Public Weigh House, Bolzano (Italy)

Author: Dagmar Exner (Eurac)

Replacing the window with a replica

Windows

What is the solution?

This solution foresees to replace the original windows with a new window handcrafted, but energy efficient, solution to match the originals as far as possible. This means typically that the frame would be an exact replica of the original except for the fact that it was adjusted to allow for another type of glazing, i.e. double- or triple-layer low energy glazing instead of the typical single-layer glazing. The change of the glazing reduces heat losses significantly making the windows perform more or less like today's standard.

Why does the solution work?

Conservation: The retrofit solution corresponds to the requirements of the heritage authority preserving subdivision and the proportions, as well as frame and sash bar thicknesses. With the historic produced single glazing in the outer sashes, the window avoids the typical optic of a double glazing. Moisture safety: The window construction after retrofit is generally moisture safe. The coupled window is identical to a new casement window in terms of moisture and driving rain impermeability. The outer layer of window sashes does have no function in terms of moisture safety as it is not tightly fitted to the inner layer. Energy improvement: Replacing the windows means at a large reduction of infiltration, improving the "airtightness" of the building. In the existing building infiltrations cause a large part of the heating energy demand. With the "air leakage test" it was verified, that (the not well maintained) windows cause a main part of the ventilation heat losses. Taking into account the window energy balance (losses minus gains) the net losses can be reduced by 70% (double glazing vs. original window) or respectively 80% (triple glazing). Looking at the total energy balance of the whole building with 14% of window area and walls in natural stones, the exchange of windows can reduce the demand by up to 20%: 10% due to thermal performance increase, 10% due to airtightness improvement (need for indoor air quality considered, without heat recovery). • U-values existing (box-type) window: Ug = ca. 2,8 W/(m^2K); Uf = ca. 2,5 W/(m^2K); Psi installation (without parapet) = 0,238 W/mK; Psi installation (with parapet) = 0,194 W/mK; g-Value = 0,77 • U-values new window after intervention: Ug = ca. 0,57 W/m^2K; Uf = ca. 0,97 W/(m^2K); Psi installation (without parapet) = 0,164 W/(mK); Psi installation (with parapet) = 0,124 W/(mK); g-Value = 0,44 • Uw-value calculated for typical window size: 2,21 W/(m^2K) (before retrofit); 0,89 W/m^2K (after retrofit)

Description of the context:

The Public Weigh House is a building of Romanesque origins in the historic city centre of Bolzano in Italy. At the end of the 16th century, there was a large reconstruction of the building, unifying e.g. the dimensions of window apertures and extending the building on the east side. The window size is therefore typical for baroque era. The major part of the original windows was however replaced by box type windows in the 1950s/60s, just a few original windows are from the late baroque era with thin wooden profiles and single glazing (e.g. in the jutty on the north façade). The unified window size dating from the 16th is typical for baroque era, also profiled sandstone frames date from this era. For shading and darkening, wooden window shutters are used. Since the box-type windows of the 1950s/60s are not of historic value, they could be replaced, reproducing the appearance of a historic window. For the development of such a new window the aim was to (i) build a highly energy efficient window with Passive House quality and (ii) a window that answers to the heritage demands of the building.

Pros and cons of the solution:

Pros: (i) Energy performance of a heritage compatible window can reach passive house standard and can be improved significantly (Uw-value after: 0,89 W/m^2K), (ii) preservation of the appearance of a historic window: subdivision and proportions, as well as filigree thicknesses of the wooden parts and historic produced single glazing in the outer sashes. Cons: (i) View from inside to the outside: Relatively high frame depth, optic of the three panes and single pane in series, (ii) fundamental questioning from heritage point of view if composite windows is the right choice (when before the window solution of the 50/60s there was a single window). Innovation: Use of a extra-thin 3-pane glazing

(2-8-2-8-2 mm) with additional fourth outer pane with historic appearance.

Type of data available:

Photos, digital drawing, description, heritage value assessment (before retrofit), thermal simulation in Framesimulator, Uw-value calculation, evaluation of conservator afterwards, passive house component certification, publications.

Additional information about the solution:

Example Public Weigh House of Bolzano: As there were no drawings from the original historic window available, the new window was based on a coupled window, thus the developed concept separates the demands and functions into two layers: one outer layer for the reproduction of the original historic window and an inner layer for high energy efficiency. In this way, it is possible to obtain the same appearance like the original historic window from outside in terms of frame dimensions, sash bars and mirroring by taking a single glazing, without any negative effect on the energy efficiency. This outer layer takes over the weather tightness. The passive house window with triple glazing is integrated in a second additional inner layer, taking over the airtightness. By rotating the frame cross section 90 degrees and by moving the centre of rotation of the fitting, a smaller frame than the conventional solution was achieved. It is positioned in a way that its frame is not visible from the outside. Following to this approach, both box type and a coupled window are executable. Additionally, it allows also preserving the original old window and just adding the second energy efficient layer (on the inside or also on the outside). Since a building historian had discovered traces of cut out imposts (in some rare cases where the outer sashes the of box type window from the 1950s/60s where installed in an original baroque frame), the prototype was built with a horizontal impost and four window sashes (2 above, 2 below). As model served the still existing window with impost in the jutty. The use of the very thin triple glazing (2/8/2/8/2), with the thickness of a double glazing, made it possible that the frame proportion became even more fragile and the optic from inside becomes very similar to a double glazing.

Available pictures or puplications of the solution:

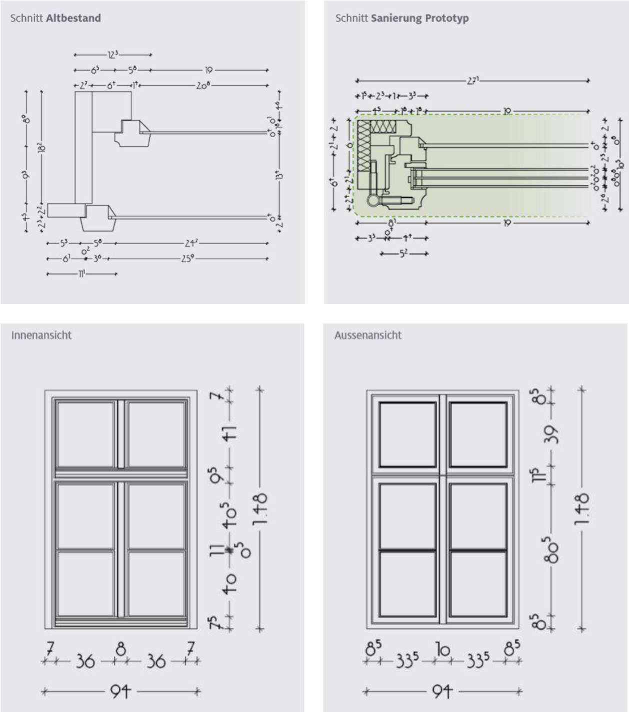
Public Weigh House 1958, www.fotobolzano.com

Public Weigh House 2011 (before renovation), EURAC

Box-type window from 1950th/60th (before retrofit), EURAC

Energy efficient prototype for a coupled window, EURAC

Detail energy efficient prototype, EURAC



Thermal properties	Existing window	Refurbished window prototype
Window type	Box-type window 1950s/60s	Coupled window
Glazing	Inner window: single glazing Outer window: single glazing	Inner window: thin triple glazing Outer window: single glazing with historical optic (2-8-2-8-2-25-4 mm)
Shading	Existing window shutters	Existing window shutters
Uw	2,21	0,89
Ug	5,75/5,75	1,22
Uf	2,40/2,14	1,22
g-value glass	0,71	0,44
Air tightness	No sealing	2-fold sealing
Approximate installation year	Building origins from end of 12th century, windows from 1950s/60s	Installation window prototype 2013

https://www.hiberatlas.com/smartedit/projects/89/18_international_Passive_House_Conference_Energy efficiency of windows in hist buildings_final.pdf
https://www.hiberatlas.com/smartedit/projects/89/D6.2_CS1_Public_Weigh_House_Bolzano_Italy.pdf
https://www.hiberatlas.com/smartedit/projects/89/02_RE_Planfenster_Waaghaus Bozen_03.pdf
Factsheet project PlanFenster

Link to best pracitce example:

http://www.eurac.edu/de/research/technologies/renewableenergy/projects/Pages/PLANFenster.aspx

Link to best practice example (Hiberatlas):

https://www.hiberatlas.com/en/timber-framed-house-in-alsace-france--2-45.html