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Research Communication

The Value of Pressure Testing to Establish the Viability of Retrofit Procedures for a High Rise Building

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1. INTRODUCTION

Part of the energy management programme currently being undertaken at Sheffield University is an analysis of energy flows in some of the larger buildings. Particular attention is being paid to the thermal performance of the Arts Tower, which is 78 metres high with a glazing ratio of 60%, as its annual energy usage averages 17 TJ of which a very significant amount can be attributed to air infiltration.

In order to quantify the air leakage coefficients, a pressurisation rig was developed to test the leakage of the windows including the seal between the window frame and the mullion.

2. TESTING OF WINDOWS

The Arts Building has some 1786 windows nominally identical. It would be a mammoth task to measure each window and it was therefore decided to categorise the windows in terms of the deterioration of the sealant between the frame and the concrete structure. The results quoted in this note are intended to show the ranges into which the infiltration coefficients fall rather than give precise coefficients for each window.

2.1. The overall values of window coefficients

A series of windows in each category were tested and their characteristics are plotted in

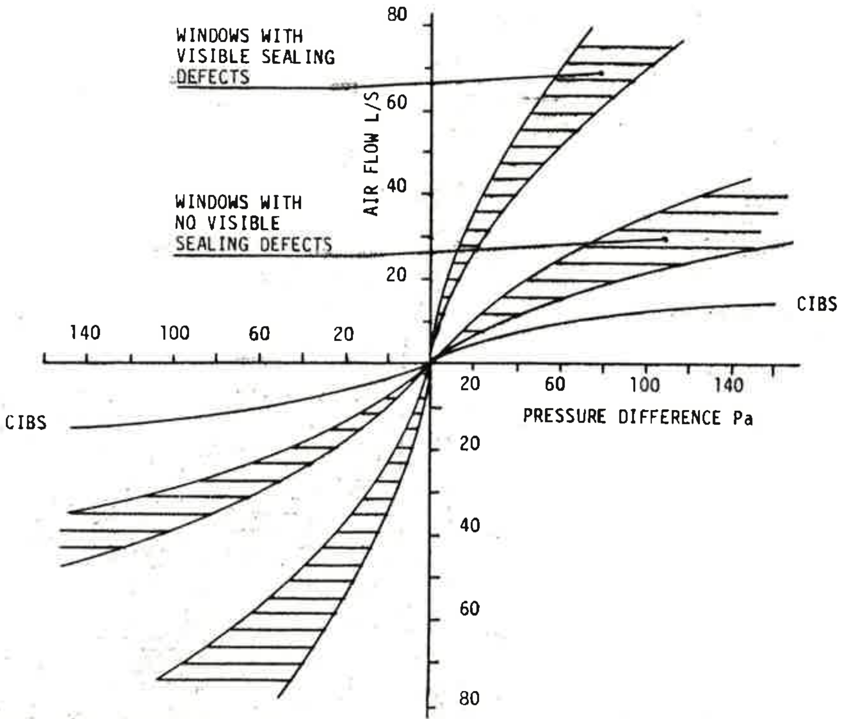

Fig. 1. Air flow measurements through windows from each category compared with CIBS suggested leakage values.

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Fig. 1. It is clear from this figure that in both cases the leakage is far in excess of the suggested leakage values from the CIBS Guide [1]. A flow equation of the following form is used to relate pressure difference (ΔP) to the flow rate (Q).

$$Q = C\Delta P^n$$

where C is the leakage coefficient and n is the flow exponent.

From the tests carried out the mean values of C and n are shown in Table 1. It is clear from these values that some form of remedial action would be beneficial in reducing air infiltration rates.

2.2. Weather-stripping of a window

During the test programme a manufacturer of weather-stripping material applied his product to a window as a demonstration of his product. A pressure test was subsequently carried out on this window and it was found that the product reduced the infiltration by some 65%.

3. PAY-BACK PERIODS FOR RETROFIT SEALING MEASURES

The infiltration coefficients obtained from the pressurisation tests were used as input to a computer program, which is designed to estimate likely pay-back periods as a result of the application of remedial measures. This program takes into consideration the length of time when the heating is switched on, along with an estimation of the wind profile which the building is subjected to. The results of this pay-back analysis are shown in Fig. 2 for two costs per square metre of glass for resealing joins and for resealing along with weather-stripping.

It can be clearly seen from this graph that acceptable pay-back periods can be obtained near the top of the building but as one comes lower down the pay-back period increases.

TABLE 1

Values for flow parameters C and n

Type	Mean	Standard direction	Units
No sealant defect			
C	1.266	0.33	L/ms
n	0.635	0.057	—
Sealant defect			
C	4.426	1.33	L/ms
n	0.55	0.07	—
CIBS value			
C	0.15		L/ms
n	0.63		—

REFERENCE

1 *Guide to Current Practice, Section A4 - Ventilation*, CIBS, London, 1978.

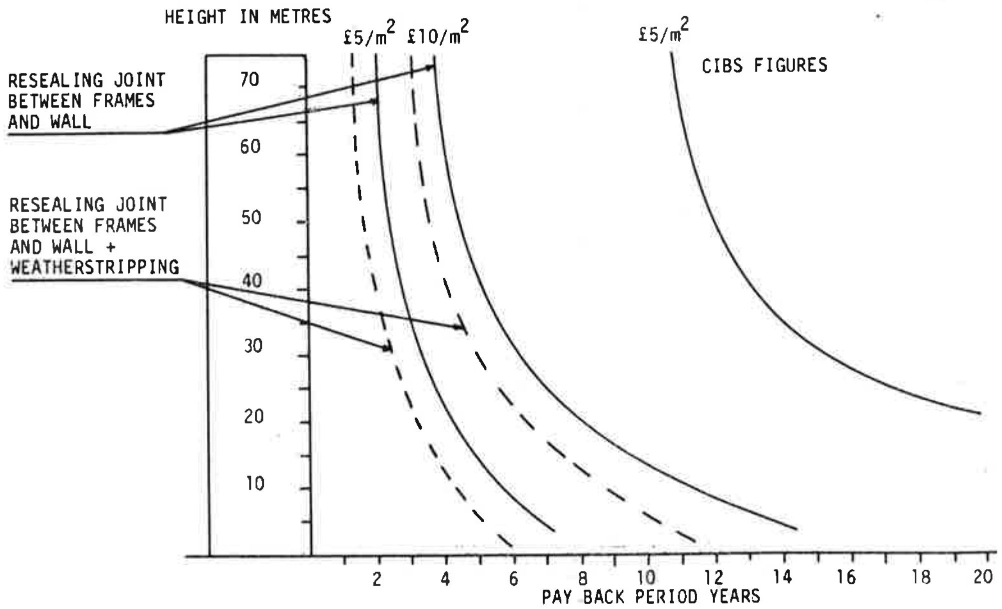

Fig. 2. Pay-back periods for modification to the windows in the Arts Tower.