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THE AIRTIGHTNESS OF ROLLER BLIND BOXES

Rangel das Neves, A.; Abrantes, V.
Faculdade de Engenharia, Universidade do Porto
Rua dos Bragas, 4099 Porto Codex, Portugal

ABSTRACT. The generality of windows in portuguese housing, are protected from the outdoor by external roller blinds or roller shutters. Pursuing the study of the airtightness of buildings envelope, it is presented the characteristic curves of leakage flow, from some roller blind boxes. Graphs were constructed to permit direct comparison of characteristic curves for the two positions of the roller blind.

1. INTRODUCTION

The airtightness of building envelope is of considerable importance to indoor climate and energy consumption. The building airtightness primarily affects ventilation and thus heat losses. An energy balance for a normal family dwelling shows that the sum of intentional and unintentional ventilation, is an important item in the energy balance. It should be possible therefore to reduce the unintencional ventilation, this means, uncontrolled air leakage flows, through improved airtightness.
Apart from the effects on energy requirements, uncontrolled air leakage also causes discomfort, resulting in loud and widespread complaints of uncomfortable draughts and dust.

2. EXTERNAL SHADING DEVICES

The pressurazing method of the element, specified by Shading devices have been strongly influenced by the local temperature climate. In summer, hot days can occur, mean daily temperatures are within the range where occupant confort is possible, as long as daytime overheating is prevented through shading. The most effective way to reduce the solar load on fenestration is to intercept direct radiation from the sun, before it reaches the window. So, in portuguese housing the habitable rooms are shading with external shading devices.

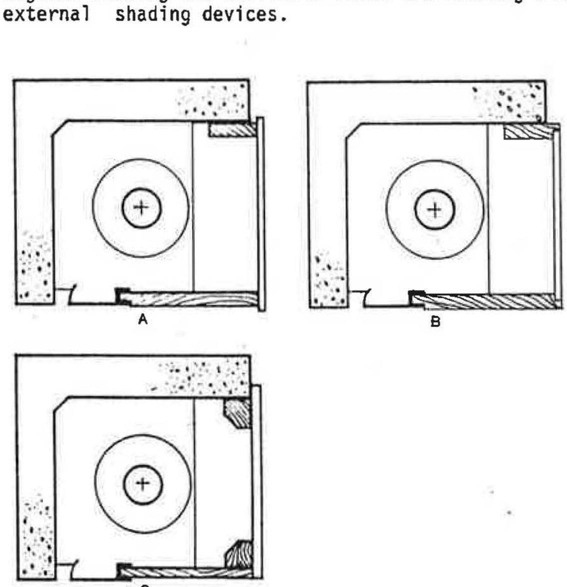


Figure 1: Roller blind boxes

The most representative device is the roller blind, made of rules of PVC and in a small percentage from aluminium. Pursuing the study of the airtightness of building envelope, this study turn up on roller blind boxes illustrates on Figure 1. This set of roller blind boxes is representative of the housing stock.
Figure 1 shows some of the constructional details, where no attention was given during the design and construction in order for the roller boxes to be airtights. Joints between edge beams and roller boxes materials are not design on the principles for achieving airtightness or thermal insulation. A wooden box frame supports wood board or plywood front cover and wooden bottom cover.

3. METHOD OF TESTING

ASTM Standard E283.84, and European Standard EN-42 Methods of Testing Windows, Part 1. Air permeability test, were used in this work.
The test consists of sealing a test specimen against one face of an air chamber, exhausting air from the chamber at different air flow rate and measuring the air flow through the specimen and the correspondent pressure difference.
A metalic enclosure frame was used to make possible to rebuild in laboratory a window with unchangeable dimensions, but allowed the construction under control from roller blind boxes.
Pressure measurements were taken with an electronic micromanometer having resolution of 10E-4 mm of water gauge and air flow was measured with two rotameters, one for flowrates up to 27 m3/h and the other for flowrates up to 175 m3/h. The rotameters had a 2% precision.
The exhaust system, with 700W, designed to provide 70 m3/h was controled with two spheric valves.
The static pressure tap into the chamber pressure was located in order that the reading was unaffected by the velocity of the air exhaust.
The system provided constant air flow at a fixed pressure for the period at last 10 s, required to obtain reading of air flow and pressure difference.
The roller blind boxes were subjected to increasing negative pressure from 40 Pa until 600 Pa or higher, and then the pressure was applied in the reverse order. Each box and for each estreme position of roller blind, was submited to three tests.
For each test, the higher of the two readings at each pressure, increasing as well as decreasing, was noted. The measurements from the three tests were then correlated to an equation, by the least squares method. The caracteristic curve of leakage flow as a function of pressure difference is given by:

$$q = f(\Delta p) = c(\Delta p)^n$$

where

q = air flow (m3/h)
p = pressure difference (Pa)
c = infiltration coefficient, air flow by unit of pressure difference (m3/h Pa)
n = exponent in approximate leakage function (0,5 < n < 1)

In order to compare different roller boxes, the curves were fitted for n = 0.65 and n = 0.67, the best approximation to n = 2/3.

4. RESULTS

Figure 2 shows three record readings corresponding to equal number of tests, for the same roller box and to the same position of the roller blind. This set of air permeability reading enable plott the characteristic curve of leakage flow as a function of pressure difference.

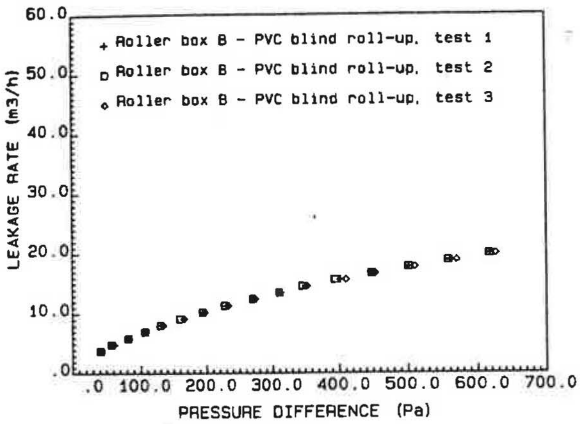


Figure 2: Roller box B readings test record, with PVC blind roll-up

This set of points is obtained by the application of standard EN42. The testing method is reliable. The precision and bias of the test method are quite good.
Figures 3 and 4 shows characteristics curves from tested roller boxes, and for the two extremes positions of the roller blind: roll-up in daytime period and roll-down in nightime period.

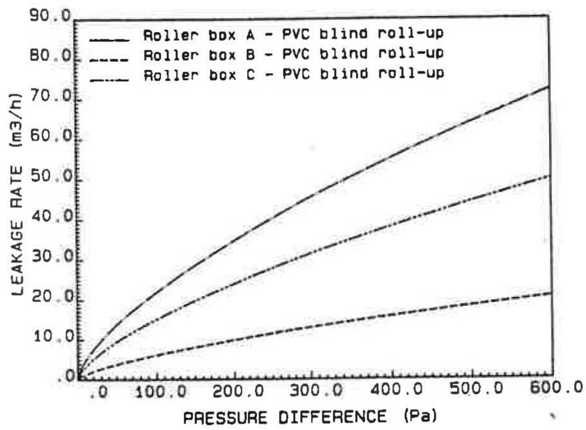


Figure 3: Leakage characteristics with PVC blind roll-up

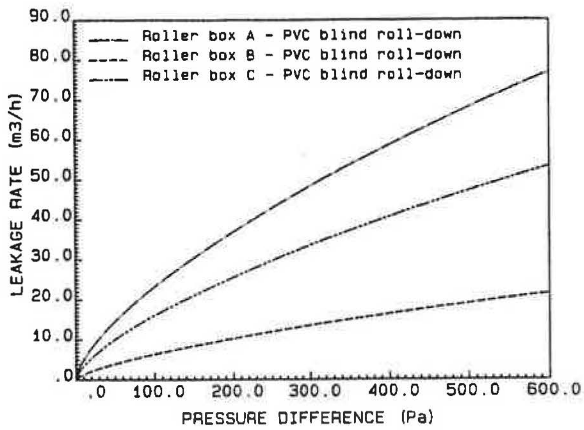


Figure 4: Leakage characteristics with PVC blind roll-down

In Table 1, the values of the flow coefficient c and flow exponent n are shown for all the tests.
The standard deviation and the correlation coefficient shows how the curves are a satisfactory criterion of goodness of fit.

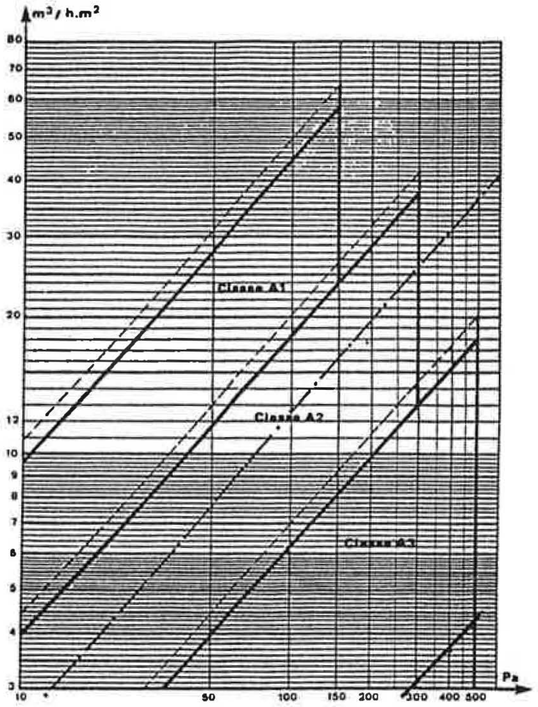
Table I: Experimental values of flow coefficients

Roller box	Flow coefficients c	n	Statistics σ	r
Roller box A				
roll-up	1.106430	0.65	0.902609	0.998556
	0.996955	0.67	0.598897	0.999364
roll-down	1.172166	0.65	1.059389	0.997944
	1.057847	0.67	0.737304	0.999005
Roller box B				
roll-up	0.321034	0.65	0.427048	0.996391
	0.286319	0.67	0.565365	0.993667
roll-down	0.332264	0.65	0.428107	0.996728
	0.296793	0.67	0.573790	0.994114
Roller box C				
roll-up	0.772772	0.65	0.309009	0.999717
	0.690623	0.67	0.268127	0.999787
roll-down	0.821708	0.65	0.139142	0.999958
	0.734138	0.67	0.396956	0.999657

In order to compare these results with the infiltration througt to the corresponding window, it was plotted the Figure 5. For the sake of simplicity, the presentation has been concentrated in one roller box and one type of window. This inswinging casement window is one of the most common in 80's.

5. CONCLUSIONS

Results indicate that infiltration rates through roller boxes are significatives in the contest of the whole infiltration balance of a building.
The set of thermal regulation, to be introduced soon in Portugal, it's very permissive to the envelope airtightness. But the awareness of the need to save energy and money, and improve indoor environment, in conjugation with the presented results, may be a contribution to the design improvement of these components, which could be a challenge to the portuguese architectural concepts of roller blind boxes design.
Depending on materials and design there are a number of available alternatives to ensure airtightness of roller blind boxes.



—— Aluminium inswinging casement window
—·— Roller box A with PVC blind roll-down

Figure 5: Inswinging casement window versus roller box, comparative leakages

Airtightness requires very careful sealing of joints with EPDM sealing strips or polyurethane foam, rigid or soft, and joint sealing compounds. For airtightness requirements to be satisfactory during the buildings life, there must be good resistance to aging in the construction materials used on roller boxes, and the design of the joints must be such that they can be maintained easily. Vapour barrier and thermal insulation are of fundamental importance to achieving new performance from this building component.

6. REFERENCES

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