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Building modernization located in the conservation protection zone in the aspect of technical conditions

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Abstract

The paper presents a description of the technical condition of the building after many years of operation and analyzes the impact of the current use and the lack of regular periodic repairs on the technical efficiency of the building. The influence of the technical solutions applied during the construction of the building on the current limitations related to the planned, target change in the way of use was discussed. Variant conceptual solutions for the modernization of the building were also presented, taking into account the preservation of its historic character.

Keywords: renovation, monument, reconstruction, strengthening of structural elements

1 Introduction

Economic development results in the intensification of housing construction in cities, not only in their suburbs, but is also related to the development of housing in the centers of urban agglomerations [25–27, 37]. Nowadays, the development of housing in cities takes place mainly in post-military and post-industrial areas. In the case of buildings with an ultimately increased standard of use, they are very often planned for construction in areas under conservation protection or in areas covered by conservation protection [4, 5, 35, 36]. The implementation of such facilities is most often associated with the need to reconstruct and adapt the existing historic buildings, combined with their modernization [1–3, 8, 14, 19, 28, 31, 32]. Often the end use of a building as a housing substance is associated with the need to change its use [6, 7].

The paper is a case study of an existing service and residential building from the turn of the 19th and 20th centuries, in which there was a book warehouse since the end of World War II, and in which residential premises in one part of the building were used as communal flats. The intention of the current owner was to modernize the building and its intended use as an apartment building [15, 17, 33]. Due to the location, the construction works planned for implementation had to take into account the conditions of the conservator of monuments.

2 General data

The building was built in traditional technology, as a structure of various heights, 2 and 3-storey, with an unused attic, partially with a basement (in the area of the elevated part) (Fig. 1 and Fig. 2). The external structural walls are made of homogeneous, full ceramic brick. Inter-story ceilings, above the ground floor, first and second floors were made on wooden beams, the ceiling above the basement was made of ceramic, with the use of sectional brick vaults. The structural system at the level of the above-ground storeys was made of spatial wooden frames (wooden mullion and transom system). The building was covered with a steep wooden carpentry roof.

During the operation period, the building underwent numerous reconstructions, which mainly involved changes in the functional and utility layout. On the basis of the visual inspection of the building's body, it was found that the building was expanded in the past period: an unloading ramp was added on the south-west side, used when there was a book warehouse in the building [24].

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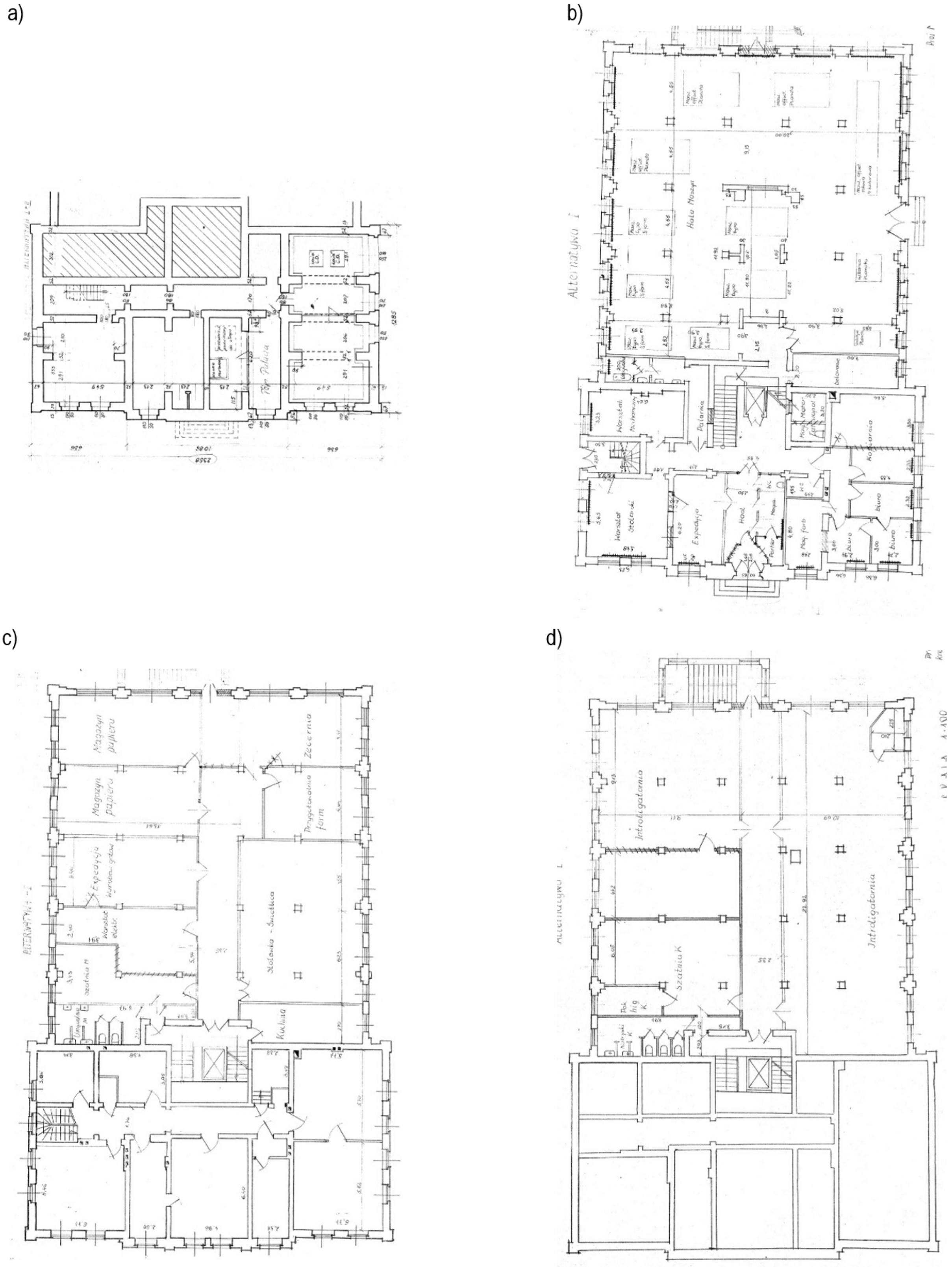

Figure 1. Building planned for modernization - projection of: a) basement, b) ground floor, c) 1st floor, d) 2nd floor (based on the archival construction inventory)

3 Description of the condition of the existing building

The general view of the building from the north-eastern façade is shown in Figure 3a. On the north-west façade, traces of mechanical damage to the wall were visible, moreover, extensive damage was visible in the form of scratches in the

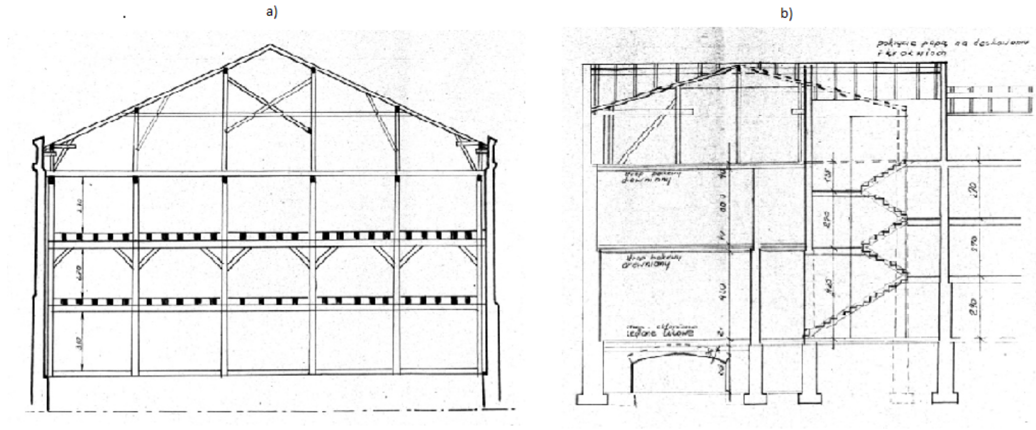

Figure 2. Building planned for modernization - cross-section: a) transverse, b) longitudinal(based on the archival construction inventory)

sill zones (Fig. 3b). In addition, scratches on the window vaults were visible on the façade (Figure 3c). Decorative thrust washers of front bolts were visible on the elevation plane (Fig. 3d).

Figure 3. Building planned for modernization - elevations: north-east: a) view, north-west: damage to: b) the sill zone, c) brick basement window lintels (arches), d) front anchoring retaining plate

The corner of the building at the junction of the south-west and south-east façades was cracked, and the morphology of its scratches (scratches and diagonal cracks) indicated that it was gradually subsiding (Fig. 4a).

Very large losses of ceramic decorative elements were visible on the façade surface (Fig. 4b).

a) b)

Figure 4. Building planned for modernization - south-eastern elevation: damage to the brick wall: a) in the level of the plinth, b) in the level of the above-ground part

a) b) c) d)

Figure 5. Building planned for modernization - outcrops from the side of the elevation: a) north-east, b) north-west, c) south-west, d) south-east

The groundwater level was not visible in the F1 outcrop along the north-eastern (front) elevation (Fig. 5a). The top level of the concrete footings made of rubble concrete was 60 cm below the ground level. In the F2 outcrop along the north-west elevation, groundwater was visible at the level of 65 cm below the level of the top of the continuous footings (Fig. 5b). The top of the footings was 85 cm below the area around the building.

In the F3 outcrop, also made along the north-west elevation, groundwater was visible at the level of 60 cm below the level of the top of the footings (Fig. 5c). The top of the footings was 90 cm below the area around the building.

In the F4 opencast along the south-eastern elevation, groundwater was visible, similarly to the F2 and F3 opencasts, at the level of 60 cm below the level of the top of the continuous footings (Fig. 5d). The top of the footings was 95 cm below the area around the building.

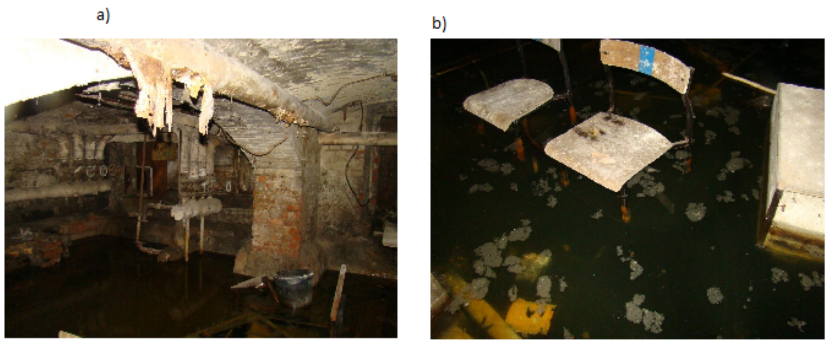

Figure 6. Building planned for modernization - flooded cellars: a) view, b) close-up

Figure 7. Building planned for modernization ceiling above the ground floor: a) fragment of the wooden frame, b) foundation of the column, c), d) structure of the stop

In the basement level, the consequences of the utilization of the building with inefficient waterproofing of parts of the walls sunk into the ground were visible. In practice, the entire cellars were flooded with water (Fig. 6a).

Section vaults constituting the vaulting of the basement storey were loosened, loose bricks falling out of keystones and scratches of joints on the entire palate of the vaults were visible. In most of the rooms in the basement level there was water, the basements were flooded to a height of 50 cm (Fig. 6b).

Wooden posts and wooden bolts on the ground floor level showed numerous scratches, delamination and cracks (Fig. 7a). The dimensions of the wooden poles in the cross-section were 32x32 cm, the transoms were made as two-branch transoms from beams 2x15x31 cm. The foundation of the columns on a brick foundation (Figure 7b) was to ensure the vertical non-deformability of the wooden structure. Stiffening of the structure of wooden frames was provided by swords measuring 15x35 cm. Wooden ceiling beams with dimensions of 15.5x28 cm were spaced from 65 to 80 cm. The ceiling above the ground floor was made of wooden naked. In the outcrops, it was found that the floor beams were made of 3.8 cm thick boards (Fig. 7c and Fig. 7d). On a part of the ceiling, additionally, during the period of operation, a hard-type fibreboard with a thickness of 0.5 cm was impaled on the boards.

a) b)

Figure 8. Building planned for modernization ceiling above the first floor: a) fragment of the wooden frame, b) structure of the ceiling

a) b)

Figure 9. Building planned for modernization - ceiling above the second floor: a) a fragment of a wooden frame, b) a structure of the ceiling

Wooden posts and wooden bolts on the first floor level, similarly to the ceiling above the ground floor, showed numerous scratches and cracks (Fig. 8a). The dimensions of the wooden poles in the cross-section were 32x32 cm, the transoms were made as two-branch transoms from beams 2x15x31 cm. Stiffening of the structure of wooden frames was provided by swords measuring 25x35 cm. Wooden ceiling beams with dimensions of 15.5x28 cm were spaced from 80 cm to 90 cm. The ceiling above the ground floor was made of wooden naked, as in the case of the ceiling above the ground floor. It was found in the open-pit mines that the floor beams were made of 3.8 cm thick planks covered with 0.5 cm thick hard-type fibreboard (Fig. 8b).

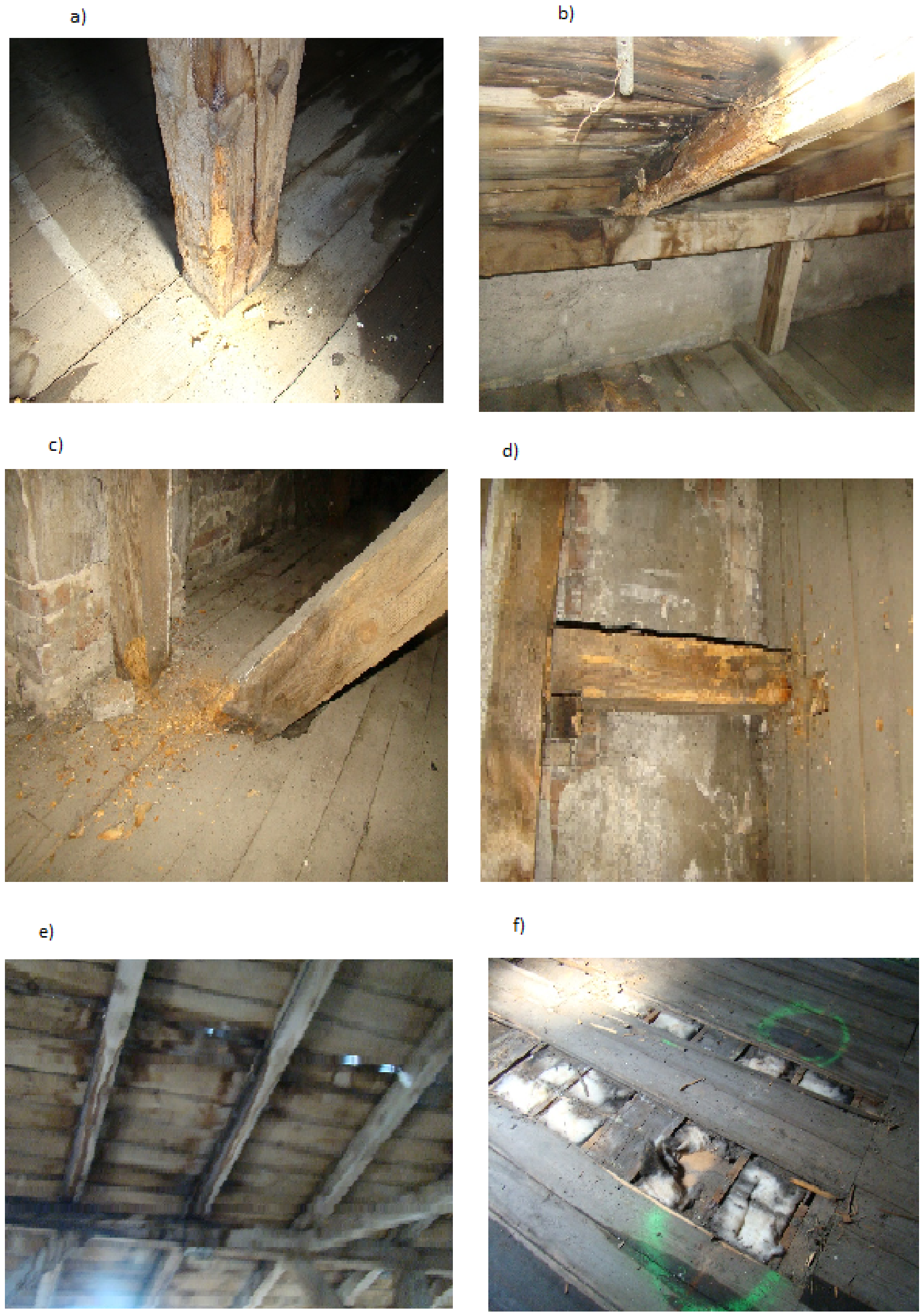

Figure 10. Building planned for modernization - attic: damage to the wooden roof truss in terms of: a) post foundation, b), c) rafter backrest, d) wall board support, e) roof formwork, and f) ceiling structure above the second floor

Wooden posts and wooden bolts on the second floor, similarly to the ceiling above the ground floor, showed numerous scratches and cracks (Fig. 9a). In some of the rooms on the second floor, leaks were visible due to leakage of the roof covering. The dimensions of the wooden poles in the cross-section were 32x32 cm, the transoms were made as single-branch transoms from 25x30 cm beams. The structure of the ceiling above the second floor does not have a stiffening in the form of swords next to wooden poles. The direction of constructing the transverse frames horizontally above the 2nd floor (perpendicular to the front façade) was perpendicular to the direction of their construction horizontally above the 1st floor and above the ground floor (parallel to the front façade). Wooden ceiling beams with dimensions of 15.5x28 cm were spaced from 85 cm to 90 cm. The ceiling above the ground floor was made as wooden naked, as in the case of the ceiling above the ground floor and above the first floor (Fig. 9b). In the outcrops, it was found that the floor beams were made of 3.8 cm thick planks with a 0.5 cm thick hard-type fibreboard covering.

In the attic level, the elements of the wooden roof truss had extensive damage. Some of the wooden posts showed, along their entire height, traces of larvae and insect feeding (Fig. 10a). In most cases, the roof rafters were damp as a result of leaks in the roofing material. Long-term dampness led in some cases to significant corrosion losses, reaching up to 80% of the cross-sectional area (Fig. 10b). Corrosion damage also occurred at the anchoring point of the diagonal strut in the floor beams (Fig. 10c). The posts supporting the wall plate were in some cases so damaged by corrosion that they hung in the air (Fig. 10d). The formwork of the roof was damp as a result of leakage of the roof covering (Fig. 10e). Moistening of the floorboards was also identified (Fig. 10f).

a) b)

Figure 11. Building planned for modernization - damage to the runs of staircases: a) main and b) side

a) b)

Figure 12. Building planned for modernization – lokale mieszkalne: a) broken ceiling above the ground floor, b) depreciation of equipment

The main staircase had landings and running boards made of wooden elements. The steps were worn, the footrests and legrests were mechanically damaged (Fig. 11a), with extensive traces of larvae and insect feeding. The side staircase was in a very similar technical condition, the communication of which was provided by the return operation stairs (Fig. 11b).

The residential premises in the area of the building were out of service, there were visible traces of extensive water stains and mechanical damage to the finishing layers (Fig. 12). The walls and ceilings of the plastering were chafed and locally damp. There were pipe installations in the rooms, and the cable systems in most of the rooms of the residential premises were also dismantled.

4 Analysis of the condition of the existing building

4.1 Foundations

The walls of the building to be modernized, made of homogeneous solid ceramic bricks, were set on benches made of rubble concrete, sunk into the ground. The top of the footings was at a depth of 60 to 95 cm below the ground level around the building, and the height of the footings (pedestals) ranged from 60 to 90 cm. Due to the level of foundation, the benches were placed below the ground freezing zone.

At the level of the top of the footings, there was no anti-moisture insulation to prevent capillary rising of moisture by the ceramic wall, and the footing itself (foundation plinth), as well as the part of the ceramic wall recessed into the ground, were not protected against the negative effects of moisture (water). On the basis of the excavations, it was found that the groundwater level was approximately at the foundation level, which resulted in the building structure being exposed to deformation due to the changing (fluctuating) stiffness of the ground caused by its periodic irrigation or drying. Thus, the probability of subsequent damage to structural elements, including external walls, was significantly increased. It should be noted that in the event of a targeted change in the use of the building, the unit ground pressure on the ground would increase and thus the probability of faster and increased subsidence of the building structure as a whole would increase. At the stage of assessing the technical condition of the building in terms of its potential modernization, it was not possible to clearly determine what will be the increase in loads and pressures on the ground after the target change in the way of use. According to the recommendations commonly used in engineering practice, if this increase is more than 20%, which is highly probable, the existing footings will be eligible for reinforcement.

4.2 Construction walls

The walls of the building under study are made of solid ceramic bricks. Based on the macroscopic assessment, the brick built into the walls, along the entire height of the walls: in the level of the basement, ground floor, as well as the first and second floors and the attic, were rated as classes from 75 to 100 (f_b = 7,50 – 10,0 MPa), while the mortar as brands M1 - M2 (f_m = 1,0 – 2,0 MPa).

The scratches visible on the façade occurred in the sash strips and in the area of lintels - these are places where the stiffness of the wall was changed and the occurrence of scratches in these places, especially diagonal and close to diagonal, was explainable. The vertical and slightly sloping cracks visible on the elevations, locally turning into cracks, were damage whose morphology indicates that they are the result of thermal deformation of the external walls.

The oblique scratches, in particular the oblique scratching in the corner area of the south-west and south-east façades, testified to the local occurrence of uneven subsidence, probably caused by local softening of the subsoil resulting from changes in the groundwater level.

The external walls of the building covered by the study did not ensure proper thermal protection of the building, and thus did not provide the appropriate thermal and humidity comfort in rooms intended for use as residential or office spaces. As part of the assessment of the technical condition, comprehensive thermal and humidity calculations were abandoned - the visible traces of freezing on the inside of the walls, including on the ground floor, sufficiently confirmed the excessively high thermal conductivity of the walls, which allows for the formulation of the thesis that the external walls are made of solid ceramic bricks did not meet both the requirements set out in the now obsolete, although commonly used until now, standard [21] ($k_{real} \gg k_{max}$), as well as in [30] ($U_{real} \gg U_{max}$).

For the purpose of assessing the technical condition of the building, in terms of its target modernization, the walls were measured on the level of the basement and ground floor (without taking into account the plaster layer) [34]. The humidity measurements were made using an electronic hygrometer. The scaling method was adopted according to the guidelines of the manufacturer of the hygrometer used for the measurements. In order to assess the dampness of the walls, the collection of material samples for tests possible to be carried out using the dryer-weight method in accordance with the requirements of the standard [36] was abandoned - it was concluded that the measurements made with the use of a hygrometer would be representative for the assessment of the degree of dampness in the walls. Based on the estimated results of measurements with a hygrometer, it was determined that the degree of moisture in the external walls in the basement level, defined as the measured mass humidity U_m [%], ranged from 11,46% to 13,82%, which qualified the walls as damp (Tab. 1 and Tab. 3). The degree of moisture in the walls on the ground floor level (external walls), defined as the measured mass humidity U_m [%], ranged from 4,10% to 5,12%, which qualified the walls as damp (Tab. 1 and Tab. 3). However, it should be noted that only the surface moisture of masonry elements was measured. In fact, in the case of masonry elements, the inner layers of the wall are usually the most moist, especially in the case of walls of increased thickness ($\geq$ 38 cm) (Fig. 13) [9]. The direct cause of dampness in the walls at the basement and ground floor level was the lack of technically efficient vertical waterproofing and horizontal anti-moisture insulation.

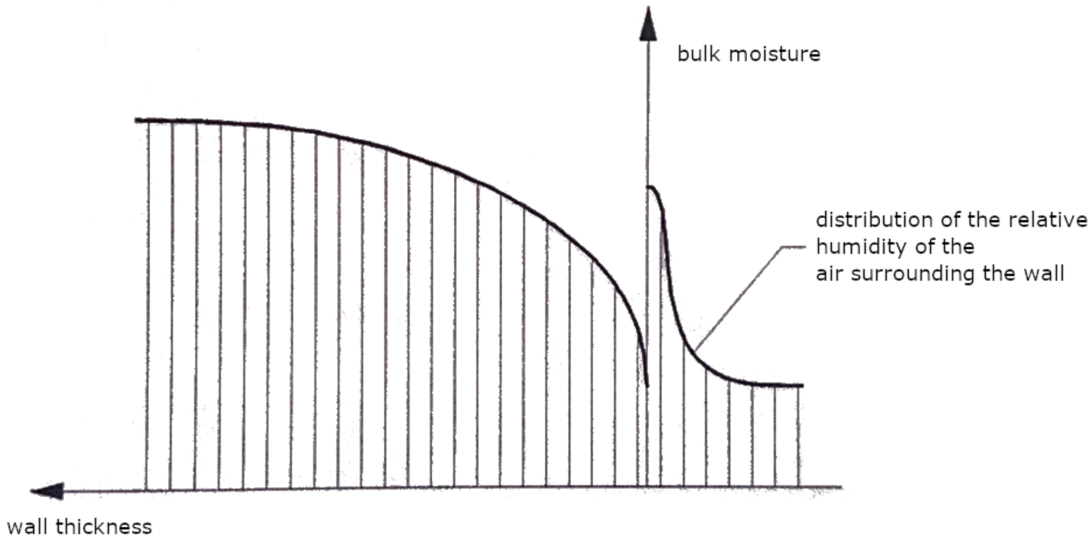

Figure 13. The relationship thickness of the wall - mass moisture U_m [9]

Table 1. Criterion of moisture content of masonry elements depending on the value of mass humidity U_m

dry material	damp material	wet material
mass moisture U_m [%]		
≤ 3	$3 < \leq 17$	> 17

Table 2. Criterion of moisture content of wooden elements depending on the value of mass moisture U_m

dry material	damp material	wet material
mass moisture U_m [%]		
≤ 15	$15 < \leq 17$	> 28

Table 3. Collective summary of the mass moisture content U_m - masonry elements

Number of the outcrop	Location of the outcrop (place of measurement)	Type of element	Mass humidity U_m [%]	Classification of moisture
1	basement floor external wall: elevation N-E measurement: firom the outside (F1)	wall made of solid ceramic bricks	12.50	damp material
2	basement floor external wall: elevation N-W measurement: from tge outside (F2)	wall made of solid ceramic bricks	13.82	damp material
3	basement floor external wall: elevation S-E measurement: from the outside (F4)	wall made of solid ceramic bricks	11.46	damp material
4	ground floor external wall: elevation S-W measurement: from the outside, (F3)	wall made of solid ceramic bricks	4.35	damp material
5	ground floor external wall: elevation S-E measurement: from the outside (F5)	wall made of solid ceramic bricks	5.12	damp material
6	ground floor external wall (corner): elevation S-E / S-W	wall made of solid ceramic bricks	4.10	damp material

4.3 Inter-story ceilings

4.3.1 Ceiling above the basement

Section vaults in the level of the ceiling above the ground floor in most cases had cracks in the key, resulting in bricks falling out in the keystone. Some of the vaults were intensely scratched in the keystone area. In addition, scratches occurred in the places where vaults were founded on the walls, in the so-called nodes. The immediate cause of the damage was local overload of the ceiling during the earlier operation of the building, in some cases the damage could have arisen as a consequence of local uneven settlement of the building. The extent of damage to the ceiling above the basement was due to the fact that there was no reinforced concrete rim in the ceiling level, which would increase the spatial stiffness of the building as a whole.

4.3.2 Ceiling above the ground floor, first and second floor

The wooden beams of the ceilings above the ground floor, first and second floors had locally visible traces of larvae and insect feeding. Damage of this type occurred in the level of all inter-story ceilings and was caused by the lack of protection of wooden elements during the building's operation period against the action of technical wood pests.

Due to the leaks in the roofing, the beams in the floor level above the 2nd floor were very damp, local signs of biological corrosion development were visible. The development of biological corrosion was particularly intense in the adjacent zones.

At the stage of assessing the technical condition of the building in terms of its target modernization, no detailed calculations of the load-bearing capacity of inter-story ceilings were performed for the design condition, e.g. using the building as a hotel facility. Due to the lack of detailed design solutions regarding fire protection, construction of the ceilings, it was not possible to accept the loads as designed - cladding protecting wooden structures in terms of fire protection. are very heavy (e.g. cement-cellulose boards weigh approximately 1800 kg /m3) and only the adoption of an exact (detailed) solution may decide about the suitability of wooden beams in terms of load-bearing capacity and the possible necessity and need to strengthen them.

However, it should be mentioned here that even in the case of reinforcement of wooden ceiling beams and their protection in terms of fire protection. ceilings on wooden beams will act as partitions through which sounds, in particular impact sounds, can penetrate. Thus, it is very difficult in practice to construct a layer system on wooden beam ceilings that will meet the acoustic protection requirements.

4.4 Chimney shafts in the part led out above the roof surface

The chimney shafts in the part protruding above the roof slope showed extensive chipping, cracks and scratches. These cracks occurred both in the plaster and spread to the brick part of the shaft. This situation resulted in the fact that, with a high probability, there could be air blows between individual ducts, including the gravity ventilation ducts, which significantly reduced its efficiency.

The direct cause of the existing condition of the chimney cores was the long-term operation period and the lack of successive renovation works.

4.5 Wooden roof truss with boarding and covering

The elements of the wooden roof truss (rafters) with dimensions of 8x16 cm are arranged with a spacing of 80 cm to 90 cm (on average every 85 cm). The wooden rafters showed local cracks and delamination. However, these damages did not significantly reduce the strength index and, consequently, their load-bearing capacity. These damages occurred in most of the wooden rafters (80% of the number of wooden rafters), both in the supporting part (at the external walls) and in the middle of the ceiling span.

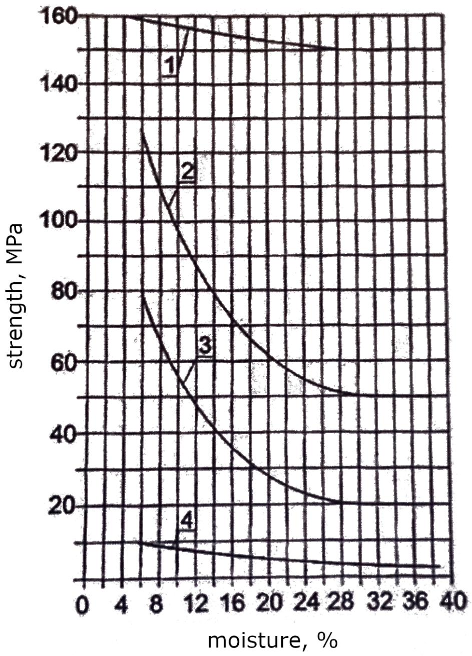

Figure 14. Moisture-strength (stress) relationship for wood [16]

Based on the estimated results of measurements with a hygrometer, it was determined that the degree of moisture in wooden rafters in the eaves zone, defined as the measured mass moisture U_m [%], ranged from 19,26% to 23,32%, which qualified the rafters as damp and from 34,26% to 36,32%, which qualified them as wet (Tab. 2 and Tab. 4). In the case of the formwork of the roof slope, the degree of moisture in the eaves zone, defined as the measured mass humidity U_m [%], ranged from 24,22% to 25,28%, which qualified the boards as damp and ranged from 31.06% to 44, 25%, which qualified the boards as wet (Tab. 2 and Tab. 4).

The direct cause of the dampness of wooden elements were leaks from the roof slope occurring in the past period, with a high probability assessing the extent of damage that has been maintained for many years.

The leaks contributed to the dampness of the floor boards at the level of the ceiling above the 2nd floor and to the dampness of the wooden elements of the wooden steep roof structure, in particular the intermediate purlins.

In the case of a fragment of the attic from the south-west elevation, the development of biological corrosion led to almost complete degradation of the rafters.

In the case of rafters and formwork made on the rest of the attic, including the central part, their increased moisture was evidenced by visible discoloration of the side surfaces of wooden rafters - damp wooden elements negatively affect

Table 4. Summary of mass moisture content U_m - wooden elements

Number of the outcrop	Location of the outcrop (place of measurement)	Type of element	Mass humidity U_m [%]	Classification of moisture
1	attic floor elevation: S-E measurement: from the inside	wooden rafter 8x16	21.68	damp material
2	attic floor elevation: S-E measurement: from the inside	wooden rafter 8x16	23.32	damp material
3	attic floor elevation: S-W measurement: from the inside	wooden rafter 8x16	19.26	damp material
4	attic floor elevation: S-W measurement: from the inside	wooden rafter 8x16	34.26	wet material
5	attic floor elevation: S-W measurement: from the inside	wooden rafter 8x16	35.74	wet material
6	attic floor elevation: S-W measurement: from the inside	wooden rafter 8x16	36.32	wet material
7	attic floor elevation: S-W measurement: from the inside	wooden board 2.5	24.22	damp material
8	attic floor elevation: S-W measurement: from the inside	wooden board 2.5	25.28	damp material
9	attic floor elevation: S-W measurement: from the inside	wooden board 2.5	31.06	wet material
10	attic floor elevation: S-W measurement: from the inside	wooden board 2.5	38.76	wet material
11	attic floor elevation: S-W measurement: from the inside	wooden board 2.5	40.24	wet material
12	attic floor elevation: S-W measurement: from the inside	wooden board 2.5	44.25	wet material

their load-bearing capacity (Fig. 14) [16].

Apart from damage, biological corrosion of the elements of the wooden roof truss showed traces of extensive feeding of larvae and insects. The scope of the damage to the wooden elements indicated that the destruction of the built-in structural timber took place in the past period and in most cases related to the so-called wood destruction phase 1:

- phase 1: damage to the built-in wood - it should be assumed that the built-in wood in an air-dry state, which was an environment conducive to the development of nests of insects having a destructive effect on wood. The channels, which were locally visible on wooden elements, were characteristic of the presence of pests in wood, such as the common pests, house knockers and dry-cheeked pests. The scope of the damage that occurred confirmed the thesis that these insects may be present in the past, because, according to the available technical literature, insects from this group cause the greatest damage to wooden elements.

The occasional occurrence of damage to the wooden roof truss was also found in the range characteristic for phase 2 and phase 3:

- phase 2: damage to the built-in wood, caused by pests feeding on the wood in the air-dry state, but causing less damage and ending its development in the affected wood elements. Damage to wooden elements may have been caused by giant spruce or hard crumb feeding in them,
- phase 3: due to the locally increased dampness of wooden elements for many years, the damage could be aggravated by the feeding in the wood of the stubborn knocker, the football-eating rafter and the red wormwood.

4.6 Pipe and line installations

In the building intended for the final modernization, industry installations: pipe (water supply, sewage installation) and cable (electrical installation) were largely dismantled earlier - this concerned in particular the electrical and water supply installations. The installations disassembled in previous years were realized in accordance with the executive standards in force in previous years.

5 Concept of the scope of modernization works

Variant conceptual solutions for the modernization of the building are presented below, taking into account the preservation of its historic character:

OPTION 1 - overhaul with simultaneous liquidation of a basement floor by constructing an internal foundation bath, which had to be carried out in the following scope:

- develop detailed, multi-sector technical documentation in which the design solutions included will take into account the possibility of changing the way the facility is used and its intended use as an apartment building,
- during design works, particular attention should be paid to the following issues:
  - foundations - possible reinforcement,
  - external walls - revitalization of external walls (homogeneous, ceramic), application of design solutions ensuring standard thermal and acoustic insulation of vertical partitions,
  - inter-story ceilings - reinforcement of wooden ceiling beams combined with front and side anchoring, ensuring non-flammability of wooden ceiling beams and proper acoustic insulation of horizontal partitions,
  - wooden load-bearing structure (mullions and transoms) - local reinforcement and replacement of mechanically damaged wooden elements, affected by biological corrosion and damaged as a result of feeding larvae and insects,
  - wooden roof truss - disassembly of the existing roof truss and its reconstruction (boarding and load-bearing structure).
  - roofing - disassembly of the existing and reconstruction of the roofing,
  - chimney shafts - checking the tightness as well as the thrust and air exchange rate of the existing gravity ventilation ducts, extension of the existing gravity ventilation to the newly designed needs, installation of additional mechanical ventilation and air conditioning in order to ensure proper thermal and humidity comfort in the rooms intended for use as living quarters,
  - staircases - reconstruction of staircases with particular emphasis on the need to adjust the width of escape routes and fire protection of structural elements.

OPTION 2 – general renovation, taking into account the leaving of the external walls and temporary underpinning of the building structure with a system of spatial steel frames founded on foundation piles, which would enable the implementation of additional storeys sunk into the ground, which had to be carried out in the following scope:

- develop detailed, multi-discipline technical documentation, similarly to OPTION 1 (the content of the technical documentation will be varied):
  - foundations - reinforcement by capturing them to be done in the following STAGES:
    - STAGE 1 Execution of circumferential steel beams (double-sided) in the levels of the existing inter-story ceilings: above the basement, ground floor, first floor and second floor.
    - STAGE 2 Dismantling the ceiling above the basement.

- ∗ STAGE 3 Implementation of micropiles, inside and outside the building, in the area of the walls to be left. The joint of micropiles and the existing foundations should be finished with a reinforced concrete cap led above the bottom of the existing foundations, so as to ensure the cooperation of the existing foundations with the newly designed ones in the event of drying out of the concrete.
- ∗ STAGE 4 Installation of the main steel beams supporting the external walls, perpendicular to them in the previously made (broken) punctures through the foundation walls, based on the pile cap.
- ∗ STAGE 5 Execution of reinforced concrete perimeter beams, in simplified terms, the so-called cheek beams, based on micropiles, on both sides of the foundation wall at the level of the main steel beams supporting the external walls.
- ∗ STAGE 6 Installation to the main steel beams (made as part of STAGE 4) and to the perimeter steel beams in the levels of inter-story ceilings (made as part of STAGE 1) of the steel structure supporting external walls - the structure is made of steel trusses, special attention should be paid to the construction of vertical and horizontal bracing of the girders steel.
- ∗ STAGE 7 Dismantling of inter-story ceilings on wooden beams and elements of wooden supporting structure (wooden frames) to be removed.
- ∗ STAGE 8 Construction of an independent reinforced concrete structure or, as an alternative, a steel structure, constructed on the internal side of external walls, intended to transfer loads from the newly designed monolithic reinforced concrete ceilings. In the newly designed structural system of the building, the existing external walls will only fulfill the functions of curtain walls, braced with load-bearing elements (spatial structural frames) solely to ensure their stability.

– external walls - revitalization of external walls (homogeneous, ceramic), application of design solutions ensuring standard thermal and acoustic insulation of vertical partitions,

– inter-story ceilings - monolithic reinforced concrete, designed taking into account both ULS (Ultimate Limit State) and SLS (Serviceability Limit State) standard conditions, after prior dismantling of the existing ceilings on wooden beams and wooden supporting structure,

– roof truss - steel or steel and wooden, earlier disassembly of the existing wooden roof truss,

– roofing - disassembly of the existing and reconstruction of the roofing,

– chimney shafts - checking the tightness as well as the thrust and air exchange rate of the existing gravity ventilation pipes, extension of the existing gravity ventilation to the newly designed needs, installation of additional mechanical ventilation and air conditioning to ensure proper thermal and humidity comfort in rooms intended for use as residential premises,

– staircases - reconstruction of staircases with particular emphasis on the need to adjust the width of escape routes and fire protection of structural elements,

OPTION 3 – demolition of the existing building and its reconstruction which had to be carried out in the following scope:

- on the basis of the developed design, carry out the demolition of the existing building,
- develop detailed, multi-discipline technical documentation, similarly to OPTION 1 and OPTION 2 (the content of the technical documentation will be varied),
- during design works, particular attention should be paid to the following issues in the field of construction and finishing solutions:
  - foundations - foundation slab,
  - basement level (part sunk into the ground) - white bathtub technology,
  - the walls of the above-ground storeys - in reinforced concrete, monolithic technology [18, 29, 38–40] or made of small-size brickwork. In the case of local application of insulation with thermal insulation material on the above-ground part of the walls, the recommendations included in [10–13] should be taken into account,
  - inter-story ceilings - monolithic reinforced concrete, designed taking into account both ULS (Ultimate Limit State) and SLS (Serviceability Limit State) standard conditions,

- roof truss - steel or steel and wooden,
- gravity ventilation - during the reconstruction of the chimneys, the recommendations included in [20, 30] and [22, 23] should be taken into account. Particular attention should be paid to the height of the chimney shafts above the roof surface due to the adjacent buildings. In the event of the presence of shutters around the building that reduce the efficiency of ventilation, the possible use of rotary chimney pots, the so-called turbochargers for all types of ducts - ventilation, exhaust, possibly smoke, if used, as well as smoke

6 Conclusions

Due to the technical condition of the building to be modernized, it was necessary to take measures to stop its progressive decapitalization and thus to counteract the possibility of a pre-failure or failure.

The immediate reasons for the technical condition of the building were: a) imperfections of the technical solutions used during its construction, b) long-term use of the building, c) lack of regular periodic repairs and d) no major renovation of the building so far.

For technical reasons, it was possible to complete a renovation of the building under both OPTION 1 - taking into account the need to leave the external walls with the simultaneous liquidation of the basement floor by making an internal foundation bath, as well as under OPTION 2 - taking into account leaving the external walls and capturing the building structure with a spatial system steel frames erected on foundation piles, which would enable the construction of additional storeys sunk into the ground.

In the author's opinion, the optimal solution, taking into account technical and economic conditions and enabling the preservation of the historical value of the object, was the target modernization of the building according to OPTION 3 - including the demolition of the building and its reconstruction with the use of modern technical solutions, preserving the external body reflecting its historic character, as well as leaving, in accordance with with the detailed guidelines of the Monuments Conservator, the so-called witnesses to history.

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