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Bucur Dan Pericleanu
Ovidius University from Constanta
Teaching assistant, Faculty of Civil Engineering,
România

Mihaela Pericleanu
Ovidius University from Constanta
Assistant professor, Faculty of Civil Engineering,
România

STUDY ON THE IMPORTANCE OF IMPLEMENTING A MAINTENANCE PLAN IN THE LIFE CYCLE OF STRUCTURES

Abstract: *Maintenance is essential to assess the beginning of degradation process and to prevent damage to building elements. The selection of the most efficient and appropriate maintenance strategy is a topical issue of essential importance because it can conduct to a better budget allocation of funds throughout the life cycle of constructions. In this paper the authors underline the importance of monitoring the behavior of buildings according to the norms in Romania and propose, based on documentary research, an approach for selecting the proper maintenance strategy.*

Key words: *life cycle, maintenance plan, monitoring, durability.*

Language: *English*

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Introduction

The life cycle of a construction represents the main stages from design and execution to the expiration of its technical and / or economic life, in which a built space satisfies the requirements of users. The life cycle is based on a complex study that indicates a series of economic, technical, social and functional aspects. In the literature, the life of construction projects is treated differently. Most authors limit the lifespan of a construction project to the time between the initiation (definition) of the project and when it is put into operation. Others consider that the lifespan of a project starts with the date of authorizing the design activity (or even on the date of concluding the enterprise contract) and ends when it is put into operation.

In order to achieve a durable structure that corresponds to the technical norms considered in design, measures must be taken to manage the quality of works on defining safety requirements as well as organizational and control measures in the stages of design, execution and operation of the building.

In selecting the proper maintenance strategy, the concept of life cycle cost analysis by comparing equivalent annual costs for maintenance work is often used.

During service life, buildings are damaged and become incomplete. As soon as they are built, the process of degradation begins [10, p.50]. The inevitable process of degradation can be controlled during the physical life of buildings and can be prolonged if they are properly maintained [3, p.82]. Building maintenance costs money and therefore even if it is built, maintenance can be planned and specified correctly from the design phases of the building and if the financing is estimated correctly, then the degradation of the building will eventually result [10, p.53]. Buildings can deteriorate for a variety of reasons, of which we will list only a few of the main ones: defective design, faulty of execution, of

maintenance, of materials used in the resistance structure and faulty during the use of the structure.

The importance of the stage of tracking in time the behavior of the construction

Monitoring the behavior of buildings over time is a main activity that takes place throughout the period of operation of buildings, aims at the following main requirements:

- knowledge from the incipient phase of the situations and causes that endanger the aptitude for the normal operation of the construction under the aspect of not fulfilling the quality requirements established by the legislation in force;
- observing the state of the construction in order to detect the deficiencies in its behavior, identifying the degradations and damages resulting from human action (technical incidents, fires, explosions) or natural phenomena (seismic, floods, landslides).

The current monitoring of the time behavior of constructions represents the systematic activity of collecting data on the technical condition of the construction, correlated with the maintenance and repair activity, having as objective the maintenance of the construction at the designed parameters. The current follow-up applies to all constructions of any category or class of importance except the temporary constructions, household annexes and GF + 1F housing buildings.

The current monitoring of the behavior in time is an activity that takes place throughout the life of a construction, starting with the final acceptance of the execution works and until its demolition. The frequency of investigations of a building is done at least once a year and mandatory after the occurrence of exceptional events on the buildings (earthquakes, fire, explosions, etc.). The current monitoring activity of the constructions is performed by the construction engineers who have experience in the field of construction degradation, and the owners or administrators of the construction that have the obligation to carry out these activities.

The results and findings formulated in the current monitoring actions are detailed in a report, which will be presented and explained to the owner or administrator of the construction, so that the technical condition of the building and the correction of possible defects will be informed. This report will be annexed to the technical book of the construction, from chapter D - Documentation regarding the operation, maintenance, repair, tracking of the behavior in time and post-use of the construction.

The owner or administrator is directly responsible for carrying out the activity and applying the intervention measures recommended in the monitoring the behavior over time report, and non-compliance with them entails contravention sanctions, according to the regulations in force.

The documentation detailing the investigation (tracking of execution behavior) will include the following [1, p.8]:

a) degradation phenomena analyzed in the form of visual observations or using simple measuring equipment;

b) areas subject to observation and measuring points;

c) possible works necessary for the arrangement of the measuring and observation devices;

d) measurement program;

e) the way of recording and keeping the data resulting from the measurements;

f) data processing mode;

g) the method of data processing and transmission in order to interpret and establish the need for intervention works;

h) description of the alarm procedure of users and persons directly involved in the situation of identifying the possibility or occurrence of a damage.

Need of maintenance strategies

The existence of maintenance plans allows the implementation of appropriate proactive maintenance strategies over the useful life of the construction, streamlining the allocation of resources and related costs without excessive and unnecessary costs of replacement or repair. The planning of these inspection and maintenance actions must be done according to their own methodologies specific to each construction time that highlight aspects related to elements related to the decision-making level of their prioritization, thus allowing a reduction of extraordinary intervention works and a minimum of interference. of them with the normal activity carried out in that building.

The inspection and maintenance plan must be implemented both in the design phase for new buildings, but also after the assessment of the degradation stage for existing buildings. In both cases, the maintenance plan must be constantly updated in the following phases of the life cycle after it is put into operation, during operation, etc.

The plans should include the main elements of the building that require lifelong maintenance work including the spaces around the building, the structure of the interior and exterior elements, installations and equipment. These investigation sheets must be prepared by specialized technical staff (multidisciplinary teams) for the study of degradation and possible causes with technical staff who have the ability to analyze and evaluate the elements of the project, the behavior of various elements in real operating conditions, various degradation mechanisms, and who have the necessary knowledge

in the field of specialized materials and techniques for damage correction and prevention.

This paper refers to damaged construction elements that can affect the owner's needs (the need to control the active budget with accepted comfort levels without potentially unsafe risks), the important purpose of which is the maintenance of buildings. Defective maintenance can be divided into two categories: maintenance that was performed incorrectly and most frequently - no maintenance was performed throughout the life of the building [5, p.1718].

Dealing with a declining maintenance budget, increasing construction maintenance costs, managing the maintenance of buildings are important tasks to minimize costs during the period of operation of the building [3, p.84]. Therefore, selecting the most effective and proper strategy can lead to an optimal financial allocation of funds. It can also minimize damage to high-performance buildings throughout their life cycle (design, execution, use and demolition).

New approaches are constantly being developed in order to have an efficient management of the maintenance of building components, materials and systems. In this context, there are certain aspects that become very relevant [5, p.1719]:

- Choosing the optimal maintenance strategy based on an analysis of different maintenance policies (is becoming necessary to distinguish the concept of maintenance from other terms normally used in the renovation of buildings, such as renovation, modernization and maintainability [6]).
- Addressing the issue of maintenance globally, building performance and cost-of-life approaches are essential (maintainability is the ability of a functional unit, under given conditions of use, to be maintained or restored in a state where it can perform a necessary function when the maintenance is performed under given conditions and using declared procedures and resources [8]).
- Evaluating building performance as an important procedure that provides recovery based on the performance of construction materials (assess the advantages and disadvantages of the life cycle costs of new materials compared to conventional materials [4, p.130]) and components for future improvements.
- The reliability of the prediction of the service life of a building strongly influences the effectiveness of a maintenance policy.
- The perception of the user’s needs and budget are issues relevant to the actual implementation of maintenance plans.

The present study aims primarily to conduct a documentary research in the field of building maintenance in the literature and after conducting such a documentary study, to conduct also an analysis of domestic legislation on this topic, including in the context of our country's membership of the European Union and compliance with all European directives.

Legislation aspects considering the maintenance strategies

Internationally, most countries have developed specific methodologies and technical regulations for the assessment of technical condition and construction activity equivalent to monitoring the behavior of constructions over time or the operation of constructions. This activity is mentioned in the literature in several forms: "building condition assessment", "condition inspection" or "structural health monitoring". The activity is regularly organized at a minimum level within each country and applies to all constructions, with certain exceptions.

The technical condition assessment procedure is the starting point both in determining the degree of execution of construction works and the evaluation and selection of intervention measures necessary to be applied to all construction elements. In the literature, technical experts have assigned several definitions for the activity of assessing the technical condition of the construction ("condition assessment").

The evaluation of the technical condition of buildings is based on the observance of well-defined stages (both at the level of legislation in the regulations referring to the technical evaluation of existing structures - for example P100-3 / 2019), and the result of the activity is transposed in the form of a technical report or a technical expertise report, prepared with a well-defined frequency. The main disadvantages of this activity are the high costs and the long time needed to prepare the report. A great advantage is the fact that through the continuous, periodic monitoring of the constructions, the causes and degradation factors that affect their aptitudes for exploitation can be identified from the very beginning. In the absence of intervention measures to remove risk factors, especially for those factors that evolve over the life of the construction, their effects amplifying over time, their impact will inevitably eventually lead to the discontinuation of construction use.

At the international level, the assessment of the technical condition of buildings is a component of the quality system in construction. This procedure is complex, requiring solid knowledge, time and adequate equipment to provide conclusive results. It is recommended that the activity be carried out on a regular basis, usually annually or biannually, because the longer the time interval between two evaluations, the considerably higher the costs and the period of development will be, and implicitly, for cases of degradation. evolution (corrosion, water infiltration, etc.) determining the level of degradation includes the use of complex methods and equipment, and intervention and remediation measures will have much higher costs.

The international standard ISO 6241 [7] identifies the main elements to be taken into account when assessing the performance of buildings and their subsystems, in particular with regard to user requirements: stability, fire protection, safety in use, water tightness; air purity, acoustic, visual, tactile, dynamic, hygiene; the adequacy of the spaces for specific uses, sustainability, durability and economy.

In this context, ASCE [2] (American Society of Civil Engineer) defines for example the evaluation of envelopes as the process by which the suitability of their components for the intended use is determined. So, in order to evaluate and improve the overall behavior and performance of envelopes over time, it is necessary to identify the performance of each component part of it over time service life.

In this international legislative context, in this subchapter we will also highlight some of the Romanian legislative provisions in force, in which those at the international level will also be applied. The implementation and permanent improvement of the transposition of the quality system in the European Union (standards, technical norms and technical regulations), is a component of the activity in the field of constructions very complex and of great importance for Romania involving the simultaneous responsibility of all economic, public and private actors, based on a planned, coherent and organized management at all levels of responsibility.

In the current context, four priorities are becoming urgent:

- Transposition in Romania of all regulations, directives, standards and community practices related to the construction field.
- Creating, developing and strengthening the institutional and administrative capacity to facilitate their implementation in conjunction with the implementation of corrective and preventive measures based on the specifics of our country.
- Defining and progressively implementing a national policy in the construction sector according to its strengths and weaknesses, as well as the threats of other sectors.
- Implementation of a national policy in the field of quality in construction, based on performance in all areas of the sector (design, verification, expertise, control and execution).

After 1990, like other Central and Eastern European countries, Romania faced the challenge of rapidly implementing accreditation and certification systems in line with EU quality systems.

Starting with 1993, the process of harmonization of the existing regulations with the regulations of the European Union was initiated. Within the common market of the European Union, the construction market has a significant share and hence the importance given to the system of building regulations. In the meantime, numerous quality assurance and consumer protection regulations have been developed and enacted.

Starting from the responsibility that Romania has as a member of the common market, not only as a producer of goods, but also as a guarantor of quality, we realize that in Romania appropriate technical structures and legislative procedures must be created in order to effectively apply the new legislation. Europe.

European directives set out both the principles of market functioning in the field of construction and the criteria for drawing up technical rules, and how to correlate and interpret the laws, and decrees of the Member States of the Union.

These requirements concern the quality assurance system in constructions according to the European legislation presupposes the fulfillment, the maintenance during the whole existence of the constructions of the following fundamental requirements (from law 10 issued in 1995 and updated recently in 2017, 2019) [9, p.1]: “mechanical strength and stability”; “fire safety”; “hygiene, health and the environment”; “safety and accessibility in operation”; “protection against noise”; “energy saving and thermal insulation” and “sustainable use of natural resources”.

Conclusions

The choice of appropriate solutions depends on the evaluation of the parameters related to durability, functionality, costs involved, accessibility and safety conditions. Construction Designer' s access to technical documents can help to choose an optimal alternative technical level. These should include the procedures to be adopted and the design techniques that allow the behavior of the elements to be predicted from an appropriate and timely maintenance perspective. The study reveals the maintenance strategies at international level correlated with the provisions of the national legislation and will be completed with case studies that correlate the technical solutions with the investment value necessary for their implementation and their effects over time from a cost-benefit point of view.

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