Environmental Effects from Recycling Windows. A case study

Professor Bertil Fredlund PhD
Lund Institute of Technology
Dept of Building Science
Box 118
SE-22 100 Lund, Sweden
e-mail: bertil.fredlund@bkl.lth.se

INTRODUCTION

Background

The point of departure for this project is the method, the "Allbäck" method, established 15 years ago by the firm Fönster Hantverkarna AB for the renovation, restoration and maintenance of windows from different epochs. So far the method has been confined to restoring windows to their original state, with the limitations in thermal properties which this involves. In this project the method has been developed so that windows can also be given better thermal properties while retaining their aesthetic values. The project has been commissioned by Fönster Hantverkarna AB at Bjäresjö, Ystad. Finance for the project has been provided by Teknopol in Lund.

The problem

Traditionally, improvement of the U values of windows has entailed replacement of the windows or various methods in which this improvement is achieved by adding an additional pane to the window. These approaches are both expensive and detract from the aesthetic qualities.

A very sympathetic alternative to the established method is to improve the U value in conjunction with renovation by replacing the inner pane by a pane with a low emission coating. One problem in this approach is that the coated panes usually have a least thickness of 4 mm.

This gives rise to two complications. In the first place there is normally no room for a 4 mm pane in the existing glazing rebate which is intended for a 2-3 mm pane. In the second place, the pane is too heavy for the existing frame.

During discussions with Pilkington Floatglas AB it was found that the firm can supply coated glass of only 3 mm thickness at no extra cost or longer delivery times (Ref Tomas Grange). This makes it possible for a simple and aesthetically attractive solution to be applied in practice for upgrading the thermal properties of windows.

The aim

The aim of the project was to investigate and document improvement of the U value of renovated windows where the inner pane is replaced by a pane with low emission coating of the hard type. The test method and evaluation of measured values complied with the Swedish Standards applicable to new production of windows, so that the results may be used for analysis and comparison with the alternative where the window is replaced by a new one, and also that an assessment may be made of the effect that renovation and upgrading of the existing window has on energy use compared with the case that the window receives no remedial treatment.

PRESENTATION

Method

In order to achieve this aim, tests were made on unrenovated, renovated and upgraded windows in which the inner pane had been replaced by one with a low emission coating. Tests were made by the hot box method in accordance with Swedish Standard 02 42 12 (SIS, 1981). Evaluation conforms to the guidelines set out in Swedish Standard SS 02 42 13 (SIS, 1987).

Three windows were selected for the tests in consultation with Fönster Hantverkarna AB. These windows are constructions typical of the periods 1880, 1930 and 1980. The outside frame dimensions of the windows in the test series are ca 1.2 x 1.2 m. The properties of other window sizes were obtained by calculations with the program Frame plus (Frame plus Toolkit, 1995).

The windows selected for testing were carefully documented with regard to their condition prior to renovation. All action taken during renovation was also documented in detail. This work was performed by Fönster Hantverkarna AB.

Description of the test objects

The test series contained three windows from different periods. These are briefly described below.

Window No 1 was initially a four-light window from ca 1880 which was too large for our test equipment. A suitable specimen size was obtained after the two smaller upper lights had been cut away. Window No 1 is thus a "two-light window" for testing purposes, with two single panes, one in the outer casement and one in the removable inner casement. The glass thickness is 2 mm and the distance between the panes is 90 mm.

Window No 2 is a two-pane window from ca 1930. It has coupled casements in which the distance between the panes is 31 mm. Glass thickness is 3 mm.

Window No 3 is a product from the firm SP Windows. It was made in 1982. The window is fitted with a sealed unit consisting of three 4 mm panes, with 12 mm air gaps between the panes.

The frames and casements of all windows are made of pine.

Measurements on the two older windows, Nos 1 and 2, were made both in their original states and after renovation, i.e. among other things removal of paint, adjustment of the fit between casement and frame, and fitting of new sealing strips. The windows were finally upgraded which means that the inner pane was replaced by one with a low emission coating, in this case Pilkington Kappa Energy Float.

In the case of Window No 1, the influence of two horizontal glazing bars per light was also tested.

Measurements on the more recent window were made only with the window in its original state since it was fitted with a sealed unit that could not be taken apart.

Evaluation of tests

In order that a direct comparison of these three windows may be possible, the test results must be corrected with respect to differences in window size. This correction was effected using the program Frameplus (Frameplus Toolkit, 1995). Calculations can be divided into three types. The first step is to perform calculations on the windows concerned in order to gain an idea of the accuracy of the program. In a second step the effect of reducing or increasing the window size by varying height and width by 10% is studied.

Finally, the U value is calculated for Windows Nos 2 and 3 when their height and width are put equal to those of Window No 1, i.e. 1200 x 1200 mm. The theoretical relative difference between the actual window size and the basic case, 1200 x 1200 mm, is then used as the correction factor for the measured U values.

The maximum difference between the calculated and measured U values is 10%. This is the expected accuracy in calculations. This implies that Frameplus has adequate calculation accuracy for it to be used in correcting the measured U values with respect to variations in window size.

Results of measurements

The U values (W/m^2,ºC) of the three windows as measured in our laboratory (Fredlund, 1999) are set out in Table 1.

Table 1. Final results of tests and evaluation of U values (W/m^2,ºC) for older windows

Measure	Window type/year of manufacture		
	1880	1930	1982
Existing state	2.44	2.56	1.83
Renovated	2.07	2.26	
One new LE pane	1.60	1.77	

As will be seen from the table, the U values (heat losses) for the older windows after upgrading are in actual fact lower than that for the three pane window from 1982. The almost 120 year old window has the lowest losses.

It is further seen from the investigation that the effect of the glazing bar is relatively marginal. It makes no difference whether the glazing bar is fitted in only the outer casement or in both the outer and inner casements. For the 1880 window the U value deteriorated by 3—5% when the window was fitted with a glazing bar

CONCLUSION AND RECOMMENDATIONS

The study shows that heat losses through older windows can be reduced by ca 35% without any negative effects on the original architecture.

The method of upgrading is based on replacing the window pane, preferably in the inner casement, by a new type of glass with a low emission coating that is available in the market today. Pilkington manufactures this type of glass in 3 mm thickness which both suits existing glazing rebates and does not place too much load on the existing casement. A thicker glass may be too heavy. This type of glass marketed by Pilkington Floatglas AB is called Kappa Energi Float. The emission coat on the glass is a very thin metallic deposit. This metallic deposit is of a very neutral colour and daylight is reduced by only a few per cent. Because of this it is very difficult to distinguish these panes of glass from ordinary clear glass.

The effect of renovating and replacing the glass in the old window from 1880 is that this becomes much more competitive than when the old window is replaced by a new one. Heat losses are of the same order as in modern windows from 1980 to the 1990s. Since the low emission glass is not appreciably more expensive than ordinary window glass, there is great potential for improving existing windows at a relatively modest cost.

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