Generally, building codes concerning the rational use of energy, set limits for the energy needs in winter that are evaluated by using simplified conventional conditions.

In the Mediterranean area the energy needs in summer are significant and therefore energy saving strategies require the evaluations of building energy loads to be extended to cover the whole year. A wider perspective of the energy problems suggests the evaluation of energy needs over the whole building's life cycle, involving production of building components (embodied energy), transport, construction processes, and the energy consumption concerning the life of the buildings life including maintenance, demolition or renovation.

As a case study, in this paper we present the project of a residential complex for the elderly, located in Andria (a small town in Southern Italy), in which some of the above mentioned criteria have been applied. In detail, in adopting a bioclimatic conception of the whole project, the design team has applied building envelope technical solutions not only directly to the optimisation of energy consumption in winter, but that are inspired by the issue of sustainability.

1. INTRODUCTION

The design process of a building generally includes verification of its energy consumption in winter that is evaluated by using simplified con-

ventional conditions.

More suitable sustainability-oriented criteria have to foresee greater attention to the behaviour of the building in summer, above all for the Mediterranean climate, and take into account the energy needs and environmental compatibility extended to all the phases of a building's life cycle: production of building components, transport, construction processes, and the energy consumption concerning the life of the building including maintenance, demolition or renovation.

2. THE CASE STUDY: GENERAL DESCRIPTION

The case study concerns a residential complex (Fig. 1) for self-sufficient elderly people that are going to be built by the Andria Municipality. The project has been elaborated with the scientific and technical consultancy of the Department of Architecture and Urban Planning of the Polytechnic of Bari.

Some of the above mentioned criteria have been applied, in order to balance the following aspects:

- building performance needs of elderly people;
- morphological and typological characteristics of local architecture;
- bioclimatic criteria related to the winter and the summer periods;
- technological innovation;
- sustainability oriented choice of materials and building components.

The complex consists of dwellings (for people who still can take care of themselves) as



Figure 1: View of the residential complex.

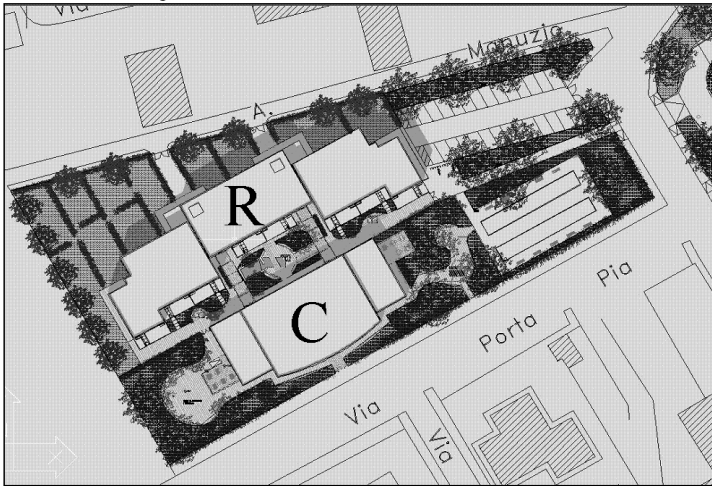


Figure 2: Plan of the complex (R = residential block, C = social centre).

well as common social and recreational space. The main goals of the whole complex are:

- adequate housing quality standard for elderly couples or single residents;
- stimulating community experience, where socialising processes involve the residential community and a wider community (at a district or at a city level).

One phase of the design process concerned an investigation into the demands of the local community. The results of this investigation show that the users prefer more personal privacy as well as the opportunity to share common so-

cial and recreational space with other people.

Therefore, the residential complex will consist composed primarily of two-storey stacked rowhouses that are directly related to the ground level. This typology is familiar to many of the future residents and guarantees the accessibility of the apartments and of their surroundings. Elevators for disabled people and a porch on the north side guarantee the accessibility of the apartments located on the second level.

The complex is composed of two buildings, integrated spatially and functionally though separate: a residential block and a common social centre (Fig. 2).

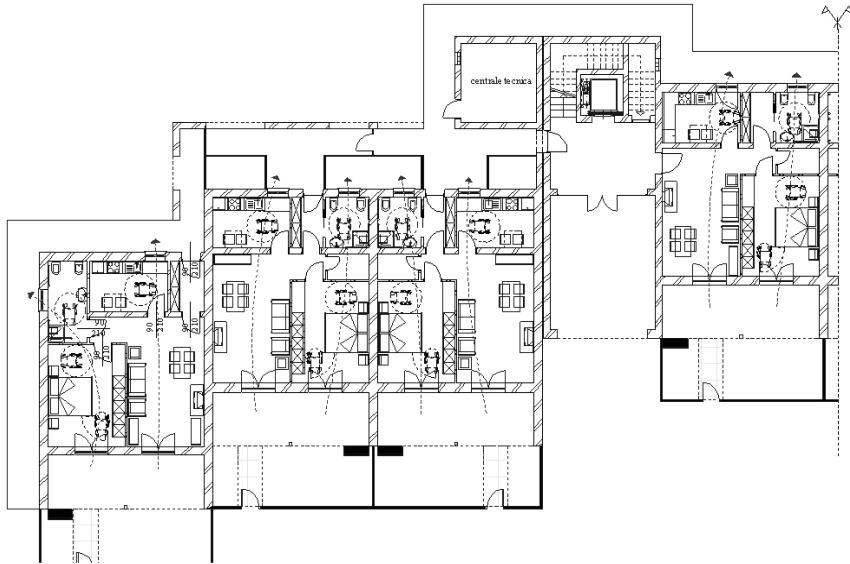


Figure 3: Residential block: ground floor.

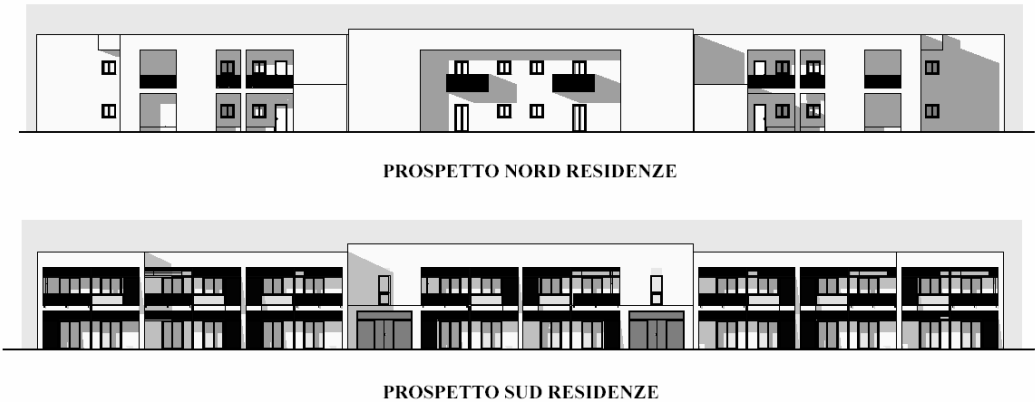


Figure 4: Residential block: views from north and south.

The area between these blocks will form a small internal plaza, a community space, an intermediary place shared between individual and public use. The model of the internal plaza is typical of external spaces of the neighbourhood units of the Apulian historical centres.

The residential units that make up the complex (16 apartments for couples and 2 units for singles) have also been dimensioned and organized in relation to the functional necessity expressed by the users (Fig. 3).

Such demands, together with the criteria of bioclimatic architecture and sustainability, have driven the main design rules:

- maximum indoor comfort in residential units, taking into account the building orientation, cross ventilation, daylighting, thermal comfort, soundproofing;
- sizing of the spaces in relationship to the use of disabled people and the ability to contain non-standard furniture (old pieces of furniture already in the possession of the residents);
- use of materials with low environmental impact;
- residential units facing opposite orientations (Fig. 4): thermal protection on the north side in winter and shading from direct sunlight on

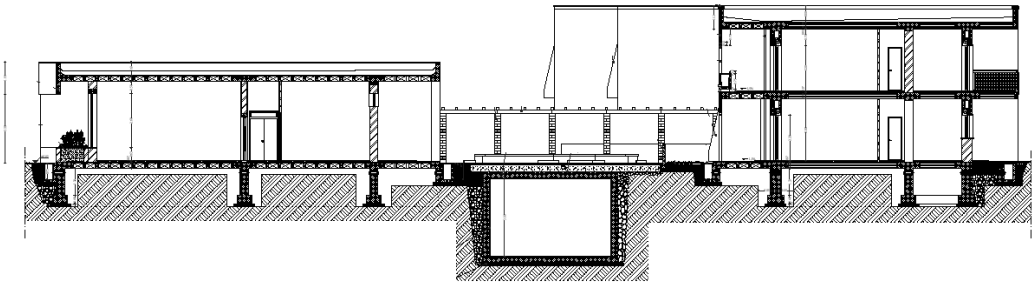


Figure 5: Main section of the residential complex.

- the south side in summer;
- technological solutions that allow the monitoring of comfort levels, building and facilities management, energy consumption.

3. THE CASE STUDY: EXPERIMENTAL ASPECTS

The meaningful part of the experimentation related to the use of renewable energy sources is the design solution itself that is inspired by the following bioclimatic rules:

- main rooms (living room and bedroom) are on the south side and glazed surfaces are increased to maximize solar direct gain;
- on the north side are located the less energy-demanding rooms (kitchens and bathrooms) that, so positioned, act as buffer spaces.

The following technical solutions have been adopted to reduce energy needs in winter and summer, avoiding mechanical cooling, and to increase the level of thermal comfort (see Fig. 6):

1. external walls characterized by high thermal inertia (Apulian calcarenite, thickness 50 cm);
2. loggias to the south side with the function of screening solar radiation in summer;
3. sunscreens on the façades to the south providing solar gain only in winter;
4. ventilated flat roof with raised floor;
5. a system of windscreens along the porch on the north that protects against prevailing cold wind and confers a certain privacy.

Glazed solar collectors for domestic hot water are integrated on the south façade (see n.6, Fig. 6), without any shading from buildings and vegetation; each apartment has its own solar

system, the collectors are tilted at about 20° and each measure 2 m². The architectural integration of the solar collector has been carefully evaluated.

4. THE CASE STUDY: BUILDING TECHNOLOGY AND MATERIALS

The technological solutions adopted are generally based on the use of locally available materials.

A masonry-based structure has been designed taking into account the local seismic regulations: the foundations are made of reinforced concrete, shallow (2,00 m above ground) and continuing under the walls; the walls are (generally) 50 cm thick made in Apulian calcarenite and the horizontal structures are parallel ribbed slabs with hollow blocks, 30 cm thick. The structure is simple and regular.

Sustainability criteria and energy evaluations extended to the whole cycle life of the building system, suggested the choice of a masonry-based structure characterized by the use of Apulian calcarenite (*tufo pugliese*) in the place of typical reinforced concrete frames with hollow brick partitions.

The *tufo pugliese* is a local material, it is easily available and characterized by very low embodied energy because it requires only the activity of extraction from quarries. The Apulian calcarenite has a good coefficient of thermal conduction and walls have a high heat capacity (when the thickness is adequate but not excessive).

The tufa-bricks can be easily recycled at the end of the buildings' life: they can be used again integrally in other constructions or can be used for the production of loose material.

The production of clay bricks and construc-

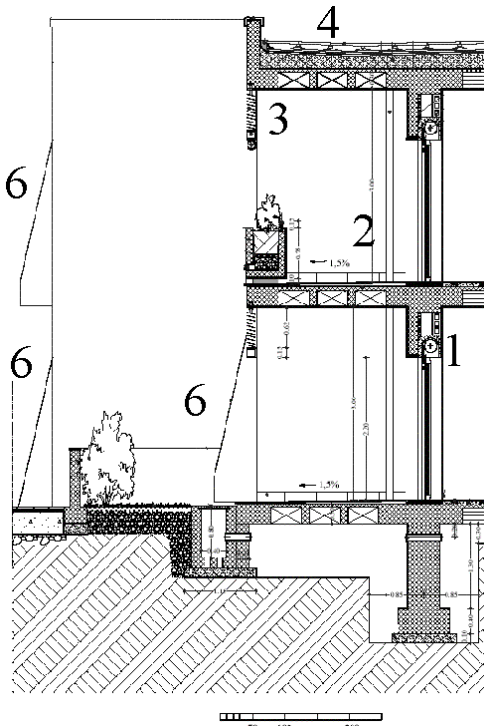


Figure 6: Main section of the residential block (detail).

tion is labour intensive and thermal hollow bricks have a higher embodied energy than tufa-brick: clay excavation, pre-processing of raw material to enhance the thermal properties, shaping, drying, firing, transport from the place of production (generally far from the construction site). Thermal hollow bricks typically used for external walls in reinforced concrete frames (thickness around 30 cm) determine less energy consumption in winter than tufa-bricks, but their thermal inertia is insufficient to guarantee good thermal performance, above all in summer. At the end of the buildings' life, the recycling or reintegration into the environment of hollow bricks is not as easy as that of tufa-bricks.

5. THE CASE STUDY: HEATING SYSTEMS

The heating systems have the following common characteristics:

- hydronic (hot water) heating systems;
- gas fired high efficiency water heaters;
- cast-iron radiators.



Figure 7: South view of the residential block (detail).

Differentiated solutions have been adopted:

- a central heating system for the common social centre;
- two central heating systems, each one heating six apartments for couples and one unit for singles;
- four individual heating systems for the remaining four apartments.

This solution will allow verification and comparisons between the different solutions with respect to:

- comfort conditions;
- energy consumption;
- management aspects.

6. THE CASE STUDY: RAINWATER RECYCLING SYSTEM

A careful study has been carried out in order to recycle rainwater: the water collected from rain falling on the roof is conveyed to a cistern of about 430 m³ (see Fig. 5); such water, after an efficient sedimentation, will be used to water the green area of the complex and for other compatible uses.

This rainwater recycling system will allow for significant savings in potable water.

7. THE CASE STUDY: VEGETATION

On the north border, tall evergreen trees will be

planted, as the evergreen bushes will be rather tall and thick: the buildings will be protected from the prevailing north winds and atmospheric agents in winter.

Furthermore, the vegetation has a fundamental role reducing the risk of the building overheating in summer. Deciduous trees will be planted on the south side to absorb or deflect the low sunrays from southeast and southwest in summer, while letting them filter through during the winter.