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Improving the Quality of Existing Urban Building Envelopes

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Improving the Quality of Existing Urban Building Envelopes

NEEDS

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General Overview of the Problems, Needs and Solutions in the Italian Urban Building Envelopes

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ABSTRACT: This paper describes the contents of the respective tables on the problems, needs and solutions of the housing developments built after the Second World War in Italy, with examples of the solutions in accordance with present-day standards.

1 INTRODUCTION

The building sector in Italy has changed in the last few years. New forms of housing emergency have emerged calling for new solutions, but the “refurbishment industry” still suffers from a lack of information and research.

In spite of refurbishment and maintenance programs covering more than 50% of the building market and the market having grown enough for building contractors operating in this field to organize themselves into a distinct sector of the construction industry, nevertheless maintenance records are so poorly kept that accurate information on the durability of buildings and building components and their functioning is far from being readily available.

2 PROBLEMS, NEEDS AND SOLUTIONS IN URBAN BUILDING ENVELOPES

2.1 Planning Aspects

The monotonous stretches of residential neighbourhoods built in Italy after the Second World War and their closed, semi-open and linear compositions of volumes, which are often ambiguous, and represent the age of the high housing demand, were generally considered a mass-production solution, often built with no attention or respect for pre-existing environments or urban locations.

Measured by population density, high-rise building had only a narrow competitive advantage over medium-rise housing, which is more typical. So the lack of contextual planning indexes and the neglect of local environmental aspects may be considered among the main reasons for the oversizing of plots with regard to the planned services that were never provided.

Although the location and insularity of estates remain major issues, concerns must be viewed in a context of policy standards. The noticeable suburban connotation of peripheral building areas and inner-city sites without an appropriate contextual building/road/building ratio has to be revitalised through combined housing regeneration projects in order to ensure an enhanced quality of life for residents.

Urban quality can’t be measured only by quantitative standards because they are not sufficient. Therefore qualitative aspects have to be analysed alongside existing strengths, opportunities and weaknesses.
2.2 Land use Aspects

Many peripheral residential estates, in particular the social residential buildings constructed in the seventies and eighties, often the work of major national architects, were on many occasions the solution of the town councils, following national policies and working with the private sector, to the spread of informal and illegal house building.

At the same time speculative private-sector developments sprung up filling the gap between the city centres and the peripheries, on land that was already equipped with primary infrastructures.

In this situation, one of the causes of the failure of those projects is closely linked to the absence of common residential facilities on the one hand and the lack of safety for the users on the other.

Moreover the extended dimensions of the buildings, often as large as a traditional district, creates the image of a stock that is very inhomogeneous and poorly arranged which contrasts dramatically with the surrounding green-field sites and low-density neighbourhoods. These quarters, nowadays, are inhabited by a disadvantaged population, largely descended from rural migrant workers, often effectively segregated in ghettos, with no social integration or interaction with the surrounding urban land uses.

2.3 Environmental Aspects

Looking at Italian post-war building stock, we can say that very few buildings were properly planned from an environmental point of view, mainly because there wasn’t any relevant legislation. The environmental impact is, in particular, related to low thermal efficiency that means maximum consumption, maximum emission of pollutants into the atmosphere, and uncomfortable thermal conditions for residents.

In many buildings the conditions for proper natural lighting are not guaranteed and acceptable air circulation is absent above all in stock built before 1970. Lighting requirements are now imposed by municipal regulations, which define an air/lighting ratio of 1/8 of the room surface. The critical situation can be improved using energy-saving windows that can help in the overall energy performances.

Most of the post-war housing stock has poor internal climate, and the people living in them are reported to be suffering health problems as a result. The main reason for this is a lack of ventilation, which is also one of the causes of damp problems, degradation of materials and of overheating in summer; the most problematic rooms are the kitchen and bathroom where most moisture is produced.

Many problems are also related to the thickness of the building envelope, with insufficient thermal insulation and thermal inertia and, consequently, of substantial energy waste and thermal discomfort. Furthermore, overheating in summer represents one of the most important problems. The lack of thermal insulation and the absence of solar shading devices lead to a high use of artificial cooling systems.

Thank to incentives, strategies to promote the use of active and passive measures and to improve environmental performances have been over the last ten years have become widespread.

The general energy performance of the majority of post-war buildings is negative. This is a result of poor building envelope insulation and inappropriate windows as mentioned above. In the last years “solar cooling” has become much more prominent as an important requirement for buildings. From the beginning of the new century in many town councils, building regulations lay down a new special set of requirements concerning general energy performances, such as the use of solar measures. Satisfying these requirements assures financial assistance for refurbishment programmes. Furthermore, the Environmental Ministry has promulgated financed programmes to provide incentives for the use of active and passive solar measures, for example the “25,000 photovoltaic roofs” programme and the “Neighbourhood Contracts”- Ministerial Decree 22/10/1997, which focus on four general issues: Morphological Quality, Eco-systemic Quality, Use Quality, and Quality System to promote the use of sustainable energies. (Fig. 1)
2.4 Architectural Aspects

From an architectural point of view, there are many important issues to be considered in the refurbishment approach.

First of all is the lack of accessibility for the user, particularly concerning the compliance with established standards by the Law 236/89 regarding the overcoming of architectural barriers (e.g. the addition or the substitution of elevators).

The lack of the architectural identity is usually the result of the massive and hasty development of the post-Second World War areas. The negative image of the spaces emphasizes the alienating character created by the repetitiveness and anonymity of the buildings as a result of the extended use of the mass-production building processes.

Moreover, with regard to the structural aspects of the building process, the houses are generally not adaptable to modern comfort or flexibility requirements because of the rigid and inflexible technological solutions adopted.
Another aspect that negatively influences the aesthetic quality of the buildings is the decay of the construction materials and of the buildings as a whole, as a result of construction errors or lack of maintenance (e.g. concrete elements, balconies). (Fig. 2)

2.5 Structural aspects

Quarters built during the post-Second World War period are the representation of the rationalist thought of that period, based on industrial production and the use of machines. Therefore, in most cases, technologies were imported from other countries and normally materials weren’t sourced locally: the result of this was the use of insufficiently tested residential building technologies.

The growth of seismic effects in relation to the physical configuration of buildings and the current evaluation of seismic risk in Italy (Ordinance 12/6/98, number 2788), expressed in terms of hazard, vulnerability and strength/exposure, lead to the use of specific control devices such as improvement and reinforcement of structures to deal with earthquakes. (Fig. 3)

But the main reasons for settlement cracks or structural damage stem from serious building structural pathologies (cracks and disintegration in the concrete, or corrosion of the tension rods), which need timely remedial action and reinforcement, and they are the result of lack of maintenance or checks during their life and this has contributed to their rapid decay. Over the next ten years, almost all blocks are likely to require major repair work.

Moreover, changes in the surrounding environment (subsidence) as a result of greatly increased total weight or natural occurrences, with the significant instability and subsidence in the foundations or in the façade that this entails, have to be considered; the compliance with current fire safety regulations, by the use of safety devices in the communal areas, i.e. lifts and stairwells, have to be considered as well in order to reduce the risk to human life and eventual damage to the building.

2.6 Building physics aspects

Thermal insulation is one of the most important problems of Italian residential building stock. Until 1976 there was no regulation regarding thermal performances in buildings, so until this date building envelopes were built without a thermal layer.

The first document about thermal regulation in buildings was the Energy saving Law 373 30/04/1976, which was updated in L.10 9/01/1991, Presidential Decree n.447 26/08/1993 and most recently MD 27/07/2005, in order to comply with the 2002 EU Directive. This law and its decrees establish standard U values for the whole building and its constituent parts (e.g. for roofs between 0.4 and 0.7 W/m² °C) depending on the thermal mass (kg/m²) of the structure, and the final M.D. introduces the control of the envelope performance particularly in the summer.

The most widespread solutions are the application of an additional thermal insulation layer (e.g. ETICS or ventilated façades) and the replacement of the windows with heat-excluding glass, to improve U value.

Moisture insulation is another relevant problem. The main reason is linked to ineffective damp-proofing (not properly designed or executed) in roofs and external walls. Concerning the frequent causes of degradation in measures against damp, this is related to the water penetration caused by rain, fog and snow, as well as to the difficulty of the removal of rainwater (due to the absence of drainage, coverings, and to condensation as a result of thermal bridges).
Those problems cause different states of degradation of the building, such as plaster swellings, biological mould and efflorescence.

The third most important issue concerns noise insulation that is definitely not up to standard. The first Italian norm about noise insulation is L.447/1995 (Framework law on noise insulation), which was then updated in DPCM 5/12/1997 n.297 that defines noise standards for buildings and their components. The lack of acoustic quality is, in some cases, a result of assembly defects in the components that accentuate noise transmission and is mainly related to the structure and materials of the building. In particular:

- The external walls are in most cases too thin and the problem is exacerbated by windows and parapets
- The rigidity of the prefabricated concrete systems (panels, modules) increase acoustic conductivity between the elements of the structure
- The noise passes through floors and internal walls because of the thinness of the components.

2.7 Cultural aspects

As living is one of the highest expressions of a people’s culture, looking at the latest living trends means gaining an insight into the features that characterise a country’s inhabitants.

This is why the rapid changes in building, due to the use of industrialized technologies after the Second World War, and the resultant changes in residential patterns in cities as a whole and their neighbourhoods, led to an over-rapid development and resultant change in the traditional lifestyles of the residents of the affected areas.

These can be considered the main reasons for the feelings of exclusion and unhappiness on the part of the inhabitants because of the exclusion of traditional values.

Some technological solutions that will help to tackle this problem may involve the maintaining and valorisation of the original plan in its unfulfilled typological and historical potential which have to be considered and highlighted on a case-by-case basis.

2.8 Social aspects

Up to now serious problems have been especially prevalent in the oldest and poorest social rented council housing estates.

Juvenile delinquency, high unemployment and low-income families, as well as inadequate services for the aged population, are just a few of the present and future problems for the allocation system of social housing and for the users.

The problem of social integration in local communities and the failure of the planning ideology of the neighbourhood have served to focus political and popular attention on the decline of these areas and their resulting negative image.
The priority is to solve the problems of poor health and of the lack of the wide urban avenue/traditional square city model, creating quality accommodation with modern comforts through redesign and expansion of the areas which provide public and private spaces. All the decisions have to be supported by an active community participation in the redevelopment programme (i.e. Quarter Laboratories) which represent the decision-making core of the project and the key to its success.

2.9 Managerial aspects

The new Italian laws on Urban Refurbishment (L. 179/92, and L. 493/93: “PRU – Urban Refurbishment Programs”) commit the bulk of building activity to the category of “Rehabilitation”. The Act on “Contratti di quartiere” (“Neighbourhood Contracts”), M.D. 22/10/1997, which is dedicated mainly to the regeneration of town districts seriously affected by social, economic and physical decay, points out the paramount role of rehabilitation of the existing housing estates, rather than that of overall renewal.

Moreover, recently, the “Experimental Housing Programs” (that started in Italy with the Law 457/78 and that are responsible of most of the non-conventional technologies in housing building) have been largely turned to the themes of the use of technologies, products and building procedures for the rehabilitation of existing buildings.

But, despite the fact that the market is increasing, very little progress has been made in developing new technologies and assessment procedures to improve and to plan a refurbishment strategy.

The assessment of size and conditions of the large housing estates can be still considered the main problem of a rehabilitation and maintenance policy due to the lack of maintenance management until now.

Moreover, the implementation of the refurbishment programs in different stages should be considered, in order to facilitate temporary rehousing.

2.10 Financial aspects

The above projects have to satisfy all the refurbishment issues using a large variety of public financial resources regarding special renewal programs.

The opportunity to make use of different financial programs for the same complex is the common procedure-strategy used to improve the integration and the improvement of the economic opportunities in refurbishment programmes.

Nevertheless new systems to define public procedure with the aim of identifying private parties (surrender of public areas, special grants, residential use change) are necessary.

Both public and private parties have contributed, during the last ten years, to the growth of real-estate investment strategy. This procedure represents a financing strategy, for public housing institutes as well as for local town councils or private parties, in a perspective of optimisation and increase of the maintenance management.

3 CASE STUDIES

3.1 Residential district Le Piagge, Florence

The project has been developed within the urban renewal programme of the Town council of Florence and it concerns the inner peripheral area where, at the end of the 70’s, several buildings, owned by the Town council, were constructed for renting to low-income users.

The intervention affects two identical buildings each consisting of 140 living units, with a supporting structure characterized by cast in situ reinforced concrete walls, strip windows and prefabricated panels (for the balcony balustrades).

The regeneration programme is made with public finances coming from three different programmes: the “District Contract”, the “Programme of Urban Recovery”, the “Programme of Experimental Building” whose co-ordination has entailed a significant engineering effort. These programmes are aimed at the urban and environmental recovery of the “Le Piagge” district.
They contribute to the social and economic development of the area by the direct involvement of the residents in the development of the programme.

The interventions solve, in particular, four main factors of building deterioration:

- The inadequacy of the residential typologies in relation to the distribution of families and requirements of the users
- The overall presence of serious building pathologies due to the use of unsuitable/low-quality materials and construction technologies
- The low quality of the building services and/or their poor performance, in relation to the distribution of the buildings (the “central atrium” typology with duplex housing on two sides, inevitably, impacts negatively on the internal quality of the units. These negative factors affect: air flow, lack of transversal ventilation, dampness, stagnation in the rooms, etc.)
- The lack of solutions that could give an architectural identity to the various parts of the site and reduce the alienating character created by the repetitiveness and anonymity of the buildings

The project offers a solution to these problems by concentrating efforts on three main tasks:

- To modify the distribution of the residential typologies and optimize the planning of the units with the aim of making them more responsive to the needs expressed by the users
- To point out the maintenance, renovation and substitution interventions necessary to eliminate the effects and causes of the decay, to comply with standards and, more generally, to improve living conditions
- To introduce, as far as the restoration of the facades is concerned, architectural elements capable of reinforcing the architectonic identity of the two buildings. The diversification of the facade solutions will create a less alienating and more friendly urban landscape. The units are single-sided and this creates air circulation problems that are solved by a system of induced ventilation and re-circulation of air.

From an architectonic point of view the solutions foreseen by the project are aimed at maintaining and validating the original plan in its unexpressed potential. In particular these solutions are aimed at:

- Communicating in a clear and readable way the regeneration and transformations carried out, in such a way that can be easily understood by a public which goes beyond the direct users of the units
- Giving an identity to the buildings, contributing to a reduction of the alienating character of these peripheral urban areas (as in surrounding areas) of high residential density. These results were reached by making choices such as:
  - Façade solutions aimed at the reduction of the repetitiveness of the elements, introducing, in particular in the balconies, variations of rhythm and shape
  - The introduction in the façades and gable-ends of some elements for specific technical performances, such as the blinds of the terraces
  - The completion of the gable-ends at the ground floor to be destined to non-residential functions.

In particular, the technologies used for the external envelope are:

- The complete restructuring of the façades with the juxtaposition of a diaphragm of protection and thermal insulation (mantle coating)
- The substitution of the external windows and doors to improve their characteristics of thermal insulation (this contributes furthermore to characterise and enrich the external façades)
- The complete substitution of the balustrades of the existing balconies with diversified solutions which comprise: galvanised steel balustrades with a solid lower part, and glass upper
- The setting up of new balconies overhanging the duplex units level with galvanised steel balustrades and coloured safety glass
- The finishing of the balconies at the last two levels with a grille in galvanised steel on which balustrades are inserted. Balustrades are made of coloured security glass and fixed grilled and light panels in galvanised steel
The partial filling of the balconies in correspondence to the new heating units (boilers) with galvanized steel panels (inserted with the “dry method” in accordance with prefabrication techniques)

The engineering of light roofing on top of the existing flat roofs to create a new ventilation system

The insertion of internal courtyards that interrupt the long (internal) distribution corridors and that allow natural illumination and air flow (improvement of environmental conditions). (Fig. 4, 5)

Moreover, the intervention includes:

- The improvement of the acoustic comfort of the units. In fact the partition walls between units and between units and the common areas have been engineered to create acoustic isolation. This has also had the effect of improving thermal isolation

- Compliance with seismic regulations through an intervention of solidifying with the introduction of wind-bracing tension rods between every structural module

- Compliance with current standards regarding hygiene (sanitary facilities) and utilities (electrical plant)

- Solutions of powered ventilation and re-circulation for an improved air displacement in the single-sided units

- Services for the residential facilities at the building gable ends which will be architectonically characteristic.

The re-qualification of the overall site area has been planned. This area has a surface of about 55,000 square metres. The project involves the creation of a public garden of high environmental quality, with wooded areas, small hills to break the monotony of the landscape, creating more interesting pedestrian and cycling areas. The site will host set-aside areas for domestic animals, leisure areas for children and for the social activities of the inhabitants of the district.

The final design involves an overall investment of 17 million euros, with a net building cost of 13.5 million euros, of which 3.2 will be spent on the building envelope.

Hence, the cost per refurbished unit is about 43,500.00 euros, of which 10,300.00 euros will have been spent on the building envelope. The total area of the units is 25,600 square meters.

Therefore the estimated cost is 530 euros per square meter, of which 125 euros are aimed at the building envelope.
3.2 Residential district S.Eusebio, Cinisello Balsamo, Milan

The area under consideration, located north of Cinisello Balsamo, includes part of the S.Eusebio quarter. The building system is characterized by public residential housing complexes, which were built at the end of the ‘60s in response to an increase in housing demand as a result of migration.

It is a context marked by serious forms of social exclusion and marginalisation accompanied by episodes of building deterioration and intervention problems by institutions. The complex’s only function is housing and it consists of 288 homes arranged around 15 stairwells. The in-line typology forms a closed C with a large 142x56 m internal garden courtyard.

The housing development presented the following critical aspects:
- Serious lack of services in relation to norms
- Lack of accessibility for the user, in particular
- Homes greatly inhomogeneous and poorly arranged
- Widespread building deterioration, especially noticeable in public housing dwellings, with negative consequences both in terms of the health of the residents and energy waste.

The main redevelopment objectives are, together with restoration of the building’s technological and system deficits, the raising of the construction’s user friendliness (through complying with regulations regarding overcoming architectural barriers), the identification of a wider range of housing types in line with the real needs of the users, and the reduction of the neighbourhood’s deficiencies due to the complex’s single function (through the introduction of a multipurpose centre). Two main reclamation phases are foreseen:
- Adaptation of the systems and restructuring of the homes
- Integration of social functions through new areas.

Two hi-tech shafts were created (Fig. 7, 8) which, in addition to containing the elevators necessary for complying with Law 236/89 regarding overcoming architectural barriers, and the new horizontal column manifold heating system to replace the existing one with vertical columns, constitute a new system centre that, together with the existing one, makes revising the types of homes contained in each restoration module possible.
Problems, Needs and Solutions in the Italian Urban Building Envelopes

By using the systems in the hi-tech shafts as well as those in the existing technical skylight wells, each restoration module permits the realization of apartments with characteristics, which better suit the requirements dictated by the number and composition of the users in each family. The hi-tech shafts have an area of 11 square metres and a height of 32 metres and consist of a metal structure partially buffered with metal panels and partially with transparent panels.

They are placed alongside the existing stairwells and, in addition to the elevators in accordance with the law, integrate the vertical canalizations of the new systems in a skylight well of approximately 90 cm, which may be inspected through an access door on each floor located next to the elevator. The new homes are created by dividing the pre-existing ones into smaller ones (40-70 sqm) and have areas in contact with the outside such as balconies and porches near the hi-tech shafts.
4 CONCLUSION

It is necessary to consider before looking to refurbishment projects in the near future; what designers did in the past and where, at the present time, residential buildings have to avoid repeating the same errors.

The compliance with energy performance issues is the first priority but not the only goal related to the envelope. Architectural, cultural and social questions have to be considered as well as those relating to finance and management.

Homes have to be transformed as lifestyle models change, in an attempt to find appropriate solutions to the demands of the population.

This is neither a utopia nor a dream but a necessity.

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