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PERFORMANCE CHARACTERISTICS OF RESIDENTIAL BUILDINGS

WŁAŚCIWOŚCI UŻYTKOWE BUDYNKÓW MIESZKALNYCH

A b s t r a c t

Beauty, utility, durability – these are the immanent features of good architecture and should also be the distinguishing qualities of every residential building. But do beauty and utility remain along with the passing of time? Do the performance characteristics pass?
Performance characteristics are an indicator of both the technical as well as aesthetic state of buildings. Aesthetic needs are in disagreement with the merciless aging process. The beauty of a city is formed not only by the original forms of new residential buildings, but also by existing tenement housing; thus preserving their aesthetics becomes a necessity.

Keywords: performance characteristics, technical condition, aesthetic state

S t r e s z c z e n i e

Piękno, użyteczność, trwałość – to immanentne cechy dobrej architektury, powinny być wyróżnikiem także każdego budynku mieszkalnego. Ale czy z upływającym czasem piękno i użyteczność pozostają? Czy właściwości użytkowe przemijają? Właściwości użytkowe są wskaźnikiem zarówno stanu technicznego jak i estetycznego budynków. Potrzeby estetyki kłócą się jednak z bezlitosnym procesem starzenia. Piękno miasta tworzą nie tylko oryginalne formy nowych budynków mieszkalnych, ale i istniejące kamienice, dlatego też potrzeba utrzymania ich estetyk staje się wyższą koniecznością.

Słowa kluczowe: właściwości użytkowe, stan techniczny, stan estetyczny

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1. BEAUTY

The architecture of a city is a continuously changing picture. New building structures, usually residential, are continuously being created. Space alongside buildings from the past is continuously being filled in with new ones. But the beauty of the city is created by all of these structures, new buildings as well as those dating further back; beauty lies in the original style of modern forms, but also in the sentimental relics of the past.

The passing of time brings about new tasks – the preservation of beauty. Maintaining residential buildings in an adequate technical condition is of utmost importance when creating the image of a city, while their aesthetic state is a reflection of their technical conditions. The renovation of buildings is inevitable. Aesthetic requirements combined with requirements in terms of the technical state of the building necessitate many actions. The scope of works in residential buildings is always of an individual nature. It may rely on the conservation of detail, or may involve the modernization of a tenement house: "beautifying, improving appearance – thus something added to the initial form for the sole purpose of decoration is commonly accepted,"[1]. The needs of our civilization's development often necessitate the modernization of historic building structures or their adaptation to modern-day needs. New elements are introduced in an environment of landmark buildings in two ways, as new architectural forms directly attached to the fabric of historical buildings or in their nearest proximity. Modern-day additions, when it comes to aesthetic value, are in harmony with buildings of the past and do not blur the differences between that which is new and that which is old. The idea behind modernization and adaptation is to combine the historical magic of relics with the language of contemporary architecture in common dialogue. The coexistence of landmarked buildings and modern architectural forms is currently an inseparable element of the landscape. Reconstructions, expansions, and insertions of infill buildings in frontages are all being carried out.

The interiors of historical objects subjected to renovation which incorporates contemporary details into the historical design one-of-a-kind. The original ceilings, columns, woodwork, balustrades or brick walls combined with bold lines and bright modern colours of modern-day solutions give the interiors a unique character. Connecting history with the contemporary ideas of a designer results in the creation of inimitable objects.

All buildings demand attention, especially those closest to people – residential buildings. Aesthetic requirements, which stem from the passing of time, are most focused on these buildings.

2. DURABILITY

Time is continuously passing and along with it, aging intensifies. The aging process is a natural phenomenon for every material. The life expectancy of building materials is also limited.

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[1] W. Bonenberg, *Ornament dziś: zbrodnia czy chluba?,* Czasopismo Techniczne, iss. 15, nr 5-A/1/2012, Wyd. Politechniki Krakowskiej, Kraków 2012.

Residential buildings are constructed with different building materials, which vary in terms of quality. Along with the passing of time, they age, lose their performance characteristics, and undergo natural wear and tear. Materials in the buildings are different and characterized by various, each their own, defined life expectancy periods. The processes of aging, wear and loss of performance characteristics do not take the same course in each fragment of the building. The roof cover is not as durable as the structure of the roof trusses. The life expectancy of a wooden roof truss structure is shorter than that of load-bearing walls.

Passing, however, is not inevitable. "Enduring is not only the permanence of form and substance as in a pyramid. Enduring takes place by the rebirth of forms, repetition and recreation from a new substance"[2]. In the modern-day world, the protection of cultural heritage is connected with the needs of civilization. Historical objects are used. The modernization of historical structures and their adaptation to modern needs is inevitable: "Modern-day conservation doctrine is based around changing the emphasis from instrumental to more personal treatment of a relic, the concept of which evolves over time, nowadays signifies not only an increasingly extensive scope of protection but also the multiplication of meanings which this relic is a carrier of"[3]. Dynamic changes taking place around the world and technological advancement are completing the guidelines of the Venice Charter. General assumptions regarding the different approaches to handling relics of course remain. The rules of fully respecting the original substance or choosing solutions which do not harm the object are always current. The rule of minimal interference calls for maintaining form and substance, however it does not exclude introducing contemporary elements. These elements may not distort the historical content. A following rule regarding the clarity and distinctiveness of the insertions also allows for contemporary additions

The permanence of buildings, including residential buildings, is shaped not only by the forces of nature but also by the activities of humans. A long lifespan is ensured by carrying out ongoing, systematic renovation-repair works. It is thanks to them that buildings derived from past centuries are still being used, and their market attractiveness is not decreasing.

3. USABILITY

Along with the passing of time, the technical state of residential buildings continuously deteriorates. With the passing of time, the aesthetic values and preferences of users of flats change and the usability of the building decreases.

The modernization and adaptation of historical objects is the result of ever-changing human needs. Adapting post-industrial objects in residential areas for modern-day uses has become something of a trend. The beauty of a historical building, however, has made it so that the changes carried out in the object are small. The novelties introduced are essentially fitted into the existing architecture. The needs of our civilization's development continue to increase, and the performance requirements of buildings are, therefore, becoming increasingly

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[2] J. Królikowski, *Trwanie architektury. Kilka uwag*, Czasopismo Techniczne, iss. 14, nr 4-A/2011/1, Wyd. Politechniki Krakowskiej, Kraków 2011.

[3] A. Kadłuczka, Idea zrównoważonego rozwoju a problemy ochrony dziedzictwa kulturowego na przykładzie Florencji i Krakowa, Wiadomości Konserwatorskie/Conservation News, 23/2008, p. 7–16.

higher. Increasing performance requirements and the coexisting problems of a deteriorating technical state pose a challenge when using residential buildings. Serving as indicators of the scale of these problems are so-called performance characteristics. Seeking effective methods of preserving the beauty of the architecture of existing residential housing is strongly connected with the assessment of these very performance characteristicp.

4. SERVICE LIFE

The secret behind connecting the problems of maintaining a proper technical and aesthetic state with the problem of the passing of time results from familiarity with change processes in performance characteristics. These characteristics are a set of properties determining the technical and aesthetic state of the building.

In accordance with the recommendations of the currently binding standards regarding "planning the service period", an assessment of the performance characteristics of a building ought to be carried out, and changes in these properties over time predicted by designing methods simulating the anticipated degradation of the material over time. The standards provide general guidelines on issues concerning the prediction of the service life of a building. The International Standards Organization (ISO) developed these guidelines based on the results of extensive CIB W080/RILEM 175 SLM research – "Service Life Methodologies Prediction of Service Life for Buildings and Components"[4], carried out by the International Council for Building (CIB) along with the RILEM Technical Committee (Technical Committee "International Association for Building Materials and Structures). The standards contain an introduction to the predicted performance characteristics. They emphasize the difficulties in indicating degradation even in the case of similar buildings because, in practice, there are many variables that influence their service periods. The variety of buildings, environments, surroundings, quality of construction works and future standards of upkeep result in uncertainty when predicting the service life[5].

Negligence in maintenance and repair is the main reason for the decline of the technical value of a building. With the passing years, the repair needs are growing, and the absence of such work results in the loss of the usability value of a building. In order to maintain the existing buildings, it is necessary to solve problems associated with the prognostication of the repair needs.

An adequate level of residential building reliability can be ensured by properly carried out renovation work. The accurate prediction of changes in efficiency as well as preventive renovation work will allow the building to be exploited efficiently. In the realization of these tasks, the building is treated as a system made up of individual components. The predictive model of maintaining the technical condition of the building is based on the adaptation of principles applied in the utilization of technical equipment. Applying optimal prophylactic replacements requires a knowledge of the time span that the components of the building can be expected to work properly. Modelling various scenarios of use helps to choose the optimal

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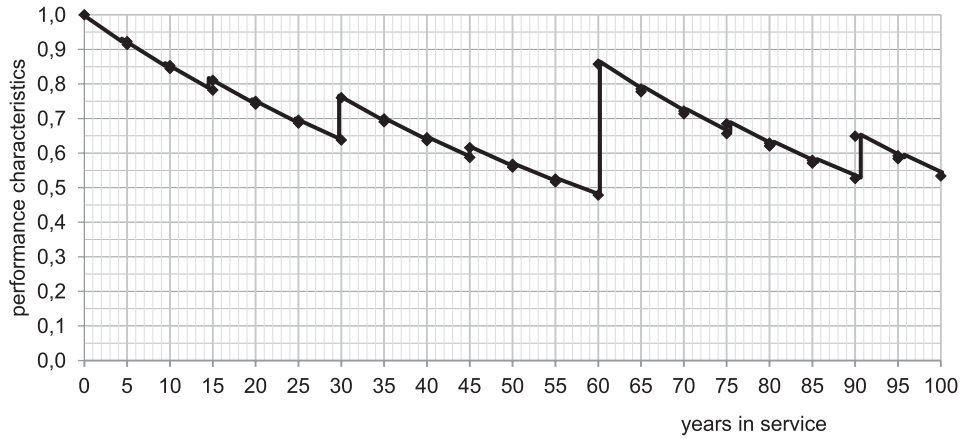
[4] L. W. Masters, E. Brandt, *Systematic methodology for service life prediction of building materials and components*, Materials and Structures nr 22(5)/1989.

[5] T. Moan, *Life-cycle assessment of marine civil engineering structures*, Structure and Infrastructure Engineering: Maintenance, Management, Life-Cycle Design and Performance nr 7, 2011.

planning of renovation works on a building. The characteristics of various strategies influence the shape of the life cycle curve of the building.

All appliances are built from parts. Similarly, each building consists of many components. These elements, which fulfil different functions, are made of dissimilar materials, each has different properties, and different durability periods. In order to determine building reliability it is divided into components which are analysed, first separately and then altogether in the entire building. A building constructed in the traditional technology is a system containing dependent and independent components. The complex structure of a building, elements of which form a heterogeneous system, implies the need to decompose the object into subsystems. The operational reliability of each object depends on the reliability of its components. However, the reliability of the set of those elements cannot be determined by just calculating their arithmetic mean. Various damages cannot be weighed equally. For example, damage to internal plasters cannot be valued the same as collapsing ceilings, or floor destruction as the failure of a sewage system, etc. The most significant are the components which perform basic functions during use. Other auxiliary components affect the reliability of the object to a lesser extent, and their effect is primarily due to the fact that any damages to auxiliary components may cause changes in the parameters of basic components.



Ill. 1. Life cycle curve of residential building – example

During the entire service period, the performance characteristics of a building deteriorate as a result of technical wear. An increase in performance characteristics (ill. 1) may occur as a result of conservation, preventive measures, modernization, replacement of elements, or overhaul and rebuilding.

The degree of wear of an object is a value that changes over time, subject to constant destructive changes lowering the utility of the object. Predicting technical states which will occur in the future can be helpful in establishing proper methods of repair work on the object.

The time of exploitation during which the components lose their exploitation properties depends on many factors: the material quality, the structural solutions, the performance quality of the building erection works, the influence of the environment, the way and conditions of building exploitation. The factors may occur with various frequency and intensity. Due to the complexity of the phenomena, the durability periods are time periods of various lengths. For respective building components and solutions, average durability periods may be assumed. They are values for average performance quality of the building erection works and building exploitation as well as average environmental conditions.

The proposed periods of carrying out planned-preventive renovations were initially determined based on experiments as well as on the ending life cycles of the building components. The proposed renovation works that aim to maintain the building in a good, satisfactory or average technical state, are based on prophylactic action, and prevent the premature onset of unfavourable changes.

Due to the various reasons for damage to building components occurring with random intensity and frequency (e.g. the influence of atmospheric processes is different on each floor of a building; traffic intensity may cause different damage to buildings of identical structure-material solutions; similarly, different ways of building maintenance, topographic conditions; neighbouring trees and many other factors), the periods of component durability may vary considerably from the ones assumed, and thus, the change in the exploitation reliability within an exploitation period will be different. Therefore, the changes in the exploitation reliability in the subsequent years of exploitation presented in the figures should be treated as approximate.

5. TECHNICAL PROBLEMS OF RESIDENTIAL CONSTRUCTION

The results of the analysis of hazards, failures and disasters of building structures presented by L. Runkiewicz[6] shows that, of the different building technologies, the majority of them occur in masonry constructions (44%), and in terms of various types of buildings – in residential ones (41%). Building stock is a significant indicator of our standard of living and comprises an increasingly higher part of tangible national assets. Maintaining a building in good condition necessitates ensuring the technical efficiency of its elements, use value and aesthetic requirements of the building. The level of intervention in the building aimed at removing irregularities may vary and be distributed differently over time as the components are characterized by various life expectancies.

One of the most important problems connected with using any building, but especially a residential building, is ensuring an adequate technical condition. The most effective type of renovation works are preventive measures based on securing the buildings against damage.

The continuous degradation of buildings and the resulting high costs of repairs and renovations have made the problem of optimal renovation prediction extremely important. However, in Poland, maintenance planning is not seen as a long-term system. Repairs are

[6] L. Runkiewicz, *Zasady kontroli i oceny jakości remontów i wzmocnień konstrukcji budowlanych*. Zeszyt Naukowy Politechniki Wrocławskiej Nr 71, Wrocław 2008.

approached as a temporary measure, and are carried out exclusively on the basis of periodic controls and inspections. Additionally, there is a series of disadvantageous tendencies as far as maintenance planning is concerned. First of all, the technical needs are not fully recognised, which is accompanied by inappropriate planning of tasks and means, which is based on finance funds resulting from the assigned limits.

In order to program the repair and renovation works, the prognostic determination of the scope of work in terms of the kind and quantity is necessary. The repairs should include preventive actions aimed at assuring that no damage will occur to the building.

The prospect of maintaining residential buildings in an adequate technical state calls for the optimal planning of renovation work, while proper determination of the scope and program of the renovation requires a diagnosis to be made. Diagnosis is the basis for properly carried out renovation work. The term "diagnostics" is derived from the Greek work "diagnosis" – identification, differentiation, evaluation. Technical diagnostics in the encyclopaedic sense is a field of studies which covers the assessment of the technical conditions of a building and its ability for proper future service. The diagnosis pertains to the assessment of the technical conditions as well as predicting the development of and change in the condition, the reasons behind such development or change, as well as a combination of all of the above. The technical condition is strictly connected with the aesthetic state.

Maintaining an adequate level of operating efficiency for each technical structure requires the application of supplementary solutions which support the diagnosis of damage and optimal planning of renovation work[7]. Familiarity with changes in the performance characteristics, e.g. as in Fig. 1, is an excellent prediction of detrimental changes in the building. The prediction of changes can be the basis for assuming proper decision strategies when planning renovation activities in residential buildings[8].

Technical diagnostics seen as a procedure of predicting operational reliability allow us to conclude that the analysed parameters of buildings constructed using traditional technology can prove to be a useful tool for those managing these objects. An approach directed at predicting when damage will occur will facilitate the optimal planning of renovation work on buildings over the course of the entire period they are in service.

6. PAST, PRESENT AND FUTURE

The world of architecture is treated as an indivisible whole, as a vast space without boundaries between the past, present and future; not limiting the territories for observation, it provides a feeling of freedom in seeking architectural forms"[9]. The coexistence of the past with the present is most felt in residential architecture. This stems from the awareness that a building in the sense of a house always has sentimental value.

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[7] Z. Janowski, *Diagnostyka, modernizacja i rewitalizacja budowli zabytkowych*, Materiały konferencyjne 56 Konferencji Naukowej KILiW PAN i KN PZITB, Krynica 2010.

[8] A. Sobotka, R. Bucoń, *Kierunki rozwoju metod przewidywania okresu użytkowania obiektów budowlanych*, Problemy Rozwoju Miast, nr 4/2005.

[9] M. Misiągiewicz, *Archiwum pamięci*, Czasopismo Techniczne, iss. 14, nr 4-A/2011/1, Wyd. Politechniki Krakowskiej, Kraków 2011.

Shaping the longevity of residential buildings is connected with familiarity with the technical problems of passing; however, the secret of lasting is found, above all, in the propagation of aesthetics. The features of architecture specified by Vitruvius are always current, which also holds true for residential buildings: the magic of beauty changes use and extends durability.

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[9] Sobotka A., Bucoń R., *Kierunki rozwoju metod przewidywania okresu użytkowania obiektów budowlanych*, Problemy Rozwoju Miast, nr 4/2005.