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The Method of Prediction of Deformations of Buildings and Failure Analysis the Examination of Technical Condition of Buildings

Olexander Terentyev[1], Malyna Bohdan[2]

[1]Kyiv National University of Construction and Architecture, 31, Povitroflotskiy Ave, Kyiv 03680, Ukraine

[2]Kyiv National Aviation University, 1, prosp. Kosmonavta Komarova , Kyiv 03058, Ukraine

Abstract: ***Objective assessment of technical condition of buildings is one of the main objectives of the system of technical supervision. Its implementation is based on periodic and unscheduled inspections of structures with identifying and fixing their flaws and faults, determining the extent of damage (wear) structures and further calculation that summarizes the condition of the structures with respect to their importance in the composition of the object on the technical condition of the latter.***

Keywords: examination, the technical condition of the building, an assessment method category.

1. Introduction

In the operation and design of buildings it is necessary to determine the behavior of structures of buildings over time. Technical inspection of buildings to determine their strength and deformation properties at the time of the survey. However, to conclude that further exploitation, the establishment of lifetime and repair of buildings necessary to know the change in these properties over time taking into account the accumulation of damage and other factors [1].

2. The problem

Three distinct stages of deformation of buildings [2]:

1) 1 stage - the stage of the load of the building for up to 1 year, which occurs primarily flexible work structures;
2) 2 stage - stage operation with a duration of several decades, during which the process of accumulation of damage and inelastic deformations in time. Working designs is derived from the operational loads in the elastic stage;
3) 3 stage - emergency stage of destruction, occur within a few days, followed by a groundswell of deformations.

Given the small life of the building in stages 1 and 3, to assess changes in the strength and deformation properties over time adopted a design scheme, based on the work of the building in the operation stage.

Example 1. You need to determine the period of operation before the occurrence of an emergency condition and the deformation of the building structure on the basis of survey data. On the basis of the survey it was observed a reduction of design bearing capacity of building structures due to the destruction of the columns from the corrosion of concrete. For reinforced concrete columns the building after 10 years of operation, the load capacity at the time of the survey is about *0.85* times the magnitude of the design load capacity. The maximum relative deformation of concrete columns, working in compression, when destruction is the average for the reference data $u_{\max} = 0{,}002$, the calculated resistance of concrete in compression $R_b = 7{,}5 МПа$, the initial modulus of elasticity of concrete $E_b = 21.10^3 МПа$.

Relative deformation of concrete columns under design loads:

$$u_c = R_b / E_b = 7{,}5/21/10^3 = 0{,}0003. \quad (2.1)$$

The maximum relative deformation in the accident:

$$u_a = u_{\max} - u_c = 0{,}002 - 0{,}0003 = 0{,}0017. \quad (2.2)$$

The relative reliability of structures:

$$y = 0{,}85 y_0 / y_0 = 0{,}85. \quad (2.3)$$

Constant wear:

$$\lambda = -\ln y / t = -\ln 0{,}85/10 = 0{,}016. \quad (2.4)$$

Lifespan prior to an emergency condition of the building structures since the beginning of operation:

$$t_a = 0{,}5/\lambda = 0{,}5/0{,}016 = 31 \text{ years.} \quad (2.5)$$

The deformability coefficient:

$$\beta = \lambda u_a /(e^{\lambda t} - 1) = 0{,}016.0{,}0017/(c^{0{,}016\,31} - 1) = 4{,}25.10^{-5}. \quad (2.6)$$

Relative longitudinal deformation of the columns using *t=10* years of operation (the time of the survey):

$$u + u_c = \beta(e^{\lambda t} - 1)/\lambda = 4{,}25.10^{-5}(e^{0{,}016\,10} - 1)/0{,}016 + 3.10^{-4} = 0{,}0008. \quad (2.7)$$

Example 2. For reinforced concrete buildings after 6 years of operation, the bearing capacity of structures was *0.85* normal secure. You need to determine the time until the occurrence of an emergency condition.

For this building are:

$$y = 0{,}85 y_0 / y_0 = 0{,}85. \quad (2.8)$$

Constant wear:

$$\lambda = -\ln y / t = -\ln 0{,}85/6 = 0{,}027. \quad (2.9)$$

Life before the onset of an emergency condition:

$$t_a = 0{,}5/\lambda = 0{,}5/0{,}027 = 18 \text{ years.} \quad (2.10)$$

The time of occurrence of an emergency condition based operation before the survey is *18 – 6 = 12 years.*

The obtained data allow to quantify the usability of the building structures, thereby increasing their reliability.

3. The Damage Analysis of Buildings

The ultimate goal of the diagnosis of such injuries is to establish the reliability of the building and the possibility of its exploitation [3]. For this purpose it is necessary to analyze the damage detection of building structures by the following parameters:

- risk of structural failure and the destruction of one design destruction while other structures and buildings in General, thereby forming a progressive collapse;
- increase the magnitude of damage to structures over time; the impact of structural damage on the durability of the building, and the possibility and feasibility of repair of damaged structures;
- level responsibility of the building;
- comparison of assessment of technical condition of building structures on the basis of his damage with data from other assessments: test calculations of structures, experimental research.

Influence the risk of destruction on other structures and buildings in General can be evaluated based on the knowledge of the constructive scheme of the building and the calculation of its designs. Special attention must be paid to ensuring the overall sustainability of the building.

Quite often, the destruction of some structures lead to the collapse of other structures and buildings in General. Approximately the impact of the destruction of some structures may need to be assessed by the ratio value.

Weight structures shall be established on the basis of expert estimates that take into account the consequences of the destruction of certain types of structures, the impact of a possible failure of certain types of structures on the collapse of other structures, destruction of nature.

For example, the destruction of the national team of the slabs of the first floor of a multistory building has little effect on the stability of other structures, while the collapse bolt this overlap will cause the collapse of several plates. The collapse of a same column of the first floor will lead to the collapse of the ceilings on all floors.
Overall assessment of damage to the building can be evaluated:

$$e = (a_1 e_1 + a_2 e_2 + ... + a_n e_n)/(a_1 + a_2 + ... + a_n), \quad (3.1)$$

where e – the damage of the building; e_1, e_2, e_n - average damage of certain types of structures; $a_1 + a_2 + ... + a_n$ - the significance of individual coefficients kinds of designs.

Certain types of damage to structures pose no danger to the strength and stability of the building, but they reduce the durability of the building. For example, roof leaks cause rotting of the wooden floors, the destruction of anti-corrosion coating leading to corrosion of steel supporting structures, which in turn will make them unfit for use.

In addition to the magnitude of damage to structures is necessary to know the number of damaged structures in relation to their total number, including sites of their mates. It is believed that when the number of damaged structures having critical defects more than 60% to their total, the renovation of the building is impractical and it is subject to demolition. When the number of damaged structures less than 60% recovery structures produced without dismantling of the structures that remained.

The assessment of the technical condition of the building on the basis of existing damage it is advisable to compare with data verification calculations of structures. This may occur for the following cases:

- examination of the structures reveals signs that the structure is in disrepair and verified by a verification calculations;
- examination reveals signs of an emergency condition of structures, but checking calculations do not confirm this;
- results of test calculations indicate the presence of an emergency condition, and the results of the survey of the signs of this condition no.

In the first and second cases should be considered that there is an emergency condition of the structures. While in the second case should be analyzed checking calculations. Perhaps the design has a hidden internal defects, which are not considered in the calculation or when calculation is incorrect accepted design scheme.

In the third case, it is necessary to additionally examine the design, specifying a valid calculation scheme and the existing regulatory burden, comparing it with the design value and to identify the design additional internal reserves that justify the increased carrying capacity of the structure due to the spatial work of redistribution of effort due to deformation, work structural reinforcement in reinforced concrete elements.

4. Conclusion

In the analysis of damage to buildings must be set: the maximum damage of certain types of structures and the risk of progressive damage of the building, the number of damaged structures in relation to their total number), the influence of damage on the durability of the building, type and feasibility of repair of the damaged structures, the possibility of exploitation of the building.

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Author Profile

Mr. Olexander Terentyev received B.Sc. and M.Sc. degree in information and computer science and the PhD. degree in information technologies" Kyiv national University of Construction and Architecture, Ukraine, in 2001, 2002 and 2009, respectively. Since 2006 associate professor, and since 2009 associate professor at the Department of information technology, Kyiv national University of construction and architecture, Ukraine. From 2002 – junior research fellow, and from 2008 to the present time – senior researcher, head of sector studies of buildings and structures of the State enterprise "State research Institute of building production, the Ministry of regional development of Ukraine". The author of numerous research, design and many other scientific works.

Mr. Malyna Bohdan received B.Sc. and M.Sc. degree in Computer Technology Building and Architecture in National Aviation University, Ukraine in 2012 and 2013 respectively. In parallel with study work in sector studies of buildings and structures of the State enterprise « State research Institute of Computer Technology Building and Architecture », as junior research fellow. Since November 2014 is a graduate student of the Kiev National Aviation University, Ukraine in the direction of Computer Technology Building and Architecture.