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A FIELD STUDY OF INFILTRATION-INDUCED VARIATIONS

IN THE HEATING OF APARTMENTS

by

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Ottawa, April 1983

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Introduction

In a study of the energy consumption of apartment buildings[1], carried out for the Division of Building Research under contract, the possible effects of infiltration were given close scrutiny since there seemed to be some major differences between these buildings and similar ones with other occupancies. This field study was added to the contract with the objective of establishing whether or not these differences existed in practice, and in particular if stack effect causes significant variations in the heating requirements of apartments according to their location in tall buildings.

Stack effect is caused by the difference in density between a heated column of air in a building and a cold column of air outside. In a simple uncompartmented building, it will cause cold air to enter at the lower levels and warm air to be displaced at the upper levels; thus the lower apartments in a tall building would have a higher heating load than the upper ones. Such buildings are not, however, simple or uncompartmented; in order to provide the necessary separation between apartments, there must be no holes through the floors. Practical construction may not achieve a perfect seal but the main paths for air flow up the building are the elevator shafts and stairwells.

In order to prevent the movement of odours from one apartment to another, it is common practice to supply fresh air to the corridors and to exhaust a greater quantity of air from each apartment via the kitchen and bathroom fans. Thus, so long as the fans are running, there will be a flow of air from the corridor into each apartment, which will prevent any stack-induced infiltration from passing through the lower apartments, rising up the elevator shafts and stairwells and exfiltrating through the upper apartments. If this theory is correct, there should be no difference between the heating requirements of the lower apartments and the upper ones.

Methodology

A field study was made of three electrically heated high rise apartment buildings located in Chicago. Each apartment was metered separately. The buildings had 30, 42 and 45 floors of apartments, and in all of them the corridor supply fans and the central kitchen and bathroom exhaust fans ran continuously. The tenants' use of electricity was determined from the May and June energy consumptions, when there would be a minimum requirement for heating or air conditioning.

The heating consumption for December through March was then computed and plotted against the floor number. This was done in two different ways. The floor-by-floor method used the total heating requirement of all apartments on selected floors, while the shaft method used the heating consumption of a series of identical apartments located one above the other. A line of best fit was determined for each set of points and in order to check that this was not being skewed by a few points, a second line was determined after some of the more widely scattered points had been eliminated. Building A was divided into two sections for the floor-by-floor analysis because there was a change in apartment layout at mid-height. One set of apartments remained typical for the full height and was used for the shaft method.

Conclusions

The results of this study (Figs. 1 to 6) are far from conclusive, but they give some credibility to the theory that normal stack effect is suppressed in a tall apartment building when the supply and exhaust fans are running. Furthermore, since the effect on heating consumption is weak in buildings of over 40 storeys, it is probably negligible in the more common case of apartment buildings of 20 storeys or less.

REFERENCES

1. Slone, Chalifour, Marcotte, et Ass., A Study of the Effects of Some Parameters on the Energy Consumption of Apartment Buildings. Prepared for National Research Council of Canada, Division of Building Research, Ottawa, 1980.

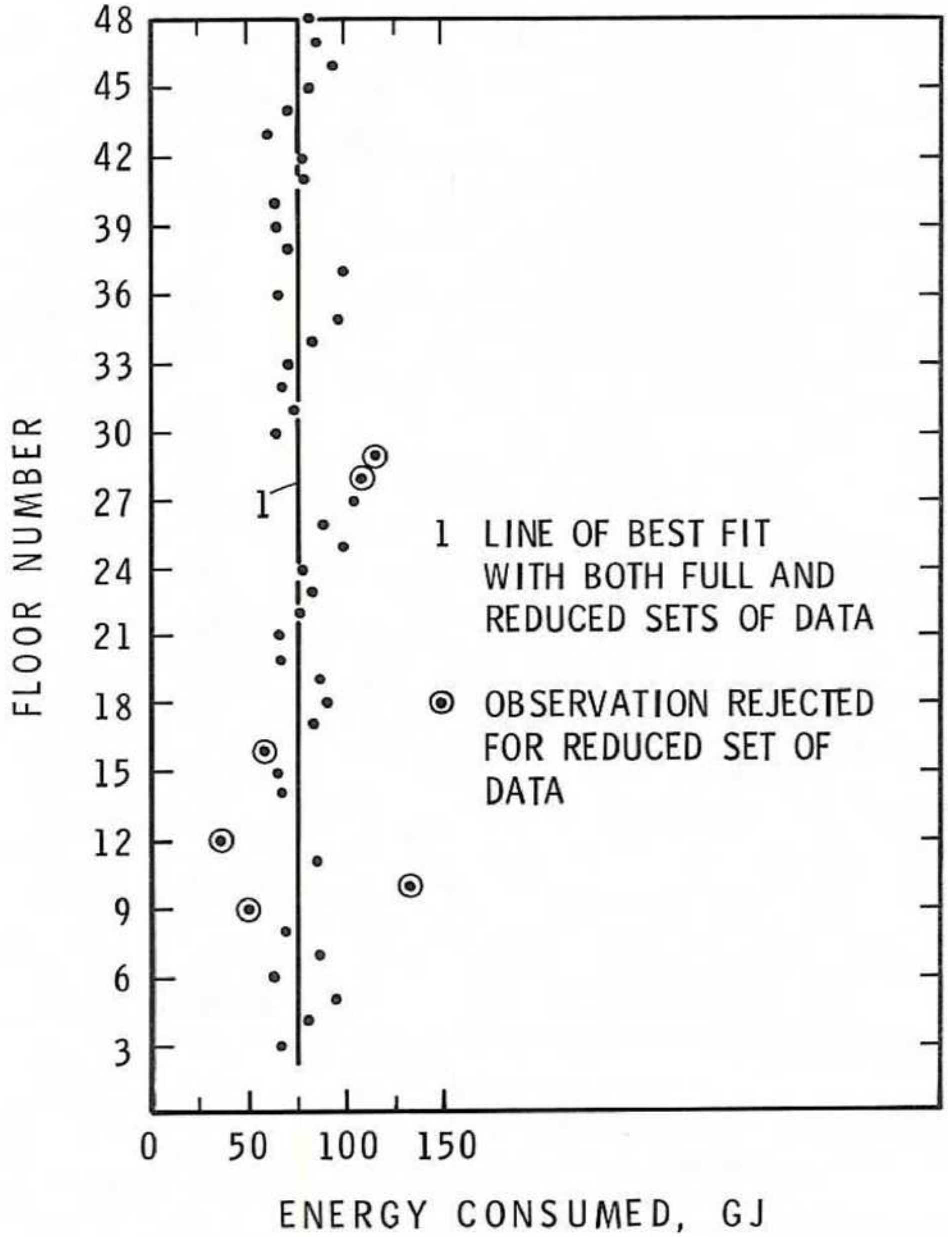


FIGURE 1

HEATING CONSUMPTION PER APARTMENT
BUILDING A,
SHAFT METHOD

BR 6385-1

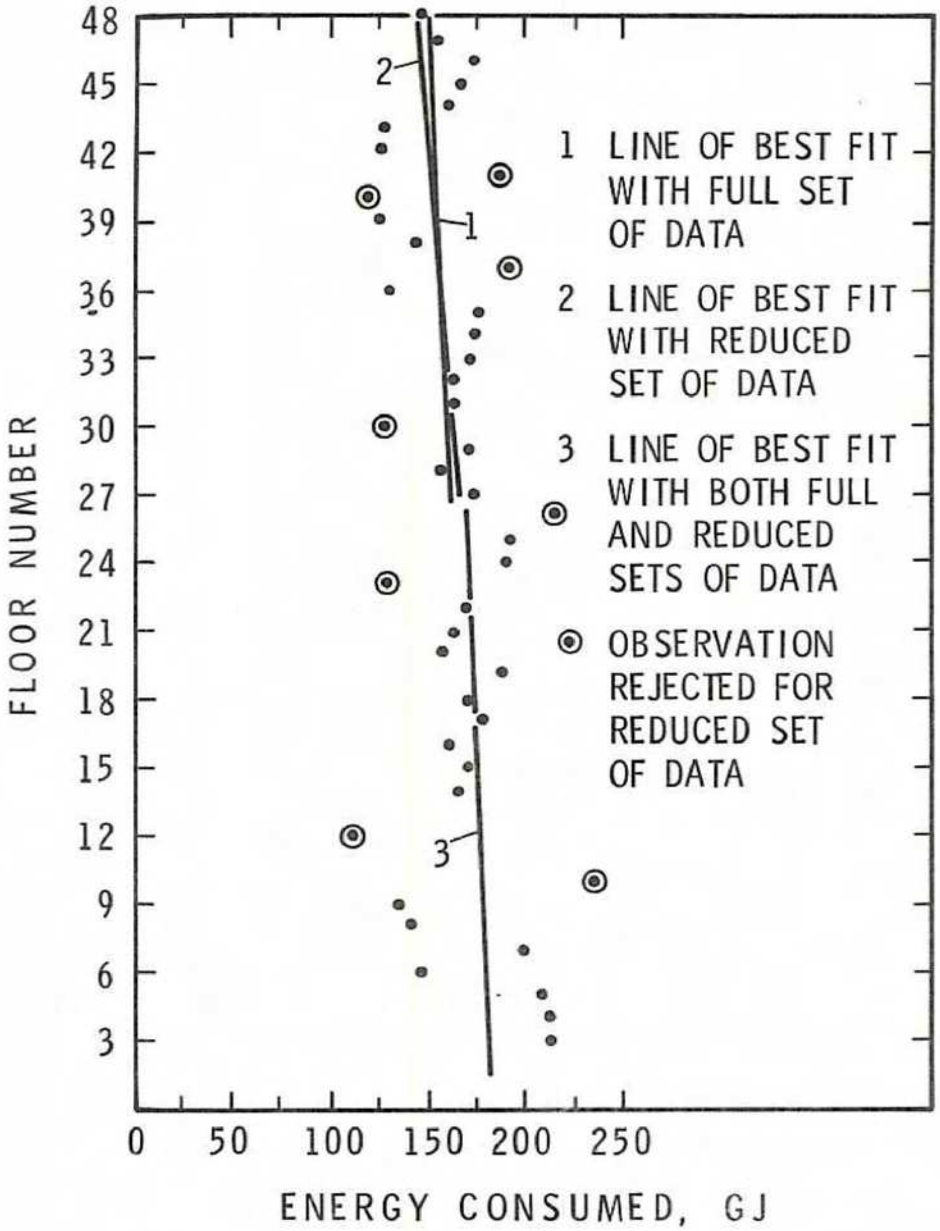
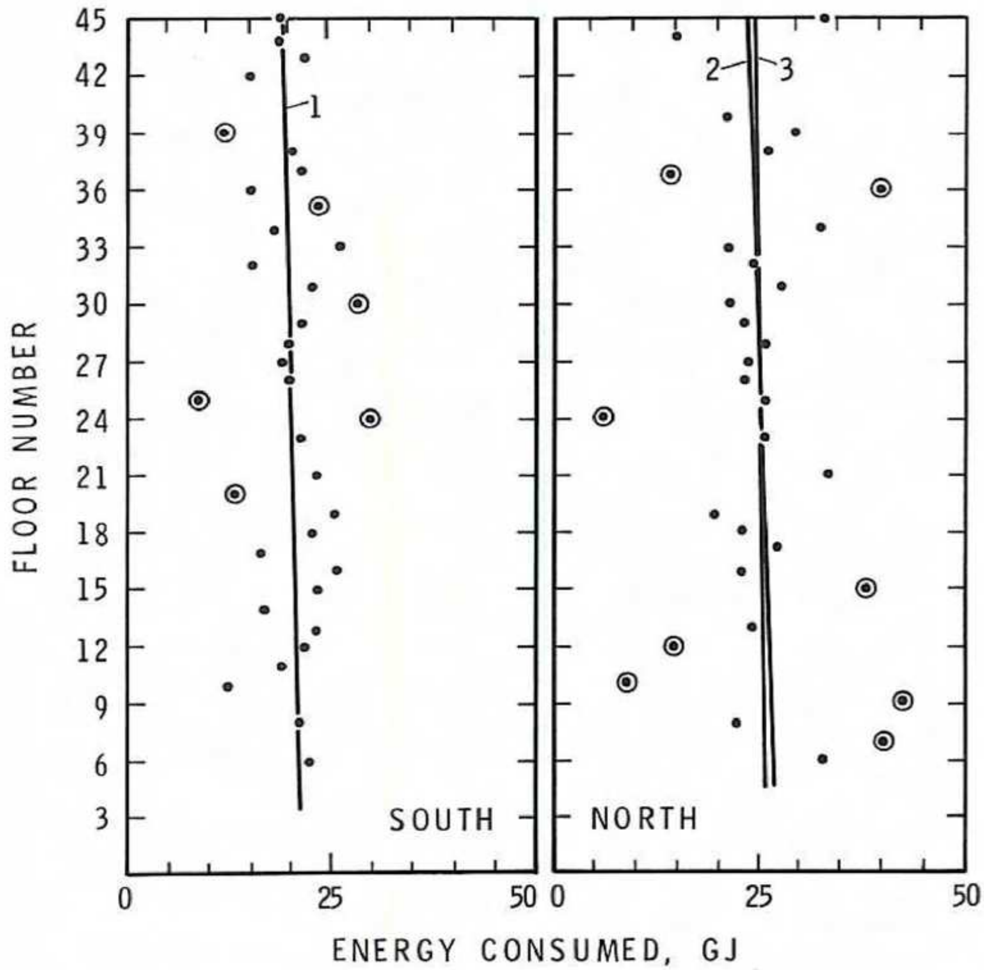


FIGURE 2

HEATING CONSUMPTION PER FLOOR
BUILDING A,
FLOOR-BY-FLOOR METHOD

BR 6385-2



1 LINE OF BEST FIT WITH BOTH FULL AND REDUCED SETS OF DATA

2 LINE OF BEST FIT WITH FULL SET OF DATA

3 LINE OF BEST FIT WITH REDUCED SET OF DATA

◉ OBSERVATION REJECTED FOR REDUCED SET OF DATA

FIGURE 3

HEATING CONSUMPTION PER APARTMENT
BUILDING B,
SHAFT METHOD

BR 6385-3

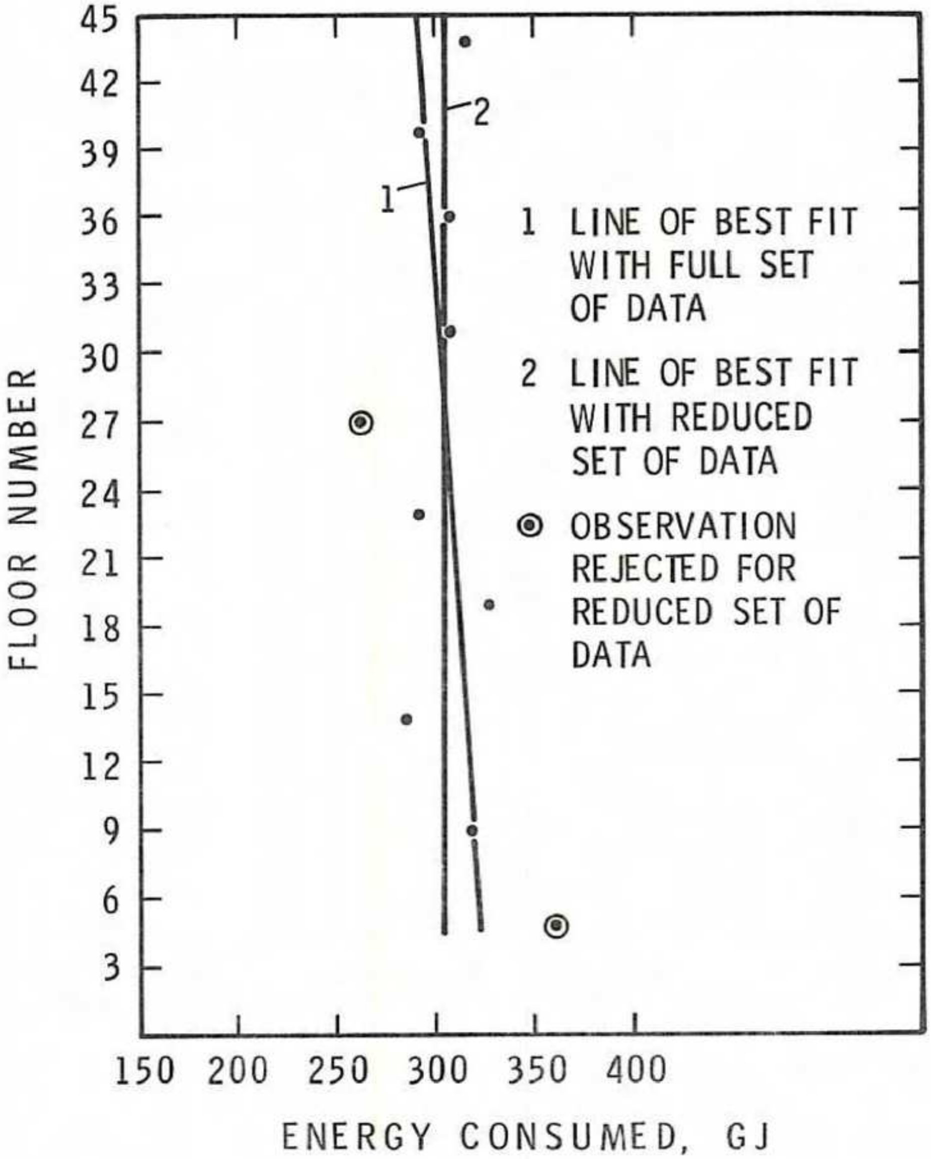


FIGURE 4

HEATING CONSUMPTION PER FLOOR
BUILDING B,
FLOOR-BY-FLOOR METHOD

BR 6385-4

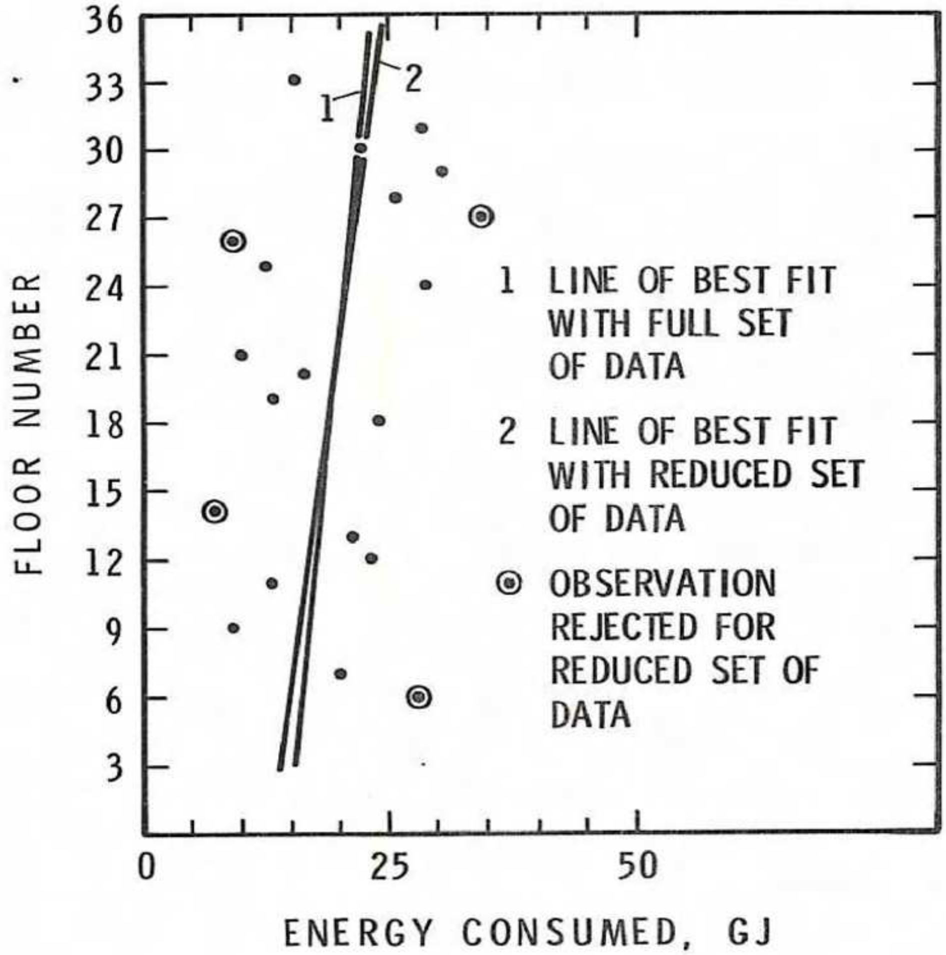


FIGURE 5

HEATING CONSUMPTION PER APARTMENT
BUILDING C,
SHAFT METHOD

BR 6385-5

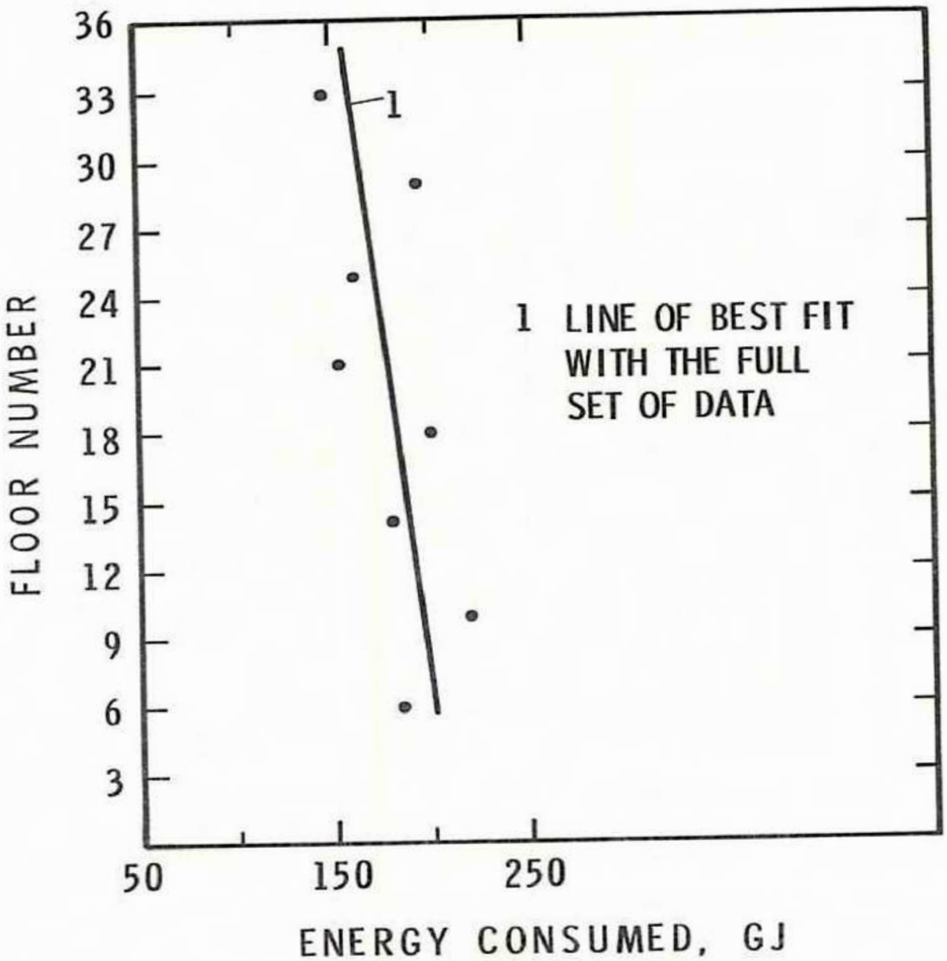


FIGURE 6

HEATING CONSUMPTION PER FLOOR
BUILDING C,
FLOOR-BY-FLOOR METHOD

BR 6385-6