Optimized Social Housing in France

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ABSTRACT: For the seventies, the energy questions concerning social housing have been a basic research axis for an increasing number of architects and engineers and the last national programmes have fixed targets to zero energy housing models and realisations.
The design concept, the compactly of flats, the solar orientation of buildings, the choice of building materials and ventilation system, the solar sanitary hot water production are the main ways of this proposal on the road of this difficult target; indeed in the case of social housing programme, the main difficulty is the low budget coupled with the low energy target.

Keywords: energy, orientation, building materials, ventilation, solar sanitary hot water,

1. INTRODUCTION

For the seventies, the social housing question have been the purpose of periodical research programmes on the field of energy to the attention of architects and engineers in France, from the « Plan Construction » in the Ministry of Equipment.

Step by step, this field of research which have started with strictly energy programmes have been enlarged to larger environmental ones including other parameters like pollution questions, water consumption and quality, health and sanitary care, thermal-hygrometry, acoustics and visual comfort, building materials and techniques, so as to reach an housing as human sized and economic as possible.

2. CELL DESIGN

The present project have been initiated for about fourteen year and step by step improved and included inside different housing research programmes.

The last one is a regional programme in Burgundy with the Plan Construction supervision including innovative construction systems.

Firstly the project has been designed both in energy and acoustic perspectives for community buildings, with possible flexibility in the future.

As medium sized and the most frequent, the T3 housing cell, including three main rooms, have been chosen as the basic module to be combined two by two and produce by extension or reduction of rooms all the other flat sizes.

Indeed, in the minimum housing surface from the French social housing rules, the extreme surfaces by respect to the T3 one are complementary:

2 T3 (60 + 60 m2) = 120 m2
T2 (46 m2) + T4 (73 m2) = 119 m2
T1b (30 m2) + T5 (88 m2) = 118 m2

So it is possible to organise 120 m2 floors with the possibility to obtain all the flats sizes (fig. 1).

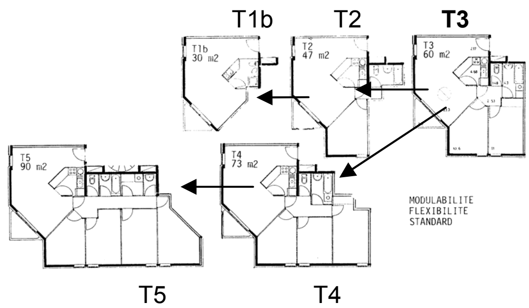

Figure 1: Flexibility of cells from the T3 size

The basic 120 m2 floor is organised so as to gather two T3 flats (fig 2 & 5) :

- the height of the buildings is limited to three floors so as to avoid the use of elevators, limit energy consumption and respect human scale in the urban landscape; in this project the buildings count three floor and the staircases are situated on the north-facing back side;
- the fluids vertical ducts (all waters, heating, gas, ventilation, electricity, etc...) are gathered in the staircase and easily accessible for maintenance;
- the technical room situated on the roof, up to the staircase, gathers devices and machines for solar hot water, active hot water, heating and mechanical control air ventilation (fig. 8);
- the humid and technical housing functions (bathrooms, toilets, kitchens) lean one's back

against the ducts thick wall for a minimum distribution length and a good acoustic inside the flats

- an entrance buffer space is interposed between each living-room and the staircase so as to limit heat losses and to achieve acoustic conditions ;
- kitchens extend from the technical plant through the living room till to the façade, using the dining area both for the two rooms;
- the main rooms extend to all the solar-lighting direction from east to south or from south to west ;
- the inhabitable surfaces are optimised so as to reduce the energy consumption, limit the distribution areas and enlarge the living areas: the living-rooms including open entrance, lounge, dining, and open kitchen, measure 30.7 m2 ! A classical one gives 20; the night area corridor is limited to 2.46 m2;

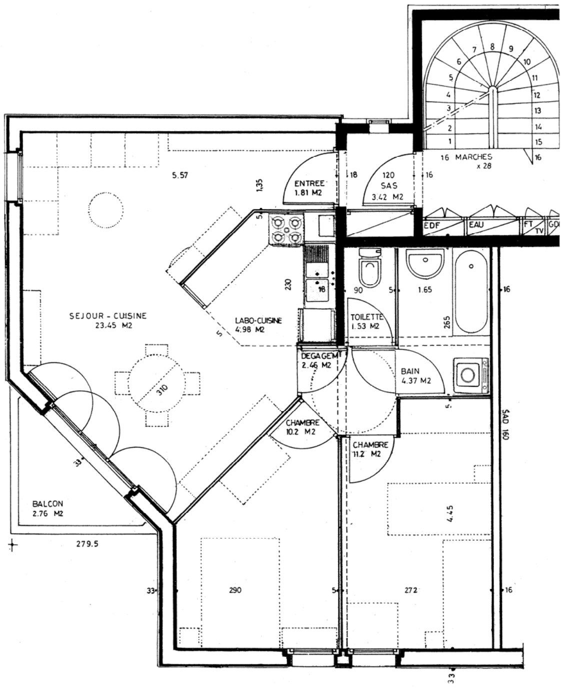

Figure 2: Basic cell T3

3. BUILDING SITE AND BUILDING DESIGN

The site proposed for this project by the Social housing public society OPH 21 is situated in Talant, a suburb in the periphery of Dijon: up to a calcareous plateau, between a forestry slope in the north-west and existing individual neighbourhoods in south-east.

The views are large and free towards the close Ouche river valley; the south orientation is open following the natural topography slope.

The programme assigned by the Talant Urban renewing plan fixed the capacity of the plot to 15 flats distributed in three 3 floors buildings (fig. 3 & 4).

The project was designed on the basis of the twin flats T3 per 120 m2 floor mixed with T2 and T4 flats on three floors with single staircase access;

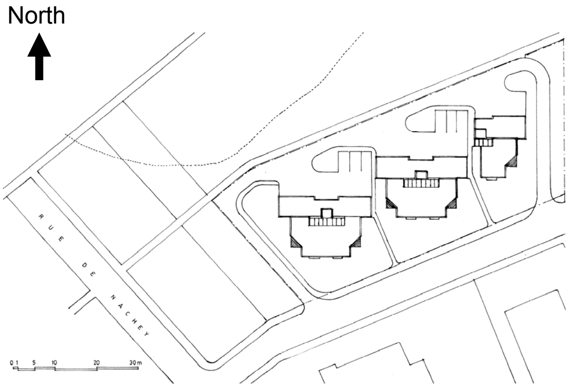

Figure 3: Plot plan

- buildings position facing full south, maximising the global sun radiation;
- the living-rooms French windows and bedrooms windows collect solar energy in direct gain during winter ;
- the living-rooms balconies & mats and the bedrooms sun-breakers shade the glazing surfaces during summer;
- quarrel distribution of building maximising east for early sun radiation and minimising west minimising overheating in summer ;
- car garages on the north side of buildings acting as buffer spaces on the ground-floor;
- roof terraces for rain-water collection;
- solar panels for solar hot water;
- two buildings gathering two flats by floor, total six flats each one ; one building with single flat by floor, total three flats;

Figure 4 : Isometric view

4. ORIENTATIONS

The flats orientations can be different depending on their position at left or at right from the staircase (fig. 4):

- the left flats face to east, south east (living rooms) and south (bedrooms);
- the right flats face to west, south-west (living-rooms) and south (bed-rooms);

This choice can be discussed with preference for living to south, but it is also commanded by the combination of flats connected by the bedrooms side.

5. BUILDING MATERIALS

The buildings structure is restricted to two main materials: reinforced concrete inside, hollow brick outside except the roof and the staircase, PVC double glazing with argon inside.

5.1. Concrete framework

Thus structure has a double function: bear inside the building and distribute fluids and inhabitants.

The elements prefabrication in workshop (blind walls, pre-stressed beams, pre-slabs, balconies and stairs) allows a cleaner and quicker yard and energy saving from time saving (fig. 5).

In addition to the resistance and strength of reinforced concrete, the strong inertia of this material makes it play an important part in the energy conservation during winter and in the summer comfort.

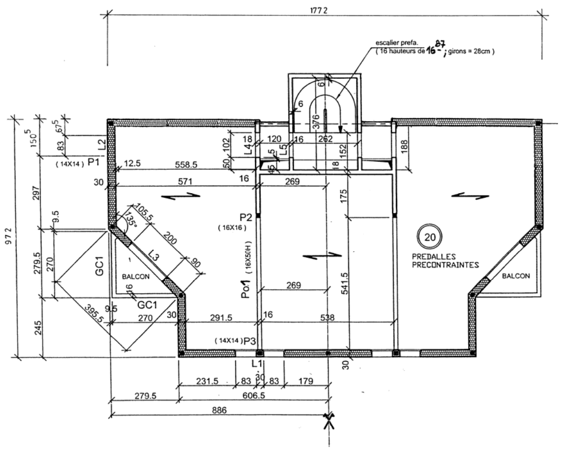

Figure 5: Structure plan

5.2. Hollow brickwork envelope

The blind vertical envelope of the buildings is made of hollow brickwork 30 cm thick from Wienerberger (fig. 7); amongst the standard and lightness advantages of this material, several environmental qualities interest specially this project:

- the performing global thermal transmission coefficient: U = 0.42 W/m2.K;
- this avoids to use inside insulation (polystyrene or others) and promote economies in this field ;
- this allows to benefit from the inertia of the material inside the building for energy conservation during winter and summer comfort;
- the thermal bridges on slab extremities are limited to 19% of the heat losses through the façade surfaces, thanks to a complex insulation + hollow brick, compared with 54% in the case of concrete wall insulated on the face inside the building (fig. 6);
- the brick works as hygrometry regulator, maintaining a balanced humidity rate.

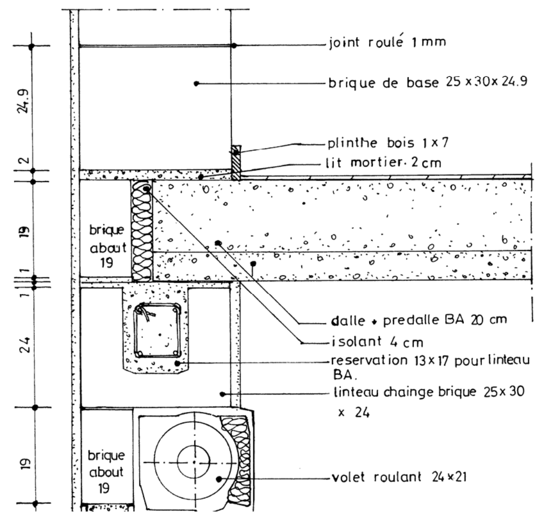

Figure 6: Slab extremity with thermal bridge treatment

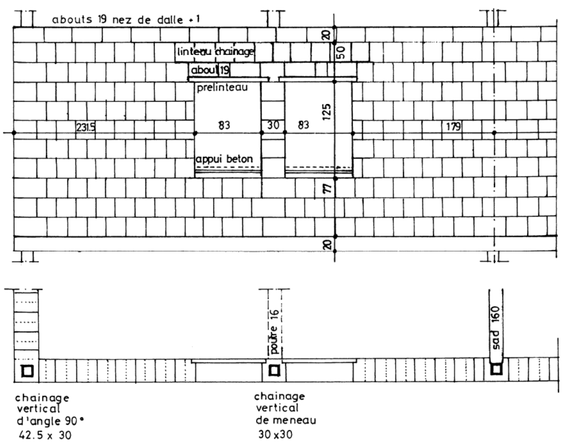

Figure 7 : Horizontal and vertical façade walls calepinage

5.3. Double glazing with argon

All the windows, including French windows, are equipped with PVC frames double glazed with argon inside; the different global thermal transmission coefficient sets up as follow:

- Ujh = 1.7 W/m2k
- Uw = 1.9 Wm2k
- Ug = 1.5 W/m2k
- Uf = 1.8 W/m2k

5.4. Building energy performances

The energy performances from the building itself, (hollow brick U = 0.42 W/m2k and thermal bridges treatment) are 7 % upper to the regulation value (Ubât = 0.95 W/m2.K) for a Ubât / ref = 1.02 W/m2.K.

6. TECHNICAL EQUIPMENTS

6.1. Collective heating

The collective (6 or 3 flats) mural condensation gas boiler is situated inside the upper part above the staircase and equipped with vertical fluid ducts (fig. 8) ; working at very low temperature and equipped with a regulation by respect to outside and radiators low warmth with thermostatic taps, the energy performance will get an improvement close to 9 %.

6.2. Double flow ventilation

The auto adjustable system with individual exchanger for heat recovery, will have two main advantages for the users:

- it will allow an energy saving for heating of about 5 % ;
- the suppression of outside air inlets in the windows frames will improve the comfort level inside the flats and avoid the risk of obstruction by the inhabitants, with the consequences on moistures and heavy disorders in the buildings

6.3. Atmospheric throwing out

For heating need and sanitary hot water production, the CO_2 throwing out are 20% lower than those from a classical construction and equipment complying the present regulation in France.

For a 6 flats type T3, they will be near 9 000 kg/year in place of 12 000 kg/year, so 3 000 kg/year savings;

The boiler, situated in the upper part of the building with a vertical exhauster, allows to limit the polluting dilution inside the atmosphere out of the human occupation areas.

6.4. Solar hot water production

The solar water collectors situated on the roof of the building, with a 2.5 m2 per flat ratio will supply two water tanks for a total of 3 m3 (fig. 8).

The solar pre-heating for sanitary hot water will allow an energy performance improvement of about 10 %.

6.5. Rain water collection

During a year the roof collector of the 6 flats standard building receives 91 m3 of rains water which is collected inside the 5 m3 cistern situated under the waste room of the building (fig. 8).

So the cistern capacity can be consumed each 3 weeks.

This water is used to wash the common floors and the waste room and containers, also to water the gardens.

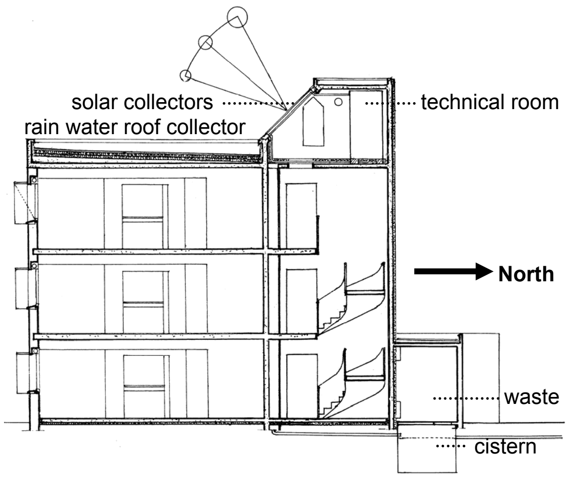

Figure 8: Standard cross section

6.6. Sanitary water savings

Double remote control allows to limit the water consumption in the toilets.

The showers and the sinks are equipped with laser commands.

7. PERFORMANCES OF THE SYSTEMS

Energy savings from building construction and technical equipments:

- from the building itself: - 7%
- from the heating system: - 9%
- from the ventilation: - 5%

Total: - 21%

Energy savings from solar gains

- from the solar pre-heating of sanitary hot water : - 10%
- from the solar direct gain : - 6%

Total: - 16%

Energy savings from internal gains

– persons, electric machines and lighting: 30 %,

Grand total: - 67%

The energy performances from the construction characteristic of the building and the proposed technical equipment are situated beyond to the French thermal regulation requirements RT 2000, actually operative, and the future RT 2005 operative at the end of this year 2006, since the global performance will situate around C ≤ C ref – 26%.

8. POSSIBLE IMPROVEMENTS

Some improvements would be possible to achieve the energy performance of the buildings:

- improve insulating wall performance by use of 375 mm (U = 0.39 W/m2K) hollow brick in place of 300 mm one;

- increase the insulating performance of the façade walls would be possible with inside insulation, but also to the prejudice of the building inertia and the summer comfort;
- increase the number of solar collectors per flat so as to increase the performance of the device.

9. CONCLUSION

In the scope of zero energy buildings, complementary renewable energy devices would be suitable, following the site resources, as:

- Aeolian wind energy with individual building wind turbines to produce electric energy;
- PV cells to for electric energy;
- Geothermal resources ;

The aim to reduce energy demand could be reached with community housing easier than with single housing, even clustered, mainly thanks to:

- the horizontal and the vertical joint use of the flats reducing the heat losses;
- the common use of technical equipments as heating, ventilation and heat water systems.