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Results of technical inspection monitoring of the operation object

Результаты мониторинга технического обследования объекта эксплуатации

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Ключевые слова: физический износ; техническое обследование; контроль результатов; условия эксплуатации; действительный возраст (с учетом условий эксплуатации); хронологический возраст

Abstract. The article proposes analysis tool of the engineering survey series results. Analysis is based on a study of the physical depreciation accumulation by capital construction objects and deterioration models presented in it for various classes of structural schemes. The main provisions and user activity sequence with a brief explanation of the possible obtained results were clarified through steps. The proposed tool will allow timely detection of factors that cause the accelerated dynamics of deterioration (exceeding the normative one), reduce the risk of an accident, increase the expenses of element/object servicing, and also accurately predict the future costs of repair and construction activities. One of the advantages of this tool is a low capital intensity in the prosses of implementing and further using of tool by the real estate company. However, in the long term, the effect of the application will be expressed in the timely detection of errors in the conduct of buildings and structures surveys. Its result will be minimizing the deviation of the estimated (planned) costs of repair and construction work from the actual.

Аннотация. В статье предлагается инструмент анализа результатов серии обследований, основанный на исследовании о накоплении физического износа объектами капитального строительства и представленных в нем моделях износа по различным классам конструктивных схем. Пошагово разъяснены основные положения и последовательность действий пользователей с кратким разъяснением возможных полученных результатов. Предложенный инструмент позволит своевременно обнаруживать факторы, вызывающие ускоренную динамику износа (превышающую нормативную), снизить риск аварии и увеличение затрат на обслуживание элемента/ объекта, а также максимально точно спрогнозировать будущие затраты на проведение ремонтно-строительных мероприятий. Одним из преимуществ предложения является низкая капиталоемкость при внедрении и дальнейшем использовании инструмента эксплуатирующей недвижимость компанией. Вместе с тем в долгосрочной перспективе эффект от применения будет выражаться в своевременном выявлении ошибок при проведении обследований зданий и конструкций, результатом чего станет минимизация отклонения расчетных (планируемых) затрат на проведение ремонтно-строительных работ от фактических.

Introduction

The problem of dilapidated and dangerous housing remains topical in Russia not for the first decade. In the 1990s during the period of market economy development the condition of housing stock had been deteriorated: building operation had come down just to the exploitation, there were almost no maintenance of the normative state. A large number of researches of domestic scientists confirms the relevance of the problem [1–5].

As far as social and economic situation was stabilized and institute of housing and public utility services was developed situation began to change for the better. First of all standard technical documentation was actualized and it keeps updating, building inspection and repair works are carried out. Some buildings still are not regularly repaired and there are still some violations of repair technology, but scales have considerably decreased.

It is noted that specific weight of dilapidated and dangerous housing in the total area of all housing stock gradually decreases. From 2007 to the beginning of 2014 the amount of dilapidated and dangerous housing stock in absolute terms remains almost at the same level that is caused by the following factors:

- high intensity of new construction;
- continuous allocation of financing for major repairs and refurbishment works;
- regional measures, for example, there is a program in St. Petersburg for renovation of the first mass series of housing (Khrushchev-era housing).

The main indicators of housing stock development in Russian Federation are given in Table 1. Data for the table was taken from the official sites of the government statistics [6, 7], in case of absence of information data was completed by other source (in the table it is marked as "*") [8].

Table 1. Dilapidated and dangerous housing stock of Russian Federation (at the end of year) volume of construction and major repairs

	Dilapidated housing stock, mln m²	**Dangerous housing stock, mln m²**	**New construction, mln m²**	**Major repair and reconstruction, mln m²**	**Cost of major repair, mln m²**
1990	28.9	3.3	49.30*	n/a	n/a
1995	32.8	4.9	41.00*	n/a	n/a
2000	56.1	9.5	36.4	n/a	n/a
2005	83.4	11.2	54.8	n/a	n/a
2006	83.2	12.7	50.60*	n/a	n/a
2007	84	15.1	61.20*	n/a	n/a
2008	83.2	16.5	64.10*	0.2	120.57
2009	80.1	19.4	59.90*	0.28	137.47
2010	78.9	20.5	70.3	0.63	107.82
2011	78.4	20.5	77.2	0.1	76.11
2012	77.7	22.2	82	0.16	128.95
2013	70.1	23.8	70.50*	0.04	80.23
2014	69.5	23.8	87.1	0.08	67.9
2015	н/д	н/д	83.8	0.06	71.29

Due to the current economic crisis stagnation or even regress of the outlined positive tendency in housing and public utility branch is expected. So it is known that in St. Petersburg some quarters of "Khrushchev-era housing" are supposed to be excluded from the program for renovation in the nearest future. However, dramatic recession will not happen again.

Responsible owner or operating company are always interested in increase of useful lifetime of the building and improvement or maintenance its operational properties at the necessary level. Along the planning of repair and construction works (RCW) the problem of forecasting of works volume and required capital investments is especially complicated.

Practice shows that qualitatively conducted technical inspection of the building, which authentically reflects the current situation, promotes timely repair and construction works and also provides an optimum finance and time expenditure.

Market monitoring showed that there is a big price difference in services of technical inspection. Companies which offer price much lower than average market price, raise big doubts. High-quality inspection requires special equipment, so, its cost has to be put in cost of technical inspection. A lot of companies give low quality reports, work of such companies is oriented to the "flow".

The problem of competence of technical inspections exists and is discussed at the field-specific events (conferences, seminars, etc.) by the practicing experts and scientific community, for example, [9-11], and also is considered in the researches and works by authors [22-27].

Literature review showed that at the present time a lot of researches on methods of scheduling of (RCW) and problems of inspection of separately taken structural elements or the whole building (construction) are conducted [12-18], it is separately possible to allocate works of P. Christoua, K. Alatorella, J. Bhandari and M. Cassar [28-31]. However there are almost no works analyzing consequences of an incorrect technical evaluation and possible methods of tracking correlation between results of technical inspection and previously conducted inspections and also their coordination with accidents and repairs during the period between inspections.

The conscientious owner or operating company conducts inspection of technical condition of an object with a certain frequency. According to All-Union state standard 31937-2011 "Buildings and constructions. Rules of inspection and monitoring of technical condition" for the structures working in normal conditions the first technical inspection after placing facility in operation is conducted not later than in 2 years, further at least once in 10 years.

Thus, during operation of the capital building the whole series of planned and unplanned technical inspections will be carried out. The comparative analysis of two and more consistently executed technical inspections of an object can be very interesting from the point of view of monitoring of technical condition in the course of time and possibility of forecasting accidents with help of indirect signs.

Methods and Results

The instrument for analysis of results of series of inspections can allow the following:

- identify possible mistakes of each technical inspection. As it was mentioned competently executed technical inspection allows predict future costs of repairs;

- timely find factors which cause accelerated dynamics of depreciation. Accelerated physical deterioration of construction conceals in itself two dangers: growth of risk of an accident and increase of maintenance costs. Both of them contradict the main postulates of effective operation;

In the Figure 1 the flowchart of control of results of technical inspection of the operated object is submitted.

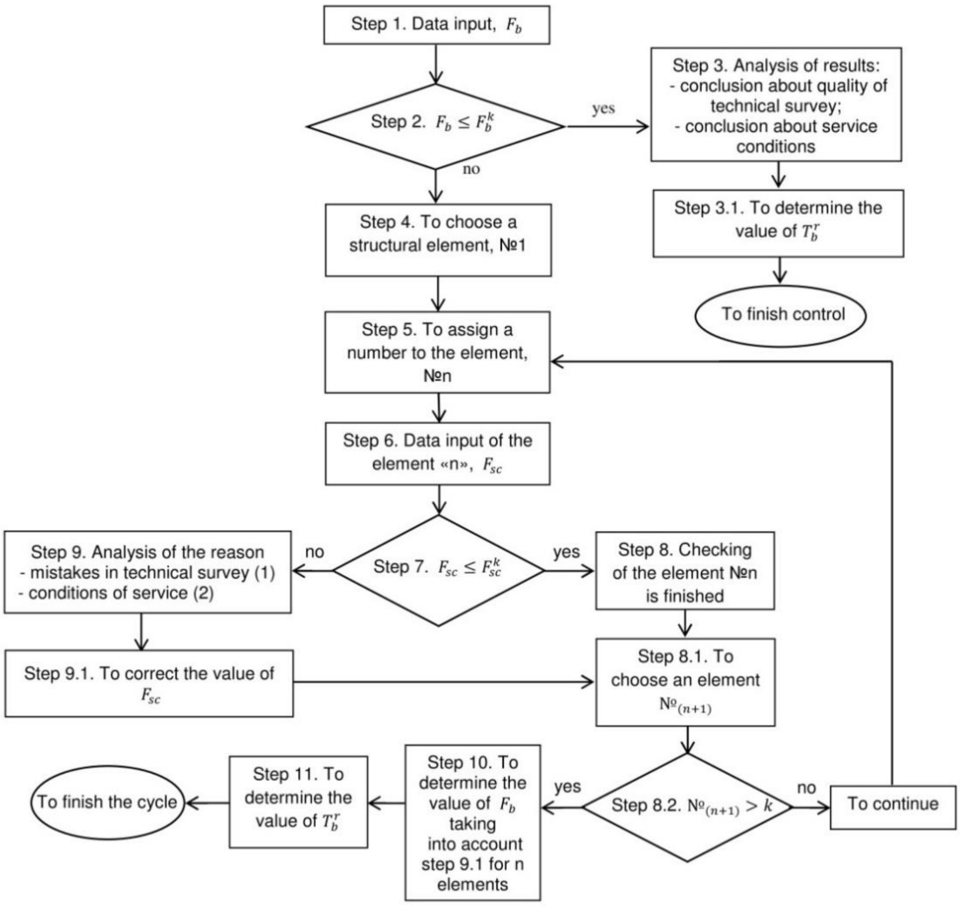

Figure 1. The flowchart of control of results of technical inspection of the operated object

Fb – physical deterioration of the surveyed object;

Fbk – control value of physical deterioration, is identified strictly by the actual age of the surveyed object;

Tbr – actual age of the surveyed object, considers service conditions (during analysis of results of the first technical survey it is accepted as equal to chronological, for the subsequent - as the sum of actual age defined at the previous inspection and the number of years between inspections);

Fsc – physical deterioration of the structural element №n;

k – total quantity of the elements;

Fsck – control value of physical deterioration of the element, is identified by the actual age of the surveyed object or the element, for example, if he was replaced.

Discussion

Let us consider features and restrictive conditions of application of a technique:

1. On the step 2 it is necessary to compare physical deterioration F_b, of the building determined during technical inspection and control value F_b^k, determined by one of possible techniques. The analysis of different techniques of calculation of physical deterioration by its valid and standard service life is carried out in work [19]. Most of the described dependencies take into consideration the lifetime of the building. However it is known that building materials and, respectively, structural elements even with similar standard service life can have schedules of a physical deterioration which are different in type of curvature, as the main applied building materials have dissimilar characteristics of plasticity, susceptibility to fatigue failures, elasticity, fragility, ability to work for compression or bend etc. Besides most of developments consider certain normal service conditions without taking into account, for example, climatic conditions and other features of external "aggressors".

Thus, using of these dependences can give very accurate calculation of physical deterioration depending on service life for one objects and essential mistake for others.

There is also more modern research [20] based on processing of representative selection of 1 880 147 buildings in different technical condition and of different years of construction. The advantage of this research is that there is represented how physical deterioration of buildings of different construction design depends on time, that is more convenient for the final consumer. Restriction – the subject of research were buildings of Moscow region, so, for example, for northern latitudes using of these dependences can be referred to controversial issues.

Nevertheless, the research confirms previously set judgment, fig.3 shows that for each type of design its own curve of accumulation of physical deterioration is determined. Interpretations of constructive schemes CS-1 – CS-13 are given in Table 2.

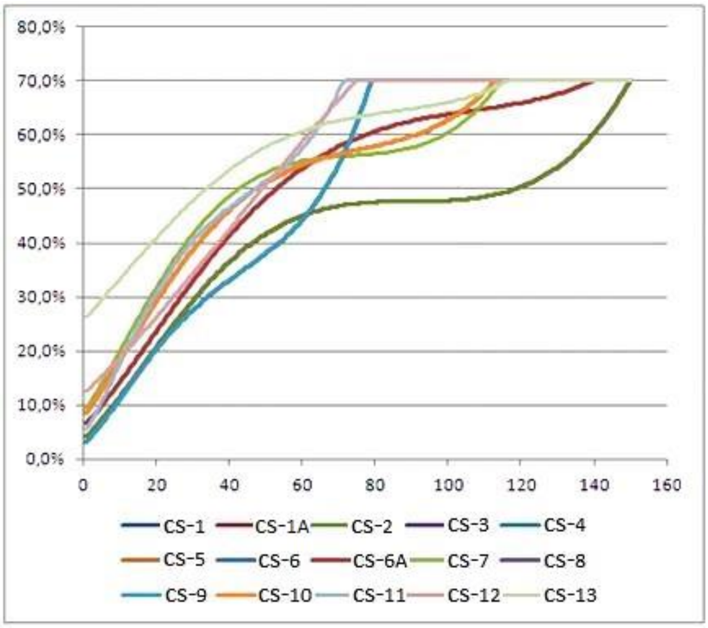

Figure 2. Graphic display of models of physical deterioration depending on classes of the constructive systems "CO-INVEST"

Table 2. Description of constructive systems

Class of the constructive scheme	Basic material
CS-1	Enclosing structures – brick; bearing structures – reinforced concrete, steel
CS-1A	Enclosing structures – small cellular and layered wall blocks; bearing structures – reinforced concrete, steel
CS-2	Enclosing structures – brick; bearing structures – wood
CS-3	Enclosing structures – reinforced concrete; bearing structures – reinforced concrete in frameless systems
CS-4	Enclosing structures – reinforced concrete; bearing – reinforced concrete in frame systems
CS-5	Enclosing structures – reinforced concrete; bearing structures – steel
CS-6	Enclosing structures – thin metal sheet and effective heat-insulating materials; bearing structures – reinforced concrete, steel
CS-6A	Enclosing structures – glass; bearing structures – reinforced concrete or steel frame
CS-7	Enclosing structures– wood; bearing structures – wood and other construction material
CS-8	With primary application of nonmetallic materials and concrete
CS-9	With primary application of cast reinforced concrete
CS-10	With primary application of prefabricated concrete
CS-11	With primary application of constructional steel
CS-12	With primary application of steel pipes
CS-13	With primary application of wood
CS-14	With primary application of cables and leads
CS-15	Site improvements (planting)

Let us give an example of definition of control value of physical deterioration F_b^k using as example building of CS-7 (enclosing structures – wood; bearing - wood and other construction material), which actual age on date of survey is 50 years (Figure 3).

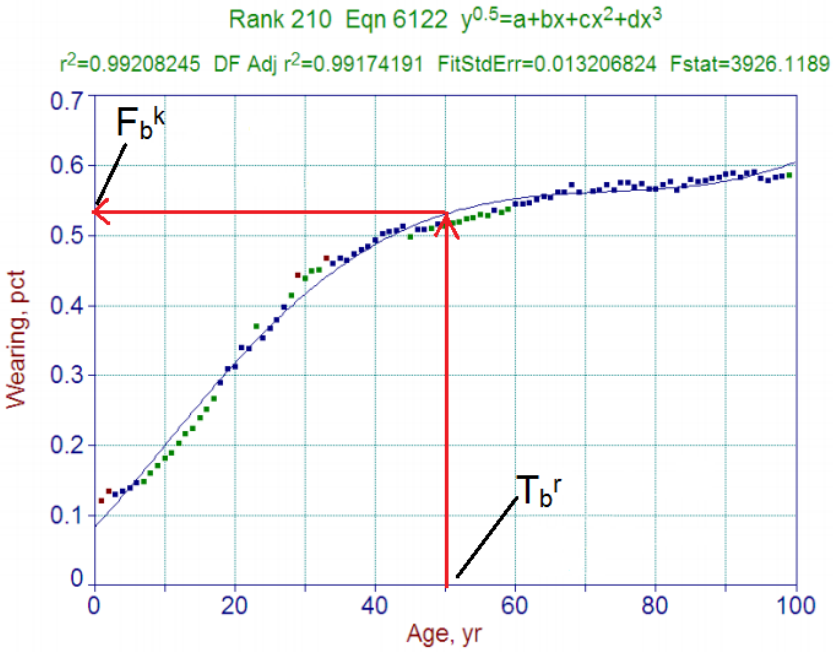

Figure 3. Graphic method of definition of control value by the form and characteristics of the model of physical deterioration for CS-7

Conclusions on the step 2 are very important, also for the analysis of results of the subsequent technical surveys:

a) if physical deterioration after survey is equal to its control value (F_b=F_b^k), then it means that service conditions are normal: object is operated in accordance with requirements of the project and standard technical documentation, repair and operational events are held on-time; actual age of the object (T_b^r), taking into account service conditions, is equal to the chronological age (T_b^t).

b) if physical deterioration after survey is less than its control value (F_b<F_b^k), then service conditions are characterized as good. Accordingly actual age is less than chronological (T_b^r <T_b^t) and it can be determined by a solution of inverse problem which idea is presented in the Figure 3.

2. By the same way control values for structural elements can be determined, for example, by VSN 53-86 (r) [21]. In this normative document there are submitted schedules of physical deterioration of layered constructions with service life of 60-125 years and 10-50. However now there is a great variety of building constructions and new materials for which such dependences are not found out yet.

3. A key step of the flowchart is the step 9. Exactly here, in case if physical deterioration considerably exceeds control value, it is necessary to carry out careful analysis of the reasons.

As a result there has to be received an answer to the question: if it was mistake in determining of physical deterioration during technical inspection or not. In this case it should be corrected. Also it is possible that the jump of physical deterioration became consequence of inadequate service conditions, then it is required to eliminate the cause immediately and take preventative actions against repetitions.

4. Step 10 assumes recalculation of physical deterioration of the surveyed object (F_b) taking into account the executed corrections of physical deterioration of structural elements (F_{sc}) by the following formula [21]:

$$F_b = \sum_{i=1}^{i=k} F_{sci} \times l_i \quad (1)$$

where F_{sci} - physical deterioration of the separate construction, element or system, %;

l_i – coefficient, which corresponds to the part of recovery cost of the separate construction, element or system in the total recovery cost of the building.

Conclusions

One of advantages of the method is possibility of monitoring of dynamics of change of technical condition of an object by results of the general inspection based on the analysis and testing payment using the data of visual survey. Cost of this work is not high as special tools and equipment are not required. It will allow the operating company to order this service and in interstandard terms (more often than once in 10 years).

Thus, in spite of the fact that costs for application of the technique are not big, its application will allow to find mistakes during inspections or inadequate service conditions, that finally will be reflected in the maximum approximation of calculation of the planned and actual costs of carrying out repair and construction works.

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