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Defects of modern wood windows – examples of expert reports

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Abstract: *Defects of modern wood windows – examples of expert report.* The paper presents the most frequently found manufacturing and installation defects of wooden windows. The defects described here relate to the quality of wood, protective coatings, manufacturing, and installation methods. All the presented problems have been the subject of expert opinions and reports elaborated by the Building Research Institute. The paper considers both the causes of the defects, as well as their influence on the functionality of windows.

Key words: window, wood, defects

INTRODUCTION

Despite the long history and tradition of use of wood windows in housing, they are still often manufactured incorrectly, leading to defects found during use. Such defects can affect the aesthetic value of the windows, but also have a highly negative influence on their performance parameters, such as durability, sealing and thermal insulation. This can be due to insufficient personnel training or failure to comply with the technology procedures. In the case of wood windows, it is extremely important to use carefully selected protective coatings, which need to be applied correctly. It must also be remembered that not every type of wood is suitable for the production of windows.
Irrespective of the quality of the windows themselves, their proper installation also requires utmost attention. Even a top class window, when incorrectly installed, will fail to satisfy the user. In such cases, users usually blame the window for draught, frost penetration etc., without considering that this may be due to faulty installation.

CASE STUDY

The Building Structures and Elements Department of the Building Research Institute deals with the problems related to windows and doors made of wood, PVC, aluminium, etc., not only in the scope of strength and functionality testing or component tests, but also in evaluation of the installed windows and doors, checking them for correct manufacturing, selection of proper materials, and installation.

The following part of the text presents – based on the experience of the elaborated expert reports – the most typical and non-typical defects of wood windows. Generally, windows are manufactured properly, using the approved glued wood, hardware, glazing, seals, coatings and silicones.

However, the functionality of the woodwork is incorrect, because its condition indicates that after installation the hardware and leaves were not properly adjusted, which is the responsibility of the manufacturer. And for this reason [lack of adjustment] in some cases the woodwork already shows some significant symptoms of reduced functionality, which can be corrected immediately after installation. Lack of manufacturer adjustment can lead to the following faults:

- Missing parts of hardware – catches are fixed to posts, but there are no rollers in the respective places to engage the catches,
- Lowered, non-adjusted leaves,
- Loose, falling out leaf drip caps,
- Rabbet gap size from 3 to 5 mm.
    - According to technical documentation, the external rabbet gap should not be bigger than 0.5–1 mm. Larger gaps lead to cooling of the external grooves and increased inflow of rainwater.
    - Groove measurements indicate that they are misplaced, which causes problems in adjoining the middle seal to the rabbet. The seal did not adjoin to the rabbet. Misplaced hardware, moved away from the groove.

- The 3 mm outer gap and misplaced hardware indicate that the window leaves were set back relative to the window face by 3 mm [into the room].

Incomplete installation of windows in the building [uninhabited buildings]. Polyurethane foam was left unprotected, causing its decomposition and disintegration. Windows were installed without supporting blocks or fixing to the sills.

In such cases the most frequent defects were:

– Seating of the leaf frame relative to the window frame should be: external rabbet gap = 0.5 mm [leaf frame to window frame offset], and the rabbet size = 4.0 mm [leaf frame overlapping the window frame] – uniformly over the entire circumference of leaves. External rabbet gap size from 3 to 5 mm. This causes the woodwork to fail to seal against the air and rainwater – visible marks of rainwater seepage on the window frame grooves, dirt in the grooves. Water leaking under the leaves percolates into the window frame wood [grooves are not protected by aluminium drip caps]. Water contained in the moistened frames evaporates outside through the face of the sill frame – this causes wood discolouration, moisture stains and paint delamination.
– Quality of wood used for the woodwork was doubtful because of open vessels of the wood, porous, uneven, rough surface. Such spots are susceptible to discolouration and delamination of the paint layers, wood greying under the influence of water.
– Evaluation of the paint coatings:
  - rough and coarse surface of the painted frames, glazing strips, grooves,
  - discoloured paint at high wood porosity spots,
  - locally missing paint, dirt and discolourations,
  - paint delaminates and flakes,
  - relative low hardness of the paint coating – confirmed by susceptibility to scratching with a scriber or fingernail,
  - adhesion of paint coatings to the substrate – measured using the cross-cut test acc. to the PN-EN ISO 2409:2008 standard; resistance to delamination from the substrate was locally 3 or 5, which is the lowest degree,
  - insufficient paint layer thickness – measurements indicate thickness of two layers from 40 μm to 50 μm,
  - paint tears off from the surface with adhesive tape [tape used in coating adhesion tests],
  - paint can be scraped off by rubbing with a rice brush [used for cleaning the surface during coating adhesion tests],
  - wood porosity indicates that the paint has penetrated the wood structure during the painting process.

Fig. 1. Incorrectly jointed window

Fig. 2. Incorrect joint between the window frame and the post

Installed aluminium/wood woodwork. The user questioned the woodwork quality in terms of acoustic insulation, sealing to air and rainwater, and lack of functionality.

The following was found in this case:

- Lack of woodwork functionality caused by leaves jamming against the lower frame members – due to their lowering.
- Condition of the corners and tenon joints indicated their incomplete gluing and unsticking.
- Faulty setting of hardware catches in grooves – they protruded and pushed the leaf frames away from the grooves – pushing into the grooves is required. Rollers of the circumferential hardware did not couple with the catches.
- External aluminium covers of locks and transom posts did not have sealed ends so external air and rainwater could penetrate under the covers. Some of the covers were installed misaligned.
- Glazing was defective and incorrectly installed. Panes could be moved from the grooves without using much force. At wind blows, air suction caused the panes to vibrate. The reason was low pressing of the panes to the glazing grooves by aluminium covers. Some clips [for strip fixing] were loose and the cover strips were unsticking, causing lack of sealing.
- Rabbet seals at joints became unglued, and in the window frame sills the seals were not pushed into the seal fixing grooves. This caused lack of sealing at the rabbets and air blowing through the rabbets.

Installed woodwork made of Meranti wood

- The quality of the wood raised objections due the following findings:
  - slanted course of grains, grain strands,
  - insect holes,
  - surface discolouration.
- Longitudinal micro-cracks of paint coating occur at the places of such faults. Moisture from air and rainwater [flowing down the frames] can freely penetrate into the wood structure through the micro-cracks. Moistened wood is affected by biological corrosion [wood darkening visible as black streaks]. This is also due to the highly porous wood structure. Vessel channels are exposed and open. Such moistened spots cause the paint coating to deteriorate and delaminate. Water percolates into the wood through the open insect holes.
- The window framework uses jointing of the external strips with spline joints. Acc. to standard PN-EN 14220:2007 "*jointing using spline joints is not acceptable in the case of components finished off with transparent coating, unless otherwise specified in the contract"*. When the woodwork delivery contract does not separately agree on the use of spline joints, the use of such joints should not take place.
- Glazing. "*Fitted glazing shall be sealed with silicone sealant, filling the following spaces: between the frame and the pane – on the external side, and between the pane and the wood glazing strip – on the internal side. The silicone sealant shall be applied continuously on the entire circumference of the leaf, and the sealant surface shall be smooth and inclined from the pane, conforming with the inclination of the leaf frame and the wood pane strip"*. The silicon used for the window glazing was applied in insufficient amount, and its surface created a convex meniscus. The meniscus surface caused rainwater to collect and permeate into the wood. This caused intensive moistening of the wood, deterioration and delamination of the paint coating. Damages were caused by moisture migrating from the wood structure to its surface.
- Execution of joints. "*Wood components of window frames shall be jointed at corners using double tenons. Wood components of leaf frames shall be jointed at corners using double tenons or two-and-a-half tenon. Joints shall be glued using a glue conforming with the applicable requirements.* The joints between the leaf frames of sliding patio doors, due to continuous and long-term influence of moisture and water, became swollen. The joints lost their sealing and weakened.
- Seating of leaves relative to the window frames. *Seating of the leaf frames relative to the window frames shall be: external rabbet gap = 0.5–1.0 mm, internal = in contact [leaf frame to window frame offset], and the rabbet size – external = 9.0 mm, internal = 4.0 mm [leaf frame overlapping the window frame] – uniformly over the entire circumference.* Frames of the window leaves were bent in the plane by about 3.0 mm [or unevenly set by hardware]. The rabbet gaps were 3 mm

(leaves were offset and bent), and the offset of the leaves was up to 3 mm. This caused the windows to lack sealing against air and water, and the hardware catches did not couple. The defects resulted in a lack of air sealing at the rabbets [rabbets with visible stains of dust].

Fig. 4. Improper hinge

Fig. 5. Badly made protective coatings

Installation of a glazed, wood façade. One of the expert reports says:

- Between the horizontal wood frames that contained the glazing [sill and header] and the wood posts there were no mechanical joints – neither with tenons, pins, or steel joints, screws, bolts, nor any other types of jointing elements. The lower frame member ends were attached to the cavities milled in the posts and glued. The upper frame members were attached using butt joints – without additional jointing elements, and pushed into the post undercuts with the use of glue.
- The posts were breaking apart at the joints. The glued butt joints were unable to provide permanent fixing. Applying silicone sealant to the joints that have broken apart proved completely ineffective. Moisture and rainwater could penetrate the joints, causing even more extensive unsealing. Posts had no fixing at the top ends – probably the installers had forgotten to fit the fasteners foreseen by the design.

The never-ending dilemma: are windows to be installed before or after the wet works?

- The windows were installed before completion of the wet works on site. During these works, there was excessive air humidity at the temperatures of 6–8°C, and the rooms were not properly ventilated – the forced ventilation was not put into operation yet at this point. Also the air diffusers were closed. Due to very high humidity, moisture was condensing on the cold walls (leading to development of fungi), headers and window frames, and also on the window components – glazing along the aluminium frames, sash bars and hardware. This led to moistness of the woodwork frames and more excessive condensation of moisture; the measurements indicated wood humidity exceeding 30%.

Fig. 5. Moisture condensation on the windows installed before completion of wet

Fig. 6. Incorrect installation and sealing of adjoining windows

- Long lasting moisture in the rooms caused condensation and creation of water drops on the inside of the woodwork and consequently water penetration into the wood. Swelling of the wood under influence of rainwater and moisture caused loss of sealing in glazing seating. Rainwater could easily penetrate under the glazing and into its seating grooves, where it could collect and percolate into the unprotected wood, thus reducing the thermal insulation of window frames.
- Similarly, water could easily penetrate into cracks of tenons and gaps of the tenon joints – rainwater on the external surfaces and condensation water on the internal surfaces.
- For the above reasons, the framework wood became moistened, causing reduction of its thermal insulation properties, consequently increasing the condensation of moisture on the wet and cold frames and cooled glazing.
- The following damages to the woodwork were observed: cracking and delamination of paint coatings, swollen wood, deterioration and ungluing of joints, warped glazing strips, silicone unstuck from the glazing, increased roughness of wood surface, difficulties in opening and closing of leaves, corrosion of aluminium drip caps and metal hardware, dirt on the rabbet seals.
- What should also be mentioned is the influence of moisture on the metal hardware of the woodwork, such as latching mechanisms, catches and screws, which were affected by corrosion causing reduction of their strength properties, and in some cases – even breaking.
- The woodwork lost its basic protections applied by the manufacturer – those were removed in order to install the woodwork – which, in many places, caused permanent staining of the components of the window and door sills, aluminium drip caps and hardware. In the observed cases the framework surfaces were stained by plaster and other mortars; in some cases those could not be cleaned from the frames. Similarly, hinges, latching strips, glazing seals, panes and silicone sealant became stained.
- The destruction was complete after grinding of the walls, floors and other elements, causing dust to permanently stain the woodwork hardware. During the installation works of horizontal water insulation applied on balconies and dominants, the lower parts of the woodwork were burned by the fire used for heating of the insulation materials.

SUMMARY

This document presents just a selection of manufacturing and installation defects of wood windows. The issues described refer only to several individual self-builders, as well as housing developers, where the number of such defective woodwork cases rises to hundreds, leading also to very serious financial responsibilities. Such numerous defects found in only one building not only prove carelessness of the manufacturers, but also insufficient supervision at the construction site. Improving this state of affairs requires popularization of knowledge regarding the correct manufacturing and installation of wood windows.

Streszczenie: *Wady współczesnych okien drewnianych - przykłady z ekspertyz* W pracy przedstawiono najczęściej występujące wady wykonania oraz montażu okien drewnianych. Opisane wady związane są z jakością drewna, jakością powłok ochronnych, wykonaniem okien oraz sposobem ich wbudowania. Wszystkie przytoczone nieprawidłowości były przedmiotem opinii i ekspertyz przeprowadzonych w Instytucie Techniki Budowlanej. W referacie podane są zarówno przyczyny powstania usterki jak i jej wpływ na funkcjonalność okna.

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