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COMPARISON OF TECHNICAL CONDITION OF MULTI-FAMILY RESIDENTIAL BUILDINGS OF VARIOUS AGES

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The article discusses the technical condition of buildings. An attempt was made to compare the technical condition and the degree of technical wear of two multi-family residential buildings erected at the interval of 25 years. The list of such objects is intended to illustrate that even relatively young buildings may exhibit differing levels of wear and technical condition of building elements.

Keywords: multi-family residential buildings, ages of building, technical condition.

1. INTRODUCTION

Residential buildings are a component of human property. Their use should be consistent with the intended use and maintenance in a proper technical and aesthetic condition. In order to make a decision as to the need to carry out renovation work, it is necessary to perform an appropriate expertise of the building, which clarifies the actual technical condition of the object [1, 2], the

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causes of any damage [3] and provides recommendations on how to remove them and safe operation [4, 5].

The article discusses the technical condition of buildings [6]. An attempt was made to compare the technical condition and the degree of technical wear [7] of two multi-family residential buildings erected at the interval of 25 years. The list of such objects is intended to illustrate that even relatively young buildings may exhibit differing levels of wear and technical condition of building elements [8]. These objects were subject to similar atmospheric impact due to the geographical location - they are both built in Krakow, a short distance from each other. The first of them (Fig. 1.), which is part of a housing estate, comes from 2015, while the second one (Fig. 2.) from 1990.

Fig. 1. Multi-family building from 2015. Source: own.

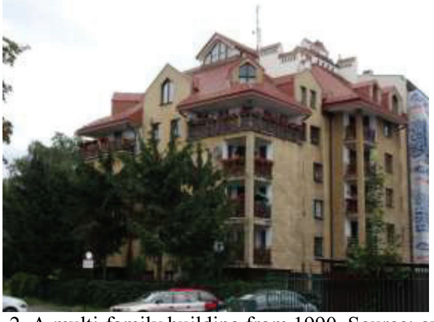


Fig. 2. A multi-family building from 1990. Source: own.

In this article, the visual method (weighted average) and three formulas of the time method were used to determine the degree of technical wear of the buildings in question.

From the moment of erection, both buildings are used in a similar way as multi-family residential buildings. Their characteristics are presented in Table 1 [9, 10].

Table 1. Characteristics of assessed residential buildings. Source: own.

CHARACTERISTICS OF OBJECTS		
	Building 1	Building 2
Construction year	2015	1990
Usable area	3411,87 m^2	1353,10 m^2
Building area	859,75 m^2	314 m^2
The building's cubic capacity	13535,46 m^2	6980 m^3
Upper storeys	3	5
Underground storeys	1	1
Fittings	Central heating and hot water installations supplied from MPEC; Water and sewage; Electrical installation with fire protection switch; Video-intercom; Lightning protection; Fire extinguishers and fire hose connection; Mechanical ventilation; Internal and external fire hydrants; Fire dampers and control centre; Emergency escape lighting;	Central heating and hot utility water supplied from MPEC; Water and sewage; Electrical installation; Lightning protection; Rainwater drainage; Collector antenna "azart";

2. SELECTED PHOTOGRAPHIC DOCUMENTATION OF FAULTS

During the local visions carried out, a series of photographs of defects in the assessed buildings were made, necessary to observe their further deterioration, for example, the behaviour and expansion of cracks on structural elements (Fig. 3 - Fig.8).

BUILDING No.1

BUILDING No. 2

3. DETERMINING THE DEGREE OF TECHNICAL WEAR OF BUILDINGS USING THE WEIGHTED AVERAGE METHOD

On the basis of the local inspection carried out and the analysis of the technical inspection documentation, an assessment was made of the state of wear of the buildings in question. The focus was mainly on structural elements having the greatest impact on the safety of operation, but also on finishing elements, which due to their lower durability should be constantly monitored and repaired as needed. Table 2 [11, 12] lists the percentage of technical wear of the listed building elements. Percentages included in the table are a subjective visual assessment of the state of wear, however they allow a comparative analysis of the technical condition of buildings. Each element for which the technical use of the element is smaller is marked in the column in green.

Table 2. Percentage consumption of building construction elements based on local vision and technical review protocols. Source: own.

Sl. No.	Building elements	Building 1	Building 2
		Element wear [%]	
CONSTRUCTION FACILITIES OF BUILDINGS			
1.	Fiber reinforced foundations	5	5
2.	Insulation of the walls of the ground floor - vertical insulation	15	10
3.	Insulation of the ground floor walls - horizontal insulation	20	15
4.	Structural walls - external	5	10
5.	Construction walls - internal	5	15
6.	Partition walls	5	10
7.	Roof construction	5	5
8.	Reinforced concrete stairs	5	5
9.	Concrete slabs	5	10
FINISHING ELEMENTS & EQUIPMENT			
10.	Railings	5	10
11.	Coatings	25	15
12.	Window and door joinery	10	15
13.	Floors and screeds	15	10
14.	Sheet metal work	15	10
15.	The surroundings of the building	30	20

The average weighted method was used to determine the deterioration of buildings [13, 14]. Due to the lack of access to the exact cost data of the examined object, an approximate definition was used to determine the percentage value of individual elements in relation to the value of the entire building [8], as close as possible to the discussed - multi-family building. For building No. 1 (from 2015) a summary was made in table 3.

Table 3. Consumption weighted for building 1. Source: own.

Integrated elements		Contribution to the cost of the object Ue_i [%]	Degree of wear of the element. Sze_i [%]	Degree of consumption "weighted"
1.	Excavation work	1,9	5	0,1
2.	The foundations	0,9	5	0,0
3.	Insulation	0,3	15	0,0
4.	Construction walls	21,8	5	1,1
5.	Partition walls	3,7	5	0,2
6.	Ceilings and balconies	10,2	5	0,5
7.	Steps	1,8	5	0,1
8.	Railings	0,4	5	0,0
9.	Wooden roof construction	1,8	5	0,1
10.	Roof covering	1,2	10	0,1
11.	Metalworking	0,8	15	0,1
12.	Internal plasters	4,5	25	1,1
13.	External plasters	1,8	20	0,4
14.	Window woodwork	5,4	10	0,5
15.	Door woodwork	4,5	5	0,2
16.	Glazing	0,8	5	0,0
17.	Floors	6,3	15	0,9
18.	Painting walls and ceilings	0,7	5	0,0
19.	Painting of carpentry	1,7	5	0,1
20.	CO installation (piping)	5,8	5	0,3
21.	Water and sewage installation	8,9	5	0,4
22.	Lightning protection	1,3	5	0,1
23.	Electrical installation	2,8	5	0,1
24.	Other	10,7	10	1,1
Total		100		**7,8**

For building no. 2 (from 1990), a comparison was made in table 4.

Table 4. Consumption weighted for building 2. Source: own.

Integrated elements		Contribution to the cost of the object Ue_i [%]	Degree of wear of the element Sze_i [%]	Degree of consumption "weighted"
1.	Ground works	1,9	15	0,3
2.	The foundations	0,9	5	0,0
3.	Insulation	0,3	15	0,0
4.	Construction walls	21,8	15	3,3
5.	Partition walls	3,7	10	0,4
6.	Ceilings and balconies	10,2	10	1,0
7.	Steps	1,8	10	0,2
8.	Railings	0,4	10	0,0
9.	Wood roof construction	1,8	5	0,1
10.	Roof covering	1,2	5	0,1
11.	Metal working	0,8	10	0,1
12.	Internal plasters	4,5	20	0,9
13.	External plasters	1,8	15	0,3
14.	Window woodwork	5,4	15	0,8
15.	Door woodwork	4,5	15	0,7
16.	Glazing	0,8	5	0,0
17.	Floors	6,3	10	0,6
18.	Painting walls and ceilings	0,7	5	0,0
19.	Painting of carpentry	1,7	20	0,3
20.	CO installation (piping)	5,8	30	1,7
21.	Water & sewage installation	8,9	30	2,7
22.	Lightning protection	1,3	25	0,3
23.	Electrical installation	2,8	20	0,6
24.	Other	10,7	30	3,2
Total		100		**17,7**

4. DETERMINING THE DEGREE OF TECHNICAL WEAR WITH TIME METHODS

By means of time methods, taking into account only the age of the building and the expected time of its durability, the theoretical degree of technical wear was calculated for both buildings in order to confront the results with the actual technical consumption, which is illustrated by the weighted average method, based on the visual inspection of the object [15, 16].

BUILDING No. 1

The following data was used for the calculations:

t - building age = 3 years

T - expected lifetime of the building = 50 years

a) Linear method

In the absence of ongoing repairs and maintenance of building elements:

(1) $$Szt = \frac{t}{T}100\% = \frac{3}{50}100\% = 6\%$$

b) Non-linear method

With proper renovation management:

(2) $$Szt = \frac{t(t+T)}{2T^2}100\% = \frac{3(3+50)}{2(50)^2}100\% = 3{,}2\%$$

With exemplary renovation management and proper use of the building:

(3) $$Szt = \frac{t^2}{T^2}100\% = \frac{3^2}{50^2}100\% = 0{,}4\%$$

BUILDING No. 2

In contrast to the building from 2015 - taking into account the difference in the age of buildings and the different design approach to the issue of durability - 100 years were assumed as the estimated period of building durability.

The following data was used for the calculations:

t - building age = 28 years

T - expected lifetime of the building = 100 years

a) Linear method

In the absence of ongoing repairs and maintenance of building elements:

(4) $$Szt = \frac{t}{T}100\% = \frac{28}{100}100\% = 28\%$$

b) Non-linear method

With proper renovation management:

(5) $$Szt = \frac{t(t+T)}{2T^2}100\% = \frac{28(28+100)}{2(100)^2}100\% = 17{,}9\%$$

With exemplary renovation management and proper use of the building:

(6) $$Szt = \frac{t^2}{T^2}100\% = \frac{28^2}{100^2}100\% = 7{,}8\%$$

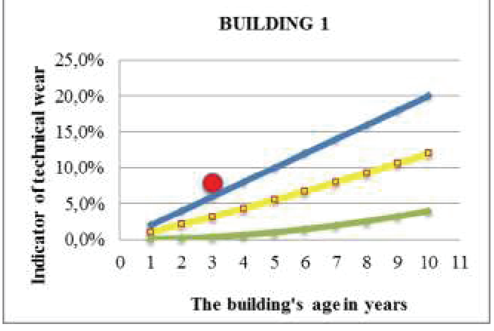
The results obtained by individual calculation methods are summarized in Table 5.

Table 5. List of technical wear results of multi-family buildings. Source: own.

Method for determination of technical wear.	**Indicator of technical wear [%]**	
	BUILDING 1	**BUILDING 2**
The weighted average method – the state closest to the real one	7,8	17,7
Line method - bad repair management	6	28
Non-linear method - correct renovation management	3,2	17,9
Non-linear method - reference repair management	0,4	7,8

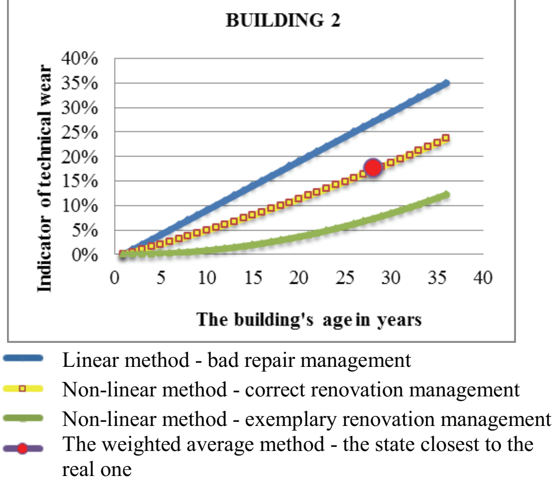
In order to analyse and visualize the changes in technical use of buildings over time, charts were created for both buildings (Figures 13 and 14).

Fig. 13. Indicators of technical wear during. Source: own.



Linear method - bad repair management
Non-linear method - correct renovation management
Non-linear method - exemplary renovation management
The weighted average method - the state closest to the real one

Fig. 14. Indicators of technical wear during. Source: own.



5. Analysis of results and conclusions

Building No. 1 shows the wear characteristics that go beyond the diagram of theoretical consumption in tough renovation economy. It should be noted, however, that such a state is not only caused by the method of maintaining the technical condition. The main elements that demonstrate a much weaker technical condition are plaster and insulation-primarily in the underground floor and garage. The reason for this is the incorrect implementation of these elements and design negligence, all the more difficult due to the location of the facility on the flood plain and high level of groundwater.

The actual technical condition of the building No. 2 (from 1990) after 28 years of use almost exactly corresponds to the theoretical consumption with proper renovation management. The building has recently undergone a major overhaul of the roof and roofing works, which distinguishes it in terms of the quality of workmanship.

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LIST OF FIGURES AND TABLES:

PORÓWNANIE STANU TECHNICZNEGO BUDYNKÓW MIESZKALNYCH WIELORODZINNYCH O RÓŻNYM WIEKU

Słowa kluczowe: budynki mieszkalne wielorodzinne, wiek budynku, stan techniczny.

STRESZCZENIE:

Artykuł porusza problematykę stanu technicznego obiektów budowlanych. Podjęto w nim próbę porównania stanu technicznego oraz stopnia zużycia technicznego dwóch budynków mieszkalnych, wielorodzinnych wzniesionych w odstępie 25 lat. Rzeczone obiekty poddane były podobnym oddziaływaniom atmosferycznym, z uwagi na fakt położenia geograficznego – zlokalizowane są na terenie Krakowa, w niewielkiej odległości względem siebie. Pierwszy z nich, wchodzący w skład osiedla mieszkaniowego, pochodzi z 2015 roku, natomiast drugi z roku 1990. Zestawienie takich obiektów ma na celu zobrazowanie, że nawet budynki stosunkowo młode mogą wykazywać odbiegający od oczekiwanego stopień zużycia oraz stan techniczny elementów budowlanych.

Do wyznaczenia zużycia technicznego budynków użyto metody średnioważonej. Z uwagi na brak dostępu do dokładnych danych kosztowych rozpatrywanego obiektu, posłużono się przykładowym określeniem procentowej wartości poszczególnych elementów scalonych w stosunku do wartości całego budynku, jak najbardziej zbliżonego do omawianego – budynek mieszkalny wielorodzinny.

Przy pomocy metod czasowych, uwzględniających tylko wiek budynku i przewidywany czas jego trwałości, obliczono teoretyczny stopień zużycia technicznego dla obu budynków, aby skonfrontować wyniki z rzeczywistym zużyciem technicznym, które obrazuje metoda średnioważona, oparta na wizualnej kontroli obiektu.

Młodszy budynek (z 2015 r.) wykazuje zużycie techniczne wykraczające poza wykres teoretycznego zużycia przy złej gospodarce remontowej. Należy tu jednak zaznaczyć, że stan taki nie jest spowodowany jedynie sposobem utrzymania stanu technicznego. Głównymi elementami wykazującymi zdecydowanie słabszy stan techniczny są tynki i izolacje – przede wszystkim w kondygnacji podziemnej oraz garażu. Powodem takiego stanu jest nieprawidłowe wykonanie tych elementów oraz zaniedbania projektowe, tym bardziej utrudnione ze względu na położenie obiektu na terenie zalewowym oraz wysokim poziomie wody gruntowej.

Rzeczywisty stan techniczny starszego budynku (z 1990 r.) po 28 latach użytkowania niemal dokładnie odpowiada teoretycznemu zużyciu przy prawidłowej gospodarce remontowej. Budynek niedawno przeszedł kapitalny remont dachu oraz obróbek blacharskich, co wyróżnia go pod względem jakości wykonania.

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