The Measurement of Air Infiltration through Metal-Framed Windows

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IN all vented windows gaps occur around the fastened sash, and through these gaps a certain amount of air infiltrates into the building. If the window is designed and manufactured competently, the gaps will be small and well distributed, as will be the consequent air leakage. Thus with a well-constructed window, whilst there will of necessity be slight air leakage, this will not be a "draught."

There is a growing tendency for architects to become more air-leakage conscious, particularly so when designing multi-storey, and air-conditioned buildings. This article deals with the equipment constructed to test windows for an application of this type where it was required to demonstrate the amount of air leakage through the window proposed.

Test Equipment

The main requirements for the test equipment were that it should give an absolute measurement of air leakage through the window, and a visual indication of water leakage, for wind velocities of at least 30 miles per hour. The time available for manufacture and test was short and consequently the rig had to be simple, and as always cost was a consideration.

A drawing of the rig is given in Fig. 1, a diagrammatic arrangement of the circuit in Fig. 2, and a photograph of the installation in Fig. 3. The rig consisted essentially of a metal box with an open face on which the window to be tested was fitted ; the outside surface of the window being mounted to face the interior of the box. Air from a compressed air supply, was led to the box via a needle control valve and a rotameter for air flow measurement. An inclined water manometer measured the pressure inside the box and consequently the differential pressure across the window. Mains water was connected to four sprinkler jets, arranged to spray at an angle on to the window, and a water drain was let into the bottom of the box.

Thus a measurable flow of air could be admitted to the interior of the box from whence it could only escape by leakage through the window. Hence with the air adjusted to maintain a constant pressure in the box, the rate of flow was equal to the leakage rate for that particular differential pressure, and the differential pressure could be converted to the equivalent air velocity.

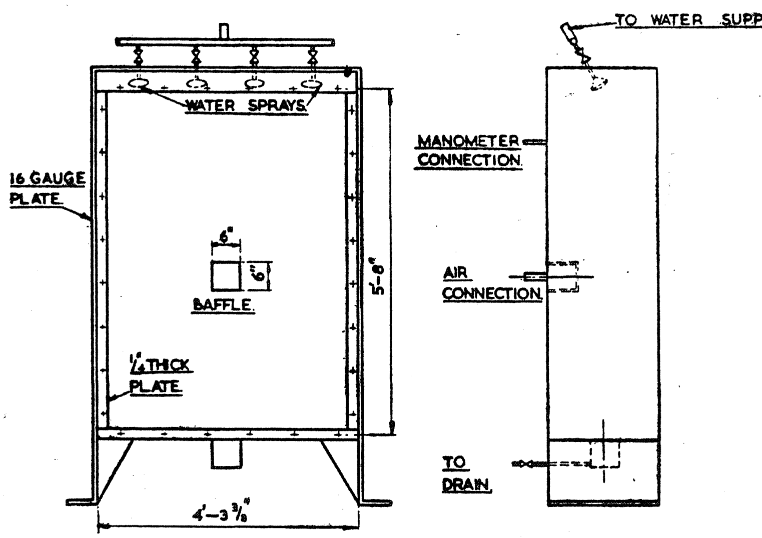

Fig. 1.—Detail of test box used in the experimental work.

The window tested was manufactured by John Thompson Beacon Windows Ltd. It was a purpose-made window, constructed in universal casement section, having a top hung

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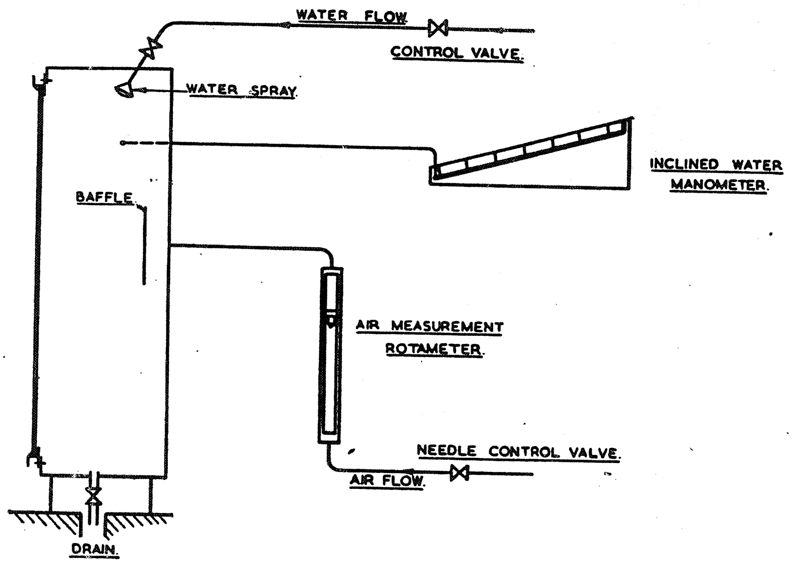

Fig. 2.—Diagrammatic arrangement of test circuit.

ventilator and a vertical centre hung ventilator, with a total openable perimeter of 21 ft. A section of the window is shown in Fig. 4.

Particular attention was paid to sealing the box to avoid any spurious leakages. The box itself was constructed from 16 G mild steel plate with a ¼-in. thick flange on the face. All joints were seal welded. The window frame was bolted to the ¼-in. flange with a soft rubber sealing gasket and on completion of fitting the window all joints inside the box were coated with a bitumastic sealing compound. Glazing of the window was carried out after fitting in the box and seven days were allowed for the putty to set.

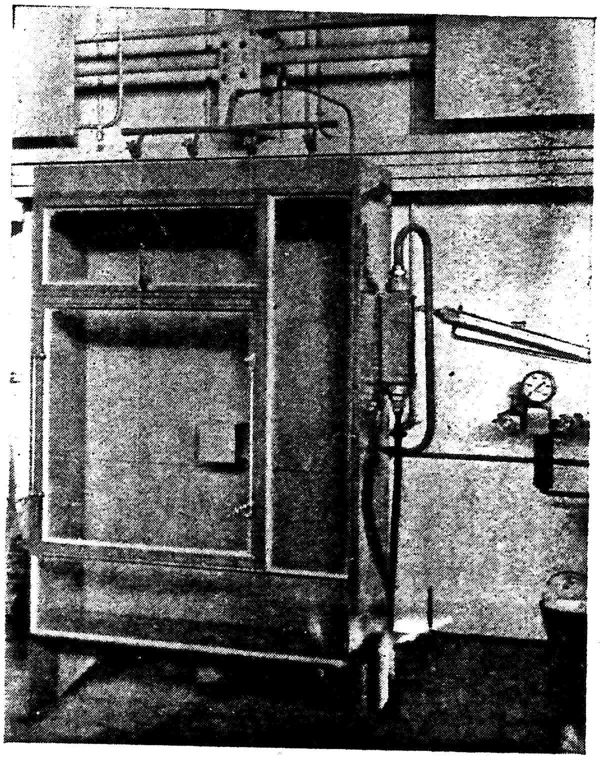

Fig. 3.—The test box as installed in the laboratory, showing, on the right, the air measurement rotameter and the inclined water manometer.

Test Procedure

A series of tests were carried out in which air leakage was measured for small increments of differential pressure up to a maximum pressure equivalent to an air velocity of 50 miles per hour ; 27 series of test runs were made, in between each run the ventilators being fully opened and closed. Whilst there was a little variation between each run nothing significant was noted.

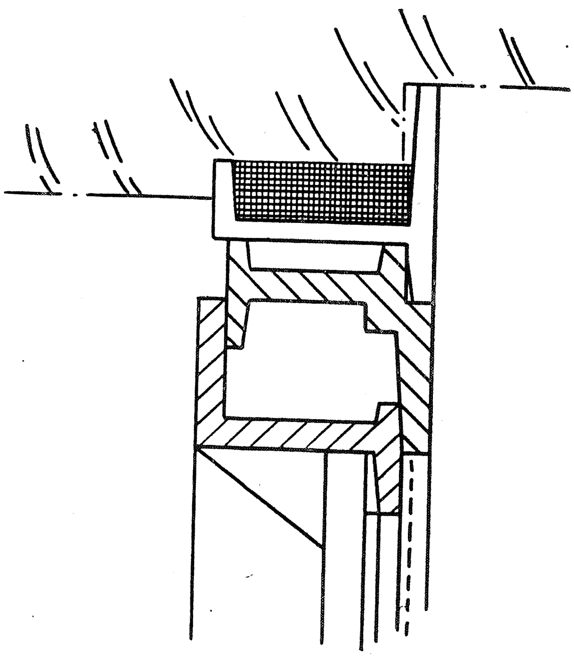

Fig. 4.—Sectional view of part of the window used in the test showing the framing and ventilating sections.

In addition water was sprayed on to the window with the differential air pressure set to correspond to an air velocity of 30 miles per hour, this condition being maintained for periods of approximately one hour, and the window observed for water leakage.

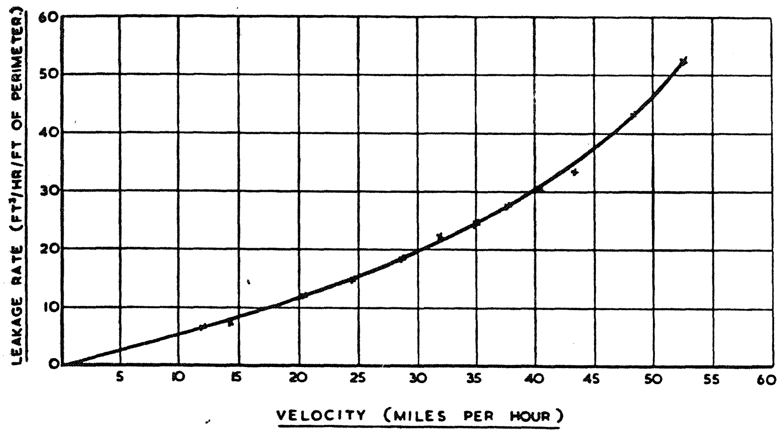

Fig. 5.—Relationship between leakage rate and air velocity.

Results

The average of the results obtained for air leakage are plotted in Fig. 5, as air leakage rate in cu. ft per hour per ft of openable perimeter against air velocity in miles per hour.

In no case was there any apparent water leakage.

Conclusions

As will be seen from the graphed results the leakage rate for an air velocity of 30 miles per hour was nearly 20 cu. ft/h/ft of openable perimeter. This was generally much less than rates quoted in various published papers.[1 2 3] It does, however, compare reasonably well with figures given by Thomas and Dick[1] for metal windows with an average face clearance of 0·005 in. This face clearance was checked on the window tested and whilst it would appear that 0·005 in. might be a reasonable average of face clearance, no definite conclusion could be drawn. In connection with the paper as referred to above[1], the authors have produced a nomogram for predicting air flow through windows, with the variables of face clearance and air pressure. This is very useful and does appear to give a reasonable estimate. However, it would seem that for special applications, actual air leakage rates could be measured quickly without any particularly elaborate apparatus. Again with the construction of multi-storey buildings in exposed locations air leakage rates will certainly become more important and standards of acceptance may be set up.

References

[1]THOMAS, D. A., & DICK, J. B. "Air Infiltration Through Gaps Around Windows." *Journal of The Institution of Heating and Ventilating Engineers.* June, 1953.

[2]COLEMAN, E. F., & HEALD, R. H. "Building Materials and Structures Report BMS 45—Air Infiltration through Windows." U.S. Bureau of Standards.

[3]RUEDY, R. (1944). "Heat Loss through Windows. A Summary of Available Information," *Nat. Research Council of Canada N.R.C.* No. 1,227.

Changes at the National Physical Laboratory

During 1957 a comprehensive review of the organisation and programmes of work of the National Physical Laboratory was carried out by a committee of the Research Council of the Department of Scientific and Industrial Research. As a result, the Research Council approved certain changes in organisation, which became effective at the end of March.

One of the most important is a reorganisation of the work at present carried out in the Divisions of Electricity, Metrology and Physics and in the Test House. These four units are replaced by three new Divisions to be called Standards, Applied Physics and Basic Physics. The Standards Division will be responsible for all fundamental work on standards of length, mass and time; of electrical and magnetic quantities and also of temperature. Basically, it will consist of the present Metrology Division, expanded to include certain work on standards now carried out in the Electricity and Physics Division. The Superintendent is Dr. H. Barrell, late in charge of the Metrology Division.

The Applied Physics Division will be responsible in general for work in the field of classical physics of fairly immediate value to industry (but excluding optics, all of which will continue to be done in the Light Division). The principal areas covered will be electrotechnics, acoustics, heat and radiology. Test House, which hitherto has come under Administration, will become an integral part of this Division, but will preserve its identity under Mr. H. Bowley. The Superintendent of the Applied Physics Division is Dr. B. Wheeler Robinson, late in charge of the present Physics Division.

The Basic Physics Division will be responsible for pioneering developments in certain branches of nonnuclear physics which have potential industrial applications in the less immediate future.

The Council recently recommended the creation of a new post of Deputy Director, and Dr. Edward Lee (late Director of Operational Research in the Royal Naval Scientific Service) has been appointed. The Deputy Director will take the main responsibility for work in the Laboratory which is closely geared to immediate demands from industry.