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Building envelope design as a contribution for improvement of urban spaces and social housing environmental quality.

The design of building envelope and the definition of its elements, can influence both the quality of the external spaces perception and the living standard referred to internal building spaces.
This improvement depends by the planning of some component design. Particularly, solar shadings and integrated plant solutions, also thanks to an increasing consequential interest about the issue and the legislative and normative evolution, represent factors able to be involved both in the performance and morphological quality of building envelope (improvement of energy efficiency and living quality of internal spaces), which can influence the perception of environment.
A study about this questions has been conducted through the elaboration of a system of Best Pratices, a Code of Practice, for the new Plans of Zone of Rome Municipality. The indications contained in the Code takes in examination the integration-mitigation and facilities connection of solar collectors in the building design, and the possibility of integration between solar shading and collector elements, customized like a support tool for the sustainable design of building envelope.
The design of building envelope, reported to morphological and technological issues, can assume particular importance in the definition of living quality. Design of closures, developed through some indications referred to its technological components, can influence both the quality perception of external living spaces through the morphological definition of building, and the life quality of internal spaces by the implementation of energy efficiency of building system.
Solar shading in particular, also thanks to the increasing consequential interest in the evolution of legislation about the argument, more in the future will represent a fundamental element for design and the increment of performance and morphological quality of building enclosure.

Key words
Building envelope, social housing, solar shading, energy efficiency, planning tools, technical solutions.

1. Introduction

The recent perspectives of the real estate market in Europe and in Italy underline as, to forehead of the changes found in the social structure and the consequent crisis of the typological traditional orders, the constructions market of existing housebuilding has reached the value of the new production (CRESME, 2006). This is not sign of a stasis of the new construction, but of the measure than the existing housing stock results inadequate to the satisfaction of the requirement of housing demand.
In the last years an active experimentation and revision of the concepts of traditional living reconsiders the distribution of the spaces, the technological choices, the materials that compose the technical solutions and the increasing use of the passive and active systems, in terms of energy saving.
Despite the real estate market reports a situation of emergency given by the great distance between demand and offer of dwelling - especially the social housing's real estate - with an apparently incompressible requirement to low cost residence, the market of the residential housebuilding of middle and high-level flourishes looking to the private market and to a band of requirement and solvent demand.

Since Nineties the Local Governments have become conscious of the necessity of promoting environmental policies turned to the improvement of the living conditions of citizens and to the mitigation of the building and productive activities effects on the urban ecosystem.

A lot of administrations have found different ways to promote the functional and energetic qualification of residential building, deepening the definition of the quality of the interventions in order to provide an offer that doesn't satisfy only the quantitative demand, but also answers to the expectations of a greater environmental quality.

The reflections on the technological aspects of the building organism are reflected in the transformations it aims to assist: the new materials introduced on to the market are joined to conventional technology, the new and elevated performance levels required have to face up to the behaviour patterns and functional schemes of contemporary life.

The quality of the architectonic envelope influences, from a morphological and formal point of view, both the quality of the architecture as well as, on a wider scale, the city. At the same time as evaluating what has been achieved thanks to new technologies, therefore, it is necessary to reflect on how much they can influence at a perceptive and morphological level the design of the envelope, with the aim of promoting the overcoming of the conditions of formal and technological obsolescence which is to be hoped for in the panorama of Italian social housing.

So the envelope, therefore, defines, contains and protects the activities that take place within the building; the protective role that is made explicit by the envelope, that of a membrane, a connective element between cold and heat, noise and silence, intense light and controlled lighting, provides the building with the possibility of functioning, to carry out the role for which is was planned and built. Connecting two neighbouring environments that respond, nonetheless, to very different logics and control systems, such as the exterior and interior of a building, means planning in an intelligent way the element that render the connection possible. This operation of understanding outlines the limits that identify and design the framework of the building.

The choice of the planner will undoubtedly be that of finding the most suitable solution within a combination of conditions, opportunities, and links that are reference points for the environmental characteristics of the site in the course of the seasons during the year, with a control of the external part of buildings in relation to their orientation and to the activities carried out internally, as well as - in virtue of the errors of the past – attributing to the morphological quality of buildings the specific character that distinguishes the history of each and every place.

The research on the solutions for the external envelope, and the implication of the technical elements in the control of the indoor environment quality conditions of the building deal to setting up a system of good practices for the creation of proper solutions to the climatic contexts of intervention, valuating and verifying their better use in exercise in the case of the social residential buildings.

The spreading consciousness of sustainable common actions, supported by the acknowledgment of a few European and national laws, is intended therefore to define local legislative tools on energy efficiency and environment quality defining measures aimed at promoting and developing for the preliminary definition and control of the construction activities.

2. Guidelines for the project of the envelope: the experience of the Code of Practice in Rome

The City of Rome confronted these questions by drawing up the Plans for Popular and Economic Buildings (Piani per l'Edilizia Economica e Populare – PEEP) that were used from time to time to determine the quantity of buildings to be constructed; in particular, the 2nd PEEP, proposed in 1985, was redefined and refinanced many times until 2005. At this point, the City, due to the requirements of regulations aimed at alleviating the "housing problem" (Law 8, February 2001, n 21), passed a new series of measures to launch a truly valid Plan to deal with the Housing Crisis.

In order to achieve this, the administration proposed accompanying the traditional structure of actual urban planning with a "Code of Practice", as a set of guidelines for the planning of future installations to be built; the Code will gather together and place at the disposition of the planners and promoters of future installations all of the indicators and tools for the definition of an integrated planning strategy, to control the overall quality of the interventions. In this way, alongside the traditional indications of technical regulations relating to the construction of residential buildings it is possible to place a system of best practices, of innovative guidelines about environmental quality of constructions, about energy and environmental management systems for sites and buildings, about the knowledgeable use of technological solutions aimed at the overall improvement of the performance of the building and the urban complex.

The Code of practice for the Zone Plans of the city of Rome foresees a reasoned appraisal, because good architecture depends on informed energy choices. The role of the architect, from this point of view, has to necessarily tend towards integrated planning, even if the specific object of the project is the planning of a city or on the scale of industrial design. Underlining the importance of logical planning throughout in terms of needs analysis, evaluation of requirements, and optimisation of performances, any architectonic element that doesn't look for a balance between the building system and the environment

in which it is to be found and on which it will have an impact should be considered incoherent.
Specifically, with regard to methodology, as with environmental analysis, the use of Ecotect software (with particular attention on the Weather Tool module) is placed alongside traditional bibliographic research.
The idea on which the entire study of the Code of practice is structured is as follows: to analyse the potential of a building-environment system, identify its eventual compatibility or incompatibility with the technical possibilities present on the market. A fundamental role, therefore, is assumed by the very concept of compatibility, intended in its widest sense, in terms of regulations, technology, economics and use. To delineate a process in this sense inevitably imposes a preliminary survey in merit of the characteristics of the urban environment, but this implicitly means looking at the technical performance of the functional models of the building envelope, successively defined as compatible.
These intentions are made concrete by means of a timely appraisal of the adoption of methods that verify and consolidate matters primarily concerned with solar radiation. It is a considered choice to deepen that environmental parameter over others: firstly, solar radiation is configured on the scale of the whole building, as having major significance in relation to the passive performance of closure packets and to their potential in terms of solar panel systems. In support of this position, it is necessary to underline the analysis of pre-existing urban environmental data: for example, the Code has agreed from the outset to exclude an approach on the theme of energy optimisation in terms of the exploitation of wind systems; the reviewed data clearly show that wind phenomena are substantially negligible in terms of intensity and frequency in the City of Rome. The analysis of solar radiation at the level of the building gives quality indications for the exteriors of buildings, shared public spaces and the divisions of the project.
The promotion of an integrated approach to the sustainable planning is translated therefore into the suggesting of multi-level intervention strategies that take into consideration the planning and possible interactions between all the elements of the interaction between the urban and natural environment.

The Code of practice for the Zone Plans of the city of Rome foresees a reasoned evaluation of construction materials to employ in projects; the identified evaluation criteria don’t aim to construct an abacus of materials to use or not to use for these buildings, but intends to supply tools to the person who will plan and realise these buildings to choose materials and construction solutions in a way that will answer a system of technical requirements identified as determining for the efficiency and sustainability of the proposed solutions. The choice to use or not to use a certain product is reached through various selection criteria that are defined to satisfy the need to obtain good physical-technical performance but at the same time guarantee a low impact on the environment.
Environmental parameters, typological models, legal and technical solutions, needs, technical legislation, compatibility matrices, assume a great value in full agreement with the Code’s objectives.

2.1 Needs of quantity and demands of quality

At the dawning of a new era in social housing, the quantity requirements have to be viewed alongside research that privileges many aspects of environmental and technological quality, characterised by both interactivity and its relationship with the natural environment.

Quality is not an objective characteristic, it's not the qualifying characteristic of a product; instead it is the response to the expression of a need. Therefore, a new demand for quality presupposes a dissatisfaction among the users of current building stock; when speaking of the quality of an architectural or urban project, its level of quality must be discussed, the degree to which it responded to the need that generated it.
It is possible to acknowledge at least two different levels of quality in a project: the intended quality and the end quality.

The experience of the "Code of Practice" for the Zone Plans of Rome explicitly inserts into this logic: organized sequence of work phases in which every option either punctual or systematic is a consequence of the analysis of the climatic variables and their possible synergic interaction in key projects.

In both the social requirement for quantity and the private demand for quality, the market responds in a uniform and unimaginative way, using very traditional technological definitions and typological solutions, blocked partly due to current regulations, offering as an added value only extra space or fittings.
The Code also appraises the appropriate and measured technological solutions to the types of buildings to be constructed in a way that doesn't differentiate them from the current approach of local promoters, though it does require a higher level of final technological performance for the environmental sustainability of the interventions. An analysis of the innovative technological solutions in the construction of residential buildings needs to be carried out, including the study of the construction materials used, in such a way as to direct intelligently the choice of the construction solutions and successive control in phases of building through management procedures. Using the same logic, the most appropriate system devices for efficiency in light of the indications of recent regulations regarding energy control management were analysed and evaluated. To support these indications, the Code proposes an integrated model of analysis of the sites where interventions are being carried out that includes all of the environmental aspects and characteristics of the single sites, and to bring to the project and planning strategy the indications that derive from the natural and cultural characteristics of the sites in question.

2.2 Technical solution to adopt in the design of sustainable social housing

The deep effects of the adopted solution on the final quality of the building have to be compared with the new increasing in the complexity and in the performances of products and system offered by the industry construction sector.
The design control of the complexity of the technical elements risks however to be practiced not more by the planner but even more by the industry sector that hold the real know how of the systems presented on the market. The planner activity is not the unconscious application of the innovative techniques, but it considers and manages the whole input design furnished by an analytical phase of the needs correctly predisposed.
The technologies and the materials more complex and performing are called to satisfy the incremented performance levels introduced by the new regulations in evolution; in this way the choice of the planner is directed to evaluate the most suitable solution inside a combination of opportunity and constrains.

In this historic period, it is well known, in fact, that there is a construction industry with the ability to always offer new products that gives the planner many choices from a catalogue of more or less complex elements.

This last consideration points to the fact that, on the one hand, the more components become complex, the more they are composed of individual layers, or sub-elements; on the other, it is established that as much more of the element's technical performance is the sum of its layers' individual performances, it will be of great importance to control their final technological quality. It will also be necessary to verify analytically the performances that respond best to both the requirements and actions that define the needs picture of the residence, and the priorities that are used to define the objectives of the effective sustainable plan.

The technological transfer of some solutions coming from analogous building sectors is conducted from an increment of its repertoire and the performance of the systems that are offered, to the introduction of material that is more or less sophisticated and has the ability to satisfy the performance levels with a minor impact on it's environment but not always easy to control in time.

We can see, therefore, how the external envelope is one of principle areas called upon to satisfy a building project's sustainability. At the same time, the elements that make it up are called on to provide, in a coherent manner, all those aspects of volumetric and spatial composition the building was not able to respond to

A similar approach modifies the planning of the technical elements, which must be thought of not only as a connection and/or separation from the other elements of the building system, but also as effectively "able to be integrated" thanks to an interdisciplinary meeting of the various specialists involved in the planning process. Technical solutions will be equipped by indications on their opportunity of employment and compatibility; particularly will be verified relationships between structure and system of building skin.

The adoption of new rules and new performance requirements will lead to a reduction in energy consumption for heating and air conditioning, therefore a notable reduction of electricity bills (installation of air conditioners, hot-water plant for cleaning, electrical plant) in the course of the useful life of the building.

On the other hand the atmospheric advantages are a direct consequence of the bettering the efficiency of the building and its installed systems: less consumption of combustibles in fact transform into less emission of gas into the atmosphere and a smaller impact of usable materials in the atmosphere.

Technical solutions will be equipped by definition of performances specific of materials individualized as compatible, to constitute an operational support to editing the specifications for new construction interventions.
Compatibility verification of materials group in different technological alternatives is also functional to furnish a preliminary instrumentation for parametric evaluation of the costs of residential intervention, regarding the choices pursued in architectural and technological terms.
To the technical economic evaluation of the solutions can be related with performing evaluations in energetic terms, verified respect to their impact on useful life of the building, with particular respect to energetic containment and the possible energetic certification to be acquired.
The so encoded abacus of conformed technical solutions configures itself as tool of support to new construction's residential building plans, but it could also be used as tool of project technical control cause articulation of the performing definition of single solutions; it

configure like an usable tool in phase of planning, both as an instrument for the public and private client in phase of preliminary interventions planning for the debugging of the technological specifications of building's performance, and for the preliminary definition of the parametric costs of the single solutions. It could be therefore used in the following phases of verification of building options, with particular reference to social housing.
The final product of this phase will be a document that accompanies planning process , that defines a system of guidelines for improving the quality of interventions projects and also that increase realization quality level making available a more refined tool control respect attended performances.
In this occasion, the indications of normative character produced until today can be made effective both to national and local level, regarding the environmental sustainability of building interventions, also overcoming one certain traditional rigidity of the same actual normative tools .
The document will be equipped by indications of best practices and it will be configure as support and address tool for the realization and the control of efficiency and effectiveness of building interventions for social housing, proposing a planning approach highly integrated. In this document will be proposed an evaluation of technological solutions appropriate and commensurate to building typologies to realize so that to not denaturalize the approach of the promoters and the local
performers, also asking for a more elevated level of technological performances finalized to the environmental sustainability of the interventions and their energetic retrofit.
The analysis of the innovative technological solutions for the realization of the residential buildings is verificated in-depht until the study of construction using materials to direct in conscious way the choice of constructive solutions and the following control in phase of realization and management in exercise.
To support these indications it's also proposed an integrated formality analysis of the intervention sites that understands all the aspects and the environmental characteristics to bring inside the projects and of the strategies of planning the indications coming from the natural and anthropic character of single places.

3. Solar shading system contribution for energy efficiency

The external envelope is vital in terms of a building project’s sustainability: its features must coherently guarantee the correct climatic control of the building that is not covered by volumetric and spatial design. For this reason, the design of solar screens requires an evaluation based on a number of specific aspects, such as the building’s climatic context and location, the movement of the sun during the year, morphological characteristics and the direction the building faces, its juxtaposition to other buildings, and the functional role of each area in the building.

The analysis achieved by the Code, underlines the legislative gap on this theme and aims to turn the attention of planners to questions relating to solar screens, and has led initially to a classification and synthesis of the intensity of sunlight; this was followed by a dimensional analysis of screens, in line with the theoretical direction the building faces. This analysis led to an accurate classification and synthesis of guidelines relating both to the choice and the preferential use of the main types of solar screens considered.

This is even more important if we are referring to countries in the Mediterranean basin, in which, apart from the need for protection from the cold, there is also the requirement to provide suitable protection from the heat during summer, to avoid or minimise the use of air-conditioning or cooling plant, thus limiting their impact of energy consumption.

3.1 The role of the legislative requirements in the design of the technical solutions

The theme of eco-efficiency should be attacked head on not just through the technological qualities that the technical solutions will be able to guarantee. The importance of building management - highlighted in the objectives of the European Council on spring (OR. EN 7224/07 of March 8th 2007), taken up then by national (Legislative Decree 311/2006) and local regulations (Del. 48/2006 City of Rome) - underline an ulterior element of reflection: the constantly growing role and importance of plant in the management of building stock. In this discussion we find the growing incidence of alternative plant needed to sustain buildings, as much from the point of view of initial costs as the dimensional impact of the same on an area under consideration.
The increase in requests to use renewable sources along with the demand to reduce energy consumption and CO2 emissions into the atmosphere, translates therefore into the need to think about the integration of plant both as a means to reduce the country's energy demands and as a source of co-generation able to guarantee positive economic returns in the conduction of the buildings.

From a legislative point of view, Italian law, using legislative decrees 192/2005 and 311/2006 – acknowledging European Directive 2002/91/CE – revolutionised the concept of solar screening. Before the passing of these decrees, screening meant the protective system, inside or outside a building, that could be made up of any of the various elements used mostly to filter direct light, among which we find internal elements made of fabric (curtains) or external elements made of wood or aluminium (blinds, shutters), designed without any specific technical criteria.
With the new norm, the planner "has to evaluate exactly and document the efficiency of screening systems, of glassed surfaces, external or internal, fixed or movable, so as to bring about a reduction in heat caused by sunlight".
This requirement changes the conception of the term "screening" and allows it the possibility of intervening directly in a building's energy balance, not only in relation to increased living comfort but also in relation to thermal wellbeing and energy efficiency.
With the term "solar screening" we mean a device capable of impacting on the effects of sunlight on glassed surfaces or reducing the thermal impact on opaque surfaces. In reality, this definition contains multiple technological solutions corresponding to different formal choices. From the interior curtain to a hi-tech screening system that might include within it elements of integrated planning, to the simple overhang of an upstairs balcony which, depending on the direction the building faces, might produces shadow on the wall and window below, to plant screens that protect the walls from the sunlight in summer and let it through in winter, there is a whole range of technical solutions capable of answering different levels of need and, at the same time, offering their own contribution to the design of the envelope.
For this reason, it is felt necessary, firstly, to pay attention to defining what is meant by "solar screening", and laying down a number of classification parameters.
Secondly, we have to reflect on the fact that the presence of an element capable of creating shade, offers benefits that have to be evaluated and calculated. To what extent and how these benefits manifest themselves must be defined by precise criteria: the size and positioning of the screening elements have to be evaluated by accurate means that can justify and direct the choice of a determined technical solution.

The control of environmental and technological requirements, as well as their satisfaction, are both essential objectives that should be reached in respect of architectural language proper to and expressed in each single culture.

On the other hand, the environmental advantages are a direct consequence of improving the efficiency of buildings and their plant systems: lower fuel consumption in fact means less emission of gas into the atmosphere and a lesser impact of materials used in the environment.

3.2 The design of solar shading systems

Sunlight captured by the screen has different intensity and height in relation to the horizon; every side of the building will have a different and specific range of sunlight, and therefore different requirements. Simulations and checks are required to ensure the correct amount of screening will be reported in particular screened areas (depending on the screen's size and shape and the distance between the screen and the occupied area); the presence of other buildings (that may create shade in certain moments of the day and in particular seasons); the quality of shade and the thermal effect caused by the screen (depending on the screen's shape, the materials used and the morphology, colour and transparency of the elements involved).

The analysis of solar radiation at a complex urban level gives quality indications of external spaces for buildings of divided public spaces of the project.

The Code of Practice contains a proposal for the classification of solar screening, and attempts to identify precise parameters that will able to direct planning. In particular, it analyses the following:

1. The relationship between the direction a building faces/intensity of sunlight.
   The positioning of the screening follows the path of the sun's rays to place itself against them and block their passage. For this reason we should study the possibility of using different screening elements with, as a result, different morphologies, depending on the direction the buildings face.
   In south-, southeast- and southwest-facing buildings, the positioning of the screens has a dual function: that of intercepting heat and at the same time filtering light, thus contributing to both thermal and visual comfort. For this reason, for buildings facing these directions, it's preferable to use external screening, which is much more effective than internal screening for solar control, since it blocks the sunlight before it reaches surfaces further behind. In north-, northeast- and northwest-facing buildings, on the other hand, there is the need to guarantee a suitable level of internal light to limit energy consumption deriving from the use of artificial lighting, and at the same time ensuring the privacy of the interior of the buildings. In this last case, it will be necessary to identify preferably internal screening capable of not blocking the light flow but still able to offer suitable protection for whatever activities take place within the building.
   The control of light flow and the protection of privacy furthermore are strictly linked to the type of activity being carried out in the single environments, that may require different modulations in the flow of light depending on the activities carried out therein. The screenings, therefore, could consist of more or less screening elements capable of balancing the need for privacy with that of allowing light in line with the specific needs of each environment.

2. The type and height of rays to be screened.
   The market offers a huge and varied range of products for solar screening: from the simple internal curtain to hi-tech screening that includes the use of capturing panels, there are multiple possibilities for controlling light and heat, that correspond to just as many technical solutions with uses and potential adaptable to every need.
   In reality, before choosing, the type of sunlight to be blocked and the climatic and seasonal characteristics of the geographical area under consideration should be considered. The Code of Practice specifically examined the city of Rome and elaborated a classification of screening elements considering a number of parameters relating to type, position, relationship to the building's façade, texture and morphology of the screen's components, and the possibility of its housing elements of integrated plant.
   So within the range of possible technical solutions we find the possibility of making significant planning choices with respect to the image of a building: once the uses that need to be satisfied have been defined, we can turn to a market that is characterised by evermore pleasing and innovative products from a formal point of view, that are able to contribute significantly to the aesthetic appearance of the envelope as well as to its capability to make a contribution in terms of energy efficiency.
3. The possibility of integration with plant.
   Screenings can be used actively to contribute to the energy balance of a building, housing elements of integrated plant such as solar heating and photovoltaic solar capturing panels. South-facing panels, in fact, allow the use of the energy captured by the screening to produce electrical-heat energy, capable of contributing to the improvement of the building's energy performance. Here too we should compare the possible technical solutions offered by the market, carry out cost-benefit analyses and find intelligent uses for the energy saving resulting from the protection offered against the sun as well as possible ways to utilise active solar systems.

3. Conclusion

Research into the envelope elements has therefore led to a moment of reflection and analysis about the morphological characteristics and specific performances of the solutions that may be considered meaningful and adoptable.
To intercept solar radiation, letting only enough enter a building for good levels of luminous and thermal comfort in interiors: this is the first role played by the envelope and the sunscreens, in particular, have become a key design element because they make it possible to enjoy natural light while eliminating its negative effects.
At the same time solar shadings as well transform the overheating disadvantages of the solar radiation in energy benefits thanks to the integration of solar and photovoltaic systems in the design of the envelope.
Thanks to new legislative initiative external sunscreens are no longer a choice, but an obligation. Growing concern about environmental issues imposed finding ways to avoid such squandering of energy: there are many different solutions, in fact, for external screening to improve energy performance: from selective glass, to films, sunscreen to blinds.
In the past solar shading were often taken into consideration only after the design phase of a building, as a hasty remedy for excessive sunlight in spaces; but nowadays something is changing.

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