Recurrent pathologies in recently built schools in Palermo

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Abstract

This topic concerns the most significant pathologies noticed in the facilities being used as schools, which were built in Palermo in the last three decades. Many among these facilities already have undergone major restoration works, while the others are in poor conditions, which remarkably compromise the quality of their utilization. Sober elegance and safety are particularly important whenever a facility is to function as a school, especially if we consider the type of users and the ways of utilization. In order to achieve such goal, it is fundamental to analyse the most frequent pathologies, relating them to their causes, so as to have the tools for correcting previous errors and prevent any future mistake. The results showed that some particular elements of the facilities presented the most severe pathologies, which in most cases could have been avoided if projects had been more attentive to the durability of the technical solutions.

Keywords: Pathology; reliability; maintenance; building failure cases; schooling premises.

1. General aims of the study of construction pathologies

Whatever the various forms that the deterioration in the quality of a building may assume, the pathology is characterised by the unexpectedness of its timing, which is often followed quite closely by the execution of the building intervention. Although it may be intensified by natural agents, the pathology derives, above all, from human factors, which with regard

to errors and omissions might involve any of the phases in the building process [1]. It is for this reason, as regards the inevitability of decay (a phenomenon of physiological ageing), that the pathology may be considered avoidable (at least in theory). Generally speaking, the main aim of the study of this construction pathology is to succeed in forestalling and containing this phenomenon through the following stages: recognition and description of the relative features (nature, entity, consequences); the connection with the causes that have provoked it; the individuation of helpful solutions for preventing it from re-occurring or for minimizing the effects. On many occasions over the last decades there have been in-depth studies of construction pathologies, mainly proceeding from close scrutiny of the operational behaviour of a wide range of building materials and solutions. These studies have contributed considerably to giving substance to the widespread shift towards building quality, by reinforcing ideas and sensitizing those working in this field. In fact, the latter have helped lay down a scientific basis for the rational management of our building heritage, by establishing a fundamental point of reference for thorny issues such as guarantees and insurance, whenever the emergence of a pathology might end in a legal dispute [2]. Apart from a few general principles of a methodological nature, studies of building pathologies arouse interest above all when dealing with specific cases. In fact, beginning with its actual identification, the pathological phenomenon is clearly characterised by reference to the specific materials and solutions adopted, as well as by the timing of its appearance. For this reason it has been decided to analyse the pathologies recurring frequently in buildings that are homogenous with regard to origin, type, condition of use and management.

2. The case-study under examination

The research described here was prompted by a study that is still going on, with regard to building structures to be used as school premises (state property in the district of the city of Palermo). In this phase the study pertained to lower-level schools: crèches, nursery schools, primary and lower secondary, totalling 190 buildings belonging to the City of Palermo (Table 1). At present a *house-keeping* model is being used as a management system, based solely on the utilisation of internal resources [3]: the administration is provided with an *Ufficio Autonomo Edilizia Scolastica (autonomous office for school premises)*, organised into two separate sectors, one for new buildings and the other for the upkeep of existing structures. The *Maintenance Sector*, consisting of a staff of fifteen experts (engineers, architects, surveyors) is responsible for a group of buildings, which, apart from being

conspicuous, are also fairly heterogeneous with regard to their date of construction (Table 2), as well as, obviously, their location and social context of reference.

Table 1. School premises belonging to Palermo City Council, divided per educational level.

| Crèche | Nursery school | Teaching administrations (nursey and primary schools) | Comprehensive institutes (primary and lower secondary schools) | Lower secondary | TOTAL |
|--------|----------------|---|--|--------------------|-------|
| 31 | 3 | 94 | 41 | 21 | 0 |

In the academic year 2005/06 a collaboration was initiated between the *Maintenance Sector* and the *Department for Technological Redevelopment and Building Maintenance, University of Palermo, Faculty of Architecture*, which is pursuing the objective of providing the City Council Administration with scientific support for rational and efficient management of structures to be used as school-buildings; the principal point of departure is the establishment of a system of information as a basis for structured knowledge that is both complete and can be updated (for all school premises belonging to the City council).

Table 2. School premises belonging to Palermo City Council, divided per period of construction.

| Pre- 1910 | 1911- 1940 | 1941- 1950 | 1951- 1960 | 1961- 1970 | 1971- 1980 | 1981- 1990 | 1991- 2000 | Post 2000 | TOTAL |
|--------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|-----------|--------|
| | | | | | 24 | 38 | 14 | 14 | !ERROR |
| 10 | 14 | 19 | 42 | 15 | | | | | E DI |
| | | | | | | | | | SINTAS |
| | | | | | | | | | SI,) |
| 5.26 | 7.37 | 10 | 22.1 | 7.89 | 12.64 | 20 | 7.37 | 7.37 | 100 |

The research described here was initiated as part of this collaboration; as it had to concentrate on the most recurrent building pathologies the research took into consideration a clearly-defined sample, which was of significant dimensions and, above all, homogenous in quality: school-buildings constructed following the *Falcucci decree* (law no. 488/1986). There were, in all, 38 buildings, corresponding to 20% of the total number of structures (belonging to the City Council) to be used as school-premises, united above all by an

urgent need for operational processes. One need merely recall that, until the 80s, Palermo City Council was paying out about 16 thousand million lire annually in rent for premises to be used for lower-level school premises: 33% of the classrooms in primary schools and 62% of classrooms in lower secondary schools were located in rented premises, which were to prove unsatisfactory for their intended use: 50% of schools did not meet the minimum legal requirements (fire, hygiene and health regulations, habitability) and 86% of the schools had architectural obstacles for the disabled [4]. Apart from the need for haste, the planning for these buildings was severely conditioned by the limit on costs imposed by the available finances, allocated on the basis of the number of classrooms to be created; not enough account was taken of the other indispensable functional units, as laid down by laws (going back to 1975) governing school premises. The operational phase was also particularly long and tiring, in certain cases only concluded after decades of interruptions; half-finished school complexes were often abandoned and then left to the mercy of vandals. The slowness of the operations was in many cases caused by the extensive Dutch auctions, through which the firms carrying out the works obtained their contracts. 38 projects financed by the Falcucci decree were completed after the year 2000; in one case the project was not even initiated.

3. Recurrent pathologies in the schools examined

Although they had been built quite recently, there were rather obvious phenomena of pathologies and decay in the cases being examined; these made their appearance much sooner than their projected life-span might have led one to believe, and were the fruit of a construction process lacking quality control, especially in the planning and building phases. An awareness of the seriousness and diffusion of these phenomena today constitutes the basis for a fresh technical approach, which is no longer so indifferent to the durability of materials and construction solutions. The studies and research initiated in this field have led to the singling out of methods of analysis for the study of pathological failures and defects in constructions; among these, an examination of visible behavioural anomalies [2] has been proposed, which would subsequently lead to the initiation of the diagnostic process. The main difficulty in analysing a building pathology arises from the fact that most of the pathologies are a symptom of phenomena that reflect failures occurring in less evident areas. Furthermore, a defect can not, by itself, generate a failure (whether this be natural or pathological) without the intervention of an agent to activate it [5]. The examination carried out on building pathology stems from an overall pre-diagnosis of the structures, aiming to discover their construction efficiency, via an analysis of technological features and a

process of analytic and critical de-construction [6]. The framework of pathologies proved to be complex and in certain instances astounding (such as in the case of windows being held open with precarious devices), especially considering the fact that we are here dealing with the essential, basic requisites as regards quality of housing (fig.1) From now on only the most common and significant examples from the buildings under examination will be described.



Figure 1. Precarious devices for holding open window

3.1. Coverings

The main pathologies noted, in the buildings examined, develop on the surfaces (the *sacrificial surfaces* to be exact), which are subject to an accelerated deterioration in proportion to the natural life-span of the construction; this decay is due to their direct exposure to environmental agents and a lack of attention in the planning and operational phases. External plaster is an element used in all the cases under examination; it is applied to the face with the aim of evening out the surface, protecting the structure and functioning as anchorage for the application of the paint. The most commonly recurring pathology in plaster-covered walls is the surface layer's lack of adherence to the underlying support; this initially reveals itself in the form of bubbles of various sizes, and subsequently in the breaking up of the surface and the complete detachment of the facing. This pathology is quite widespread, but crops up mainly in those areas that are subject to the action of water; since the water vapour's capacity for spreading from the inside to the outside is restricted, this brings about variations in volume (i.e. where the walls meet the ground, in attic walls, in the intrados of balconies and in all areas where water collects). This pathology stems, above all, from the nature of the material employed, plastic plaster, which is notoriously

non-transpiring, and is associated with a notable quantity of water in the construction elements. Another determining factor is the absence of planning precautions, which accelerate the weathering mechanisms and the consequent deterioration of performance, creating the conditions for increased, aggressive activity on the part of the water. In the case of wall-ground junctures, the water is absorbed in capillary fashion from the ground and conveyed to materials with a porous structure, such as calcarenite ashlars and lateritious bricks. The phenomenon is also emphasised by defects such as the absence of waterproofing, loose stone foundations and interspaces, and precautions for draining off rain-water that has collected at the bottom of the building. In this case the pathology is associated with forms of deterioration such as the forming of mould, efflorescence and salt crystallization, which are found principally in those areas where damp patches encounter dry surfaces, and are characterised by the typical wave-shape, which is provoked by the continual and cyclical processes of dampening and drying out [7] (fig. 2). Another area where this pathology is to be found is in attic walls; in this case the source of the agent (water) is the rain-water that has fallen and collected, and the inadequacy of the drip. More generally, the lack of precautions for the run-off of rain-water, with the glaring omission of spouts and suitable connections between the parapets and the slabs, has created favourable conditions for the development of this pathology (figg. 3, 4).







Figure 2, 3 e 4. Pathologies found in plastering.

3.2. Roofing

Another element that plays an important role in the quality of construction covering is roofing, which is designed, above all, to respond to a need for air-tightness and insulation, but which all too often proves unsatisfactory. The roofing in the cases analysed is flat and continuous, mostly covered with a surface layer of waterproof membrane; it is non-practicable, but allows suitable access for maintenance work. In this part of the building the

most common pathologies are principally failures resulting from the discontinuity of the waterproof layer (both horizontally and in the areas where there is an inadequate upturned border), and the presence of cracks where the roofing joins the attic walls (fig.13). These pathologies are allied to, and instrumental in, deterioration of an organic nature, attributable to the actions of macro and micro-organisms; superior plant species have developed by thrusting their roots deeply into cracks, where they can procure the mineral substances vital for their metabolism; this growth process causes pressure of a mechanical nature, which widens the original cracks, allowing more water to seep in. The agents responsible for these pathologies in wall-facing emanate from a situation where, because of direct exposure to the atmosphere, the walls are subjected to continual expansion and contraction due to swings in temperature [8]. Furthermore, the permanent presence of water, emphasised by the erroneous execution of the gradients, the inadequacy of the rainwater pipes, the absence of grills to prevent leaves entering, and by a neglect of cleaning operations (fig. 8, 9, 10), brings about infiltrations inside the building, to which there are corresponding stains, efflorescence and haloing (figg. 5, 6, 7). Collected rain-water on the roof-covering causes trickling along the horizontal cracks, which are level with the juncture of the attic walls. As regards the decline in performance of the waterproof layer, the origins can be attributed to the planning phase, where materials may have been utilised with restricted coefficients of thermal expansion, and lacking in adequate chemical stability, resistance to freezing, durability and mechanical features, as well as the absence of protective elements, such as flashing or coping along the perimeter of the roofing, in the attic walls and parapets. Another very serious shortcoming in planning is the absence of an expansion joint between the roofing and the attic wall. One of the causes for the pathology often lies in a particularly inaccurate overlap between the waterproof membrane and the construction of the upturned border.







Figure 5, 6, 7. Pathologies found in coverings.







Figure 8, 9, 10. Pathologies found in coverings.

3.3. Structural elements

The buildings examined were made entirely of reinforced concrete and displayed the typical pathological framework, characterised by large areas of detached cover and iron oxide stains, which were present above all in critical areas such as overhangs (balconies, roof gutters, string-courses), corners, thin elements etc. It is widely known that there are numerous causes for this pathology and they crop up mainly during the phase of execution. Some of the buildings examined have the steel structures of external fire escapes; both the trimmings and the supporting elements commonly display signs of oxidisation. In certain cases the actual functioning of the fire-escape comes under threat. At the root of this pathology there lies the absolute indifference, during the planning phase, to the need for durability; structures are often designed as if they were to be located indoors. In fact there is often no provision for a run-off for rain-water, which collects on the steps and the flat surfaces, and no indispensable protective treatment (anti-rust, zincing) has been applied to prevent oxidisation (figg. 11, 12, 13).







Figure 11, 12, 13. Pathologies found in structural elements.

4. Conclusions

Numerous buildings destined for use as school premises, and managed by Palermo City Council, were completed following the Falcucci decree. The homogeneity of type and construction that characterises these buildings is reflected in the recurrence of specific building pathologies, which appear regularly in certain components of construction systems. The structured analysis of significant pathologies provides an instrument for a more efficient management of these buildings. In fact, via the individuation of their origins, it provides the opportunity to understand pathological manifestations and to predict their subsequent evolution. This contributes considerably towards defining the most appropriate strategies, starting with a choice of the most suitable category of intervention for resolving the pathology in question. If the phenomena are due to errors in the running phase, or, in certain cases, to errors in the realisation phase, a maintenance operation might prove to be the right solution; on the other hand, if the pathology is the result of errors or planning omissions, the final solutions should be sought through more substantial interventions (in the form of upgrading). Determining the intervention required to resolve the pathological phenomenon is the first step in the planning and management of building operations, which, in the case of school premises, are of extreme social, as well as economic, importance; security, in all forms, and propriety are particularly sensitive objectives in school buildings, if we consider who is going to use the building and in what way. In the paper being presented, the analysis of building pathologies serves to help understand the errors that have been made, so as to curb damage and forestall further future damage; the present generation has a duty to bear in mind past experiences (including those from the recent past), and pursue the values of sustainability both in construction and human activity in general.

Acknowledgements

The authors would like to thank the *Settore Manutenzione* of the *Ufficio Autonomo Edilizia Scolastica* of Palermo City Council, and especially Vincenzo Pisani (engineer) and Diletta De Angelis (architect), for their helpfulness and priceless collaboration. Maria Luisa Germanà co-ordinated the research work that led to the drafting of the present paper and edited the abstracts and paragraphs 1, 2 and 4. Barbara Salemi edited paragraph 3 and the relevant photographs.

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