Technical state and renovation of buildings of Wroclaw’s 19th century city centre development

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ABSTRACT: Most of Wroclaw’s city centre development occurred towards the end of 19th and at the beginning of the 20th century. After the Second World War, major repairs were generally not conducted in the buildings that had survived destruction, it was assumed that they would be demolished and replaced by new buildings, once they became too dilapidated. This meant that it was barely 10 years ago when repair and renovation of these buildings began. These buildings have achieved expected mean time of service life, i.e. about 100 years, taking into account that they had not been repaired for so long. Now these buildings are in very poor technical condition. The review of about 80 buildings was carried out by the authors. This paper is an attempt to summarize the results of that assessment and to present ways of partially or fully revitalizing these structures.

1 INTRODUCTION

The authors performed several tens of technical assessments and did construction designs concerning fragmentary and major repairs of Wroclaw’s late 19th century city centre buildings. This article is an attempt to summarize the results of performed assessments, and to put forward ideas on ways of repairing these kind of buildings.

2 A GENERAL DESCRIPTION OF THE BUILDINGS UNDER REPAIR

Most of the city centre buildings in Wroclaw were erected at the end of the 19th century or at the beginning of the 20th century, in a quarter settlement, with compact sequences of buildings along particular streets. These are generally four- or five-storey buildings with cellars and with what is called traditional construction. The walls and foundations are made of brick, and the ceilings above the cellars are solid, of the Klein type or in the form of segmental barrel vaults on steel beams. The floors between storeys are of wood with a sound boarding. The rafter framing is wooden, most commonly of bidding rafters and rafters, with a characteristic so-called false Wrocław roof, i.e. a slanted roof slope covered with roofing tile at the front and a flat part covered with roofing paper at the further back. The staircases are usually steel, of the stringer type, with wooden stair treads, based on solid staircase landings made of Klein board on steel beams. The balcony structure is a solid bracket. Steel beams are the carrying items, and between them there is a Klein slab (a brick plate with steel reinforcement), brick placed on T-bars or prefabricated reinforced concrete slab.

3 A DESCRIPTION OF THE TYPICAL TYPES OF DAMAGE TO BUILDINGS AND THE REASONS FOR ITS OCCURRENCE

In Poland, the time of service life of the described buildings, by which we mean objects with brick walls and wooden floors, is estimated at about 80–120 years. After the war, it was assumed that as they achieved a high enough level of dilapidation, these buildings would be demolished and replaced with new ones. Thus no repair work was done, not even the most basic kind in many cases, which left the buildings in a significant state of disrepair, and some in almost disastrous condition. Not until recently have overhauls of a few theses buildings been done and repairs on other started. Since not enough funds are assigned for the latter purpose, these repairs are usually local, most often concerning elements in a failure or pre-failure condition.

3.1 Foundations

The foundations of the discussed buildings are made of common burnt brick on lime or cement-lime mortar. During their erection, the buildings did not have any horizontal insulation installed; there was usually a
circumferential pipe drainage made. During war activities, the draining system got damaged and was never repaired. This caused long-term saturation in the foundations and cellar walls and structural brick and mortar damage (slacking). At the moment, horizontal insulations are being done by resin injection, and the most damaged brick foundations are being strengthened by injections or by the placement of concrete.

3.2 Load-bearing walls

The walls of the buildings are made of common burnt brick on lime mortar. The thickness of the walls is between 62 and 72 cm in the cellars and on the ground floor, and up to 42 cm on higher floors. These walls are generally in a good technical condition. In general, it is only the decorative elements, external plaster and flashing work which have become damaged. The wall brick became corroded on the surface, especially at ground level (Figs 1, 2) where it is most exposed to rainfall splashing. Here and there, on the walls inside the flats, there are traces of freezing and moistening. These walls do not fulfil requirements of currently obligatory thermal standard, but their insulating power is good enough, so the kinds of failure described above are local and are most often caused by a loss of cornices, plaster or flashing work on the elevation, or by leaks through the window woodwork. Due to the historic character of the buildings, there is no permission to additionally protect them from the effects of cold, but it appears that it will be enough to repair the described failures.

3.3 Floors above cellars

The floors placed above the cellars are of a solid construction. They are Klein slabs or segmental barrel vaults based on steel beams (Fig. 3). In most cases, the floors are humid, and the steel beams, brick vaults and their pointing are corroded on the surface. Increased humidity in the cellars caused by the lack of effectively operating drainage and horizontal and vertical insulation had an influence on the development of the corrosion. In extreme cases, complete corrosion of the intersection of the steel beams intersection may occur. Steel delaminating may also occur, because, due to its production process, the steel from this period of time is vulnerable to this kind of damage.

The repair procedures consist of exchanging the most damaged floor fragments, strengthening the existing beams, or cleaning and applying anticorrosion protection.

During the repairs, the cellars are dried, and the brick vaults are pointed. In the case of vault surface damage, strengthening work is done using appropriate substance, and the vaults are pointed.

3.4 Floors between storeys

The floors between the storeys are wooden, with sound boarding. In places, where the manner of their usage was not changed, they most often remained in good
technical condition. During the years after the war, in the majority of flats, the functional and spatial arrangement was changed. Before the war, in most cases, on every storey there were one or two flats and the toilets were usually situated on staircase landings (Fig. 5).

After the war, these flats were divided into a few separate flats, sometimes even five or six. This meant that new kitchen spaces, and later on bathrooms and toilet had to be created, on completely ill-adapted wooden floors (in the original layout, solid floors underlay the kitchens and bathrooms). While spaces were adapted for these goals, very often there were no moisture insulations made on the floors. This caused their saturation with moisture, and later, biological corrosion. Because of that, there have been a few serious ceiling failures, even involving injury as sections of inhabited flats collapsed into inhabited flats on lower floors. While the arrangement of the flats was being changed, some of the dividing walls were moved or removed. The original dividing walls had a timber construction with a brick filling. They were based on single wooden floor beams. The load capacity of these beams was too low to transfer live loads and the dividing wall weight, but these walls either had originally been placed up the whole height of the building, thus supporting one another, or had co-operated with floor beams, creating framework structure.

When new doorways were made in or removed from these walls, this structure was violated. Also, the floor beams loaded with the new walls were not adjusted to this purpose, and show deflections and damage. The beams exploited as per their original designation retained a suitable load capacity and are not excessively deflected. Most of them were not biologically corroded, because, although the wood was not protected against corrosion, the resin was not removed from the beams that were used; this was enough to prevent damage. At the moment, the damaged floor items are being exchanged with new ones, and in wet-use rooms (kitchens, bathrooms, etc.) solid floors are being installed. Renewed transformation of some flats to their original layouts is also occurring as smaller flats are purchased and joined back into one or two larger flats.

3.5 Roofs
The roof structure is wooden, mostly built of rafters and bidding rafters, distinguished by the fact that from the front of the building, the hipped roof end is slanted, covered with roofing-tile, while further back, it is flat, covered with roofing paper. The technical condition of the rafting framing depends on the tightness of the roofing and the condition of roof work, gutters and down-pipes. In the damaged parts of these elements, biological corrosion developed almost immediately, sometimes along the whole thickness of the intersection (Figs 6, 7).

The most endangered elements were the wall plates, which are almost completely damaged in most buildings. Within the correctly secured roof slopes, most of the elements are in a sufficiently good condition.
They are generally only superficially damaged by larvae of wood borer (woodworm larvae). Often, because of wide leaks on the hipped roof end, the wooden floor of the attic and even the floor of the storey below suffered biological corrosion.

The ends of the attic ceiling beams based on the external masonry are especially endangered by biological corrosion. This is caused by excessive moisture in a wall coping connected with leaks in the gutters and roof work.

The damaged elements of the roofing are being exchanged during the repair process.

3.6 Balconies

The bracket structure of the balconies is solid, based on steel beams. The filling is composed of Klein boards, prefabricated ferro-concrete slabs (Fig. 8) or bricks, based on T-bars (Figs 9, 10). The structural condition of all the c. 150 assessed balconies is bad. The fillings, composed of bricks or boards are corroded, there is loss of plaster and fillings, and there is also balustrade damage. In all the balconies, there is also a corrosion of carrying beams. In extreme cases, this damage caused the
balconies to collapse. After these malfunctions, many balconies were stamped. The cause of this damage is long-term life-service, environmental aggression, and also a lack of suitable preservation (no suitable water drainage, choked inlets, no preservation of insulation, no finishing layer). At the moment, all the balconies are being exchanged for new ones (depending on financial limitations), and their structure and finishing is being reproduced.

3.7 Stairs

The structure of the flights of stairs is light steel, with wooden stair treads (Fig. 10). These flights of stairs are based on solid staircase landings made of a Klein slab on steel beams. The condition of steel structure is usually good. Only parts of the steel elements and some whole stair treads and balustrades need to be exchanged. Stone and masonry vault stairs can also be found.

3.8 Installations

The installations, for example the sewerage and electrical installations, in the discussed buildings are in various states, but usually bad. They generally need total exchange or unification. This is the most difficult part of current repairs. It requires interference in every flat and great expenditures. This kind of repair is also of great importance in terms of safety.

4 THE METHODOLOGY OF THE REPAIRS

Before building repair is commenced, the archival documentation must be examined. In Wroclaw, the formerly German construction archives have been kept in good condition (Figs 11, 12). They cover most of the city centre buildings. Based on these papers, one can state whether an object was rebuilt or extended after the war and how the functional and spatial arrangement was changed.

After doing archival research, an assessment of the technical condition of the building is made. In this assessment, damaged parts and ways of repairing are determined. The degree of building wear is also specified.

An evaluation of the technical wear of any building or its element can be made by methods with different numbers of details in respect of an observation and description of the building. The macro-evaluation of the technical wear of building is being worked out basing on time method. The time method describe the technical wear of the building or its element as a function of the durability and life service period. A mathematical form of this function is formulated appropriately to the way of building maintenance, in a meaning of carefulness and frequency of conservation and repairs.

Methods of an individual building observation are more penetrating. A range of observation depend on the accessibility to building structure. This accessibility is limited during building service life. Reliable conclusions can be drawn after uncovering building structure. Usually it happens after making the decision of starting to repair the building or its part. A
possible risk in the evaluation of the building wear considers usually economical matters. Modern tech­
niques used in building industry permit a quick reduction of errors in the evaluation and bring the building to the state that meets investor’s demands (Marcinkowska & Berkowski 2001).

Depending on the degree of structural deterioration, the object is qualified for repair, major repair or demolition (Table 1), if other factors (social, maintenance or functional) do not decide about this. Then, depending on the gathered funds, a modernisation of the building is commenced. At the moment, because of a chronic lack of funds, this is often only a partial repair, securing the most damaged elements.

Below, in outlines, selected repair methods of basic structural elements of renovated buildings are described.

4.1 Foundations

In case of the necessity of foundations repair or strengthening, according to the type of damage or designed future functional assignment of repaired building, there are applied different techniques of repairing or strengthening (Zaleski 1987, Masłowski & Spiżewska 2000):

1. widening of existing foundations by adding of one- or two-side concrete elements or underpinning with wider RC continuous footing
2. replacement of weak foundation’s parts with ground strengthening
3. replacement of the whole old foundation with a new one, starting from its weakest part with introducing of walls strengthening rested on these foundation
4. underpinning using expansive concrete
5. leaning of foundations on grouting or drill piles in case of weak or wet soil.

It should be stated out that old foundations were generally designed with great safety factors, so these structures have rather significant strength reserves. In this cases, stresses in the soil ought to be verified before taking a decision of foundation strengthening.

4.2 Walls

In case of cracked walls the analysis of crack system is realised. Among other things, there are studied: lay-out and running of cracks, measurements of their width and depth, changes of their running during building life service. In many cases the lay-out of cracks helps to identify the cause of their formation. One can start to eliminate cracks after the elimination of the causes of their formation. According to the size of damage or the type of element to be repaired, the following techniques can be used (Zaleski 1987, Masłowski & Spiżewska 2000):

1. mortar injections into small cracks that are running through joints between bricks
2. re-erection of cracked masonry with new bricks
3. in case of wide cracks, they can be additionally “quilt” using steel rods or strengthen with steel bars
4. column strengthening using steel or concrete reinforcement
5. repair of headers by introducing steel or concrete beams
6. in case of longitudinal and lateral walls, parting anchoring using steel strings or glued ties can be applied.

Wall repair is finished with plaster work, renovating of stuccowork and other decorative elements. If it is possible the walls are also protected from cold and wet.

Table 1. Technical condition classification of buildings.

<table>
<thead>
<tr>
<th>Element condition classification</th>
<th>Building element deterioration percentage</th>
<th>Criteria of element assessment</th>
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</thead>
<tbody>
<tr>
<td>Good</td>
<td>0–30</td>
<td>Elements of the building (or a sort of construction finish, fittings) – are well-kept and preserved, and correspond with standard specifications. Only current preservation is required.</td>
</tr>
<tr>
<td>Average</td>
<td>31–50</td>
<td>Elements of the building are kept appropriately. Local damage and losses are acceptable. Current preservation and repair work of single elements of the building are required.</td>
</tr>
<tr>
<td>Poor</td>
<td>51–70</td>
<td>Elements of the building have considerable damage or losses. Features and qualities of built-in materials have a reduced class and technical wear. Complex repair of the building is required.</td>
</tr>
<tr>
<td>Unsatisfactory</td>
<td>Above 70</td>
<td>Elements of the building show considerable damage and wear; they may endanger a security of tenants. The major repair or demolition is required.</td>
</tr>
</tbody>
</table>
4.3 Solid floors above cellars

In the repair of damaged solid floors above cellars there are used:

1. replacement of the whole floor structure, i.e. steel beams and masonry vaults with RC slabs on steel beams
2. in case of large-span vaults strengthening is made by applying RC shell.

4.4 Wooden floors and roofs

Repair of the damaged wooden inter-storey floors and rafting framing is conducted with classical technologies or using glued connections (Jasięńko 2003, Masłowski & Spizewska 2000). Conventional methods are as follows:

1. replacement of the wooden floor with the concrete monolithic or prefabricated slab floor on steel beams
2. strengthening of the floor structure by making an additional, independent steel bearing structure that can carry on all the loads except own floor weight
3. suspending of the existing floor structure to a new bearing construction; in this case all the loads are carried on by the new floor
4. strengthening by using new elements that collaborate with existing floor or roof elements: wooden or steel cover plates, replacement of damaged wooden beams parts, applying of concrete plate laid on the old wooden beams (Godycki-Ćwirko & Mielcarek 1997), strengthening with steel strings
5. replacement of the whole wooden roof structure with steel trusses.

Unconventional methods consist of applying the technology of steel rods or plates resin inserting or sticking reinforced carbon strips (Jasięńko 2003).

4.5 Balconies

The balconies are the most often repaired constructional elements of the old buildings. It is because of their great level of destruction and threat it means for their tenants. In the process of balconies repair there are used:

1. replacement of the whole structure, i.e. steel bearing beams and slabs, by using new RC slabs on steel girders
2. leaving the existing steel beams (in case of their good condition) and replacement of Klein or Wygasch plates with RC monolithic or prefabricated slabs.

In all these cases there are placed new modern insulations and all the decorations and railings are renewed.

5 CONCLUSION

After making overhauls in several tens of buildings from the turn of the 19th century, one may generally state, that their traditional structure with solid brick walls and wooden floors bore the passage of time passing.

In spite of great war damage, and later on, long-term lack of any repairs, the basic elements of these buildings were not damaged, and they preserved their service values (Figs 13, 14). Sometimes over 100 years from their being built, it is clearly visible that with suitable preservation, the term of their service life can be longer than theoretically assumed, i.e. 80–100 years.

At the same time, one can unambiguously feel that the basic factor which has an influence on the term of a building's existence is its current, careful preservation. Even a little negligence, such as a long lack of exchange of a damaged gutter, can lead to a malfunction of a whole fragment of a building.
The second extremely important factor, determining the term of building service life is its use in accordance with its original functional and spatial arrangement. All functional changes should be reconsidered and adjusted to the character of the original building structure.

REFERENCES


Even partial repair, removing the most damaged elements, leads to the housing community, which is generally the owner or co-owner of objects, more willingly decide to undertake further modernizing work, sometimes of a wide range (Figs 15, 16).