NATIONAL RESEARCH COUNCIL OF CANADA

DIVISION OF BUILDING RESEARCH

# TECHNICAL NOTE

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PREPARED FOR Information and inquiry

SUBJECT AIR LEAKAGE CHARACTERISTICS OF SOME BRICK AND CONCRETE BLOCK WALLS.

This report presents the air leakage characteristics obtained from measurements of nine brick and concrete block walls in the DBR/NRC test huts at Ottawa and Saskatoon. The leakage characteristics of the first three walls were obtained in the Saskatoon test huts; the remainder were obtained in the Ottawa huts. All the test huts had an overall plan area of approximately 6 ft by 6 ft.

The study was undertaken to compare the leakage characteristics of different types of walls as constructed in the field; and to determine the reduction in leakage effected by fill-insulation and different surface finishes.

## DESCRIPTION OF TEST-HUT WALLS

Details of the nine test-hut walls are shown in Figure 1.

Wall No. 1. - Light-weight concrete block.

The blocks (expanded clay aggregate) were 8 by 8 by 16 in. and had two hollow cores. The wall had no fill insulation. The mortar used in the wall was 1 part lime, 1 part cement and 5 parts sand (by volume). The total inside area of the four walls in the hut was 128 sq ft.

Air leakage tests were performed with the wall surfaces (a) unfinished (b) with two coats of latex paint added on the inside wall surface, and (c) with the further addition of two coats

TABLE I

WALL AIR LEAKAGE CHARACTERISTICS

Cu Ft of Air/(Hr)(Sq Ft of Wall Area)

(Average of 4 Walls)

| (A) CONCRETE BLOCK WALLS | Hw - in. of water | | | | | |
|---|---|---|---|---|---|---|
| | .05 | .10 | .15 | .20 | .30 | .40 |
| No. 1 - Light-weight concrete block wall (no insulation) | | | | | | |
| - bare surfaces | 20 | 40 | | | | |
| -two coats of paint added on inside surface | 8 | 13 | 17 | 21 | 29 | 37 |
| -two coats of stucco and one coat of paint added on outside surface | 4 | 8 | 11 | 14 | 19 | 24 |
| No. 2 - Light-weight concrete block wall | | | | | | |
| - with no insulation | 17 | 34 | | | | |
| - with fill-insulation (volcanic dust) | 14 | 25 | 35 | 45 | | |
| No. 3 - Light-weight concrete block wall, with fill-insulation (expanded mica) | 12 | 23 | 34 | 46 | | |
| No. 4 - Light-weight concrete block wall, with fill-insulation (expanded mica) | 11 | 21 | 30 | 39 | 55 | 71 |
| - three coats of stucco added on outside surface | 7 | 13 | 18 | 22 | 30 | 36 |
| No. 5 - Concrete block wall, with fill-insulation (expanded mica) | 2 | 4 | 6 | 8 | 11 | 14 |
| - one coat of paint added on inside surface | 2 | 4 | 6 | 7 | 10 | 12 |

| (B) BRICK WALLS | | | | | | |
|---|---|---|---|---|---|---|
| ASHRAE Values - 13" Solid brick, bare | 5 | 8 | 11 | 14 | 20 | 24 |
| - 8½" Solid brick, bare | 5 | 9 | 13 | 16 | 24 | 28 |
| - 8½" Solid brick, two coats of plaster added on inside surface | - | .08 | - | .14 | .20 | .27 |
| No. 6 - Clay-brick cavity wall (unvented), with fill-insulation (expanded mica) | 2 | 4 | 6 | 7 | 9 | 11 |
| - three coats of plaster added on inside surface | - | .5 | - | 1.0 | 1.6 | 2.2 |
| No. 7 - Clay-brick cavity wall (unvented) with fill-insulation (granulated mineral wool) | 2 | 4 | 6 | 7 | 9 | 11 |
| - three coats of plaster added on inside surface | - | 1 | - | 2 | 3 | 4 |
| No. 8 - SCR brick wall with interior finish, vented air space | 1.5 | 3 | 4 | 5 | 7 | 8 |
| No. 9 - SCR brick wall with interior finish, unvented air space | 1 | 2 | 3 | 4 | 5 | 6 |

of cement-base stucco and one coat of cement paint on the outside wall surface.

Wall No. 2 - Light-weight concrete block.

The concrete blocks, mortar and wall area were identical to wall No. 1. The inside and outside wall surfaces were unfinished.

Air leakage tests were performed (a) with and (b) without fill-insulation (volcanic dust) in the hollow blocks.

Wall No. 3 - Light-weight concrete block.

This wall was identical to wall No. 2 except the fill-insulation was expanded mica.

Wall No. 4 - Light-weight concrete block.

The blocks (expanded slag aggregate) were 8 by 8 by 16 in. and had three hollow cores which were filled with expanded mica insulation. The mortar used in the wall was 1 part lime, 1 part cement and 5 parts sand (by volume). The total inside wall area was 150 sq ft.

Air leakage tests were performed (a) with the wall surfaces unfinished, and (b) with three coats of stucco added on the outside wall surface.

Wall No. 5 - Concrete block.

The blocks (sand and gravel aggregate) were 8 by 8 by 16 in. and had three hollow cores which were filled with expanded mica insulation. The mortar and wall area were identical to wall No. 4.

Air leakage tests were performed (a) with the wall surfaces unfinished, and (b) with one coat of latex paint added on the inside wall surface.

Wall No. 6 - Brick cavity-wall.

The wall consisted of two wythes of clay brick, 2 3/8 by 3 3/4 by 8 in., separated by a 2-in. unvented cavity which was filled with expanded mica insulation. The mortar was 1 part lime, 1 part cement and 5 parts sand (by volume). The total inside wall area was 146 sq ft.

Air leakage tests were performed with the wall surfaces unfinished, and with three coats of plaster added on the inside wall surface.

Wall No. 7 - Brick cavity-wall.

This wall was identical to wall No. 6 except that the fill-insulation was granulated mineral wool; the same tests were performed.

Wall No. 8 - SCR brick.

The wall consisted of a single wythe of SCR brick, 2 1/6 by $5\frac{1}{2}$ by $11\frac{1}{2}$ in., finished on the inside with the following: 3/4 by 1 5/8 in. furring strips; sheathing paper; 2 3/8 by 1 5/8 in. furring strips; vapour barrier; and tempered wallboard. Glass fibre insulation filled the space between sheathing paper and vapour barrier. The air space between sheathing paper and brick was vented to the outside. A lime mortar consisting of 1 part lime to 3 parts sand (by volume) was used in the brickwork. The total inside area of the finished wall was 128 sq ft.

Wall No. 9 - SCR brick.

This wall was identical to wall No. 8 except that the air space between brick and sheathing paper was not vented.

## AIR LEAKAGE TEST PROCEDURE AND RESULTS

To ensure air leakage through the walls alone, all the other leakage sources in the test hut were sealed; these extraneous leakage sources were the ceiling, the floor, and the joints between walls, ceiling and floor.

The air leakage test consisted of pressurizing the test hut with metered air and obtaining the air flow through the four walls at a number of values of $H_w$, the difference between the air pressure inside the hut and that outside. At each value of $H_w$, the total air flow in cubic feet of air per hour was divided by the total inside wall area to give the leakage rate in cubic feet of air per hour per square foot of wall area.

The conditions of test and the air leakage characteristics for the nine walls are given in Table I; the characteristics are shown in Figure 2.

Included in the figure and table for comparison purposes are the characteristics for the following walls: a solid 13-in. brick wall, unfinished surfaces; a solid 8 1/2-in. brick wall, unfinished surfaces; and a solid 8 1/2-in. brick wall with two coats of plaster on the inside surface. These walls were of poor workmanship, and were constructed with porous bricks and lime mortar. The characteristics were obtained from the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Handbook of Fundamentals, 1967, (Chapter 25, p.410).

The leakage through the light-weight concrete block walls was much higher than the leakage through the other walls. Fill-insulation reduced the leakage by 25 per cent, but the leakage through the insulated light-weight walls was still 5 times greater than that through the dense concrete block wall.

Surface treatment of the light-weight blocks effected a greater reduction in leakage than fill-insulation. The leakage through wall No. 1 with surface treatment on inside and outside was 1/5 that through the bare wall and only twice that through the dense concrete block wall; it was comparable to the leakage through a solid wall of porous brick.

The leakage through the dense concrete block wall was of the same order of magnitude as the leakage through the clay brick and SCR brick walls, and was half that through a solid wall of porous brick. A coat of paint on the inner surface of the concrete block had little effect on the leakage.

The leakage through the bare clay brick walls was higher than that through the SCR brick walls; however, interior plastering reduced it below that of the SCR walls. None of the tested walls had a leakage characteristic as low as that given in the ASHRAE Handbook for brick walls with interior plastering.

The leakage characteristics determined from the present study are useful in indicating the relative tightness of the different wall types and wall finishes. These characteristics, however, should be used with caution in predicting the field performance of actual walls, since the workmanship involved in the construction of the test huts was probably better than that found in normal field construction.

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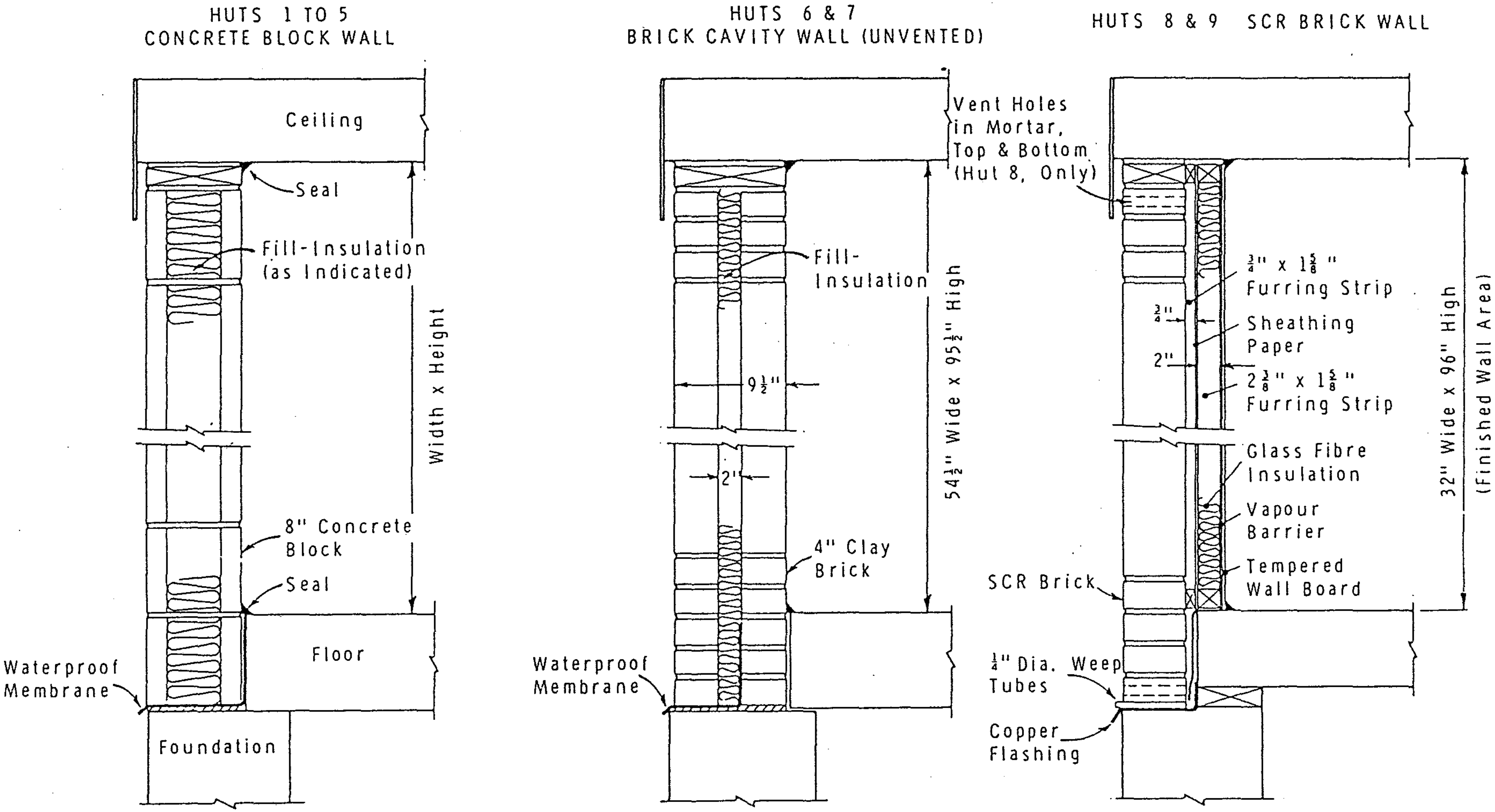


| Hut | Width x Height | Fill-Insulation |
|---|---|---|
| 1 | 48" x 96" | None |
| 2 | 48" x 96" | Volcanic Dust |
| 3 | 48" x 96" | Expanded Mica |
| 4 | 56" x 96" | Expanded Mica |
| 5 | 56" x 96" | Expanded Mica |

FIGURE 1 DETAILS OF TEST-HUT WALLS

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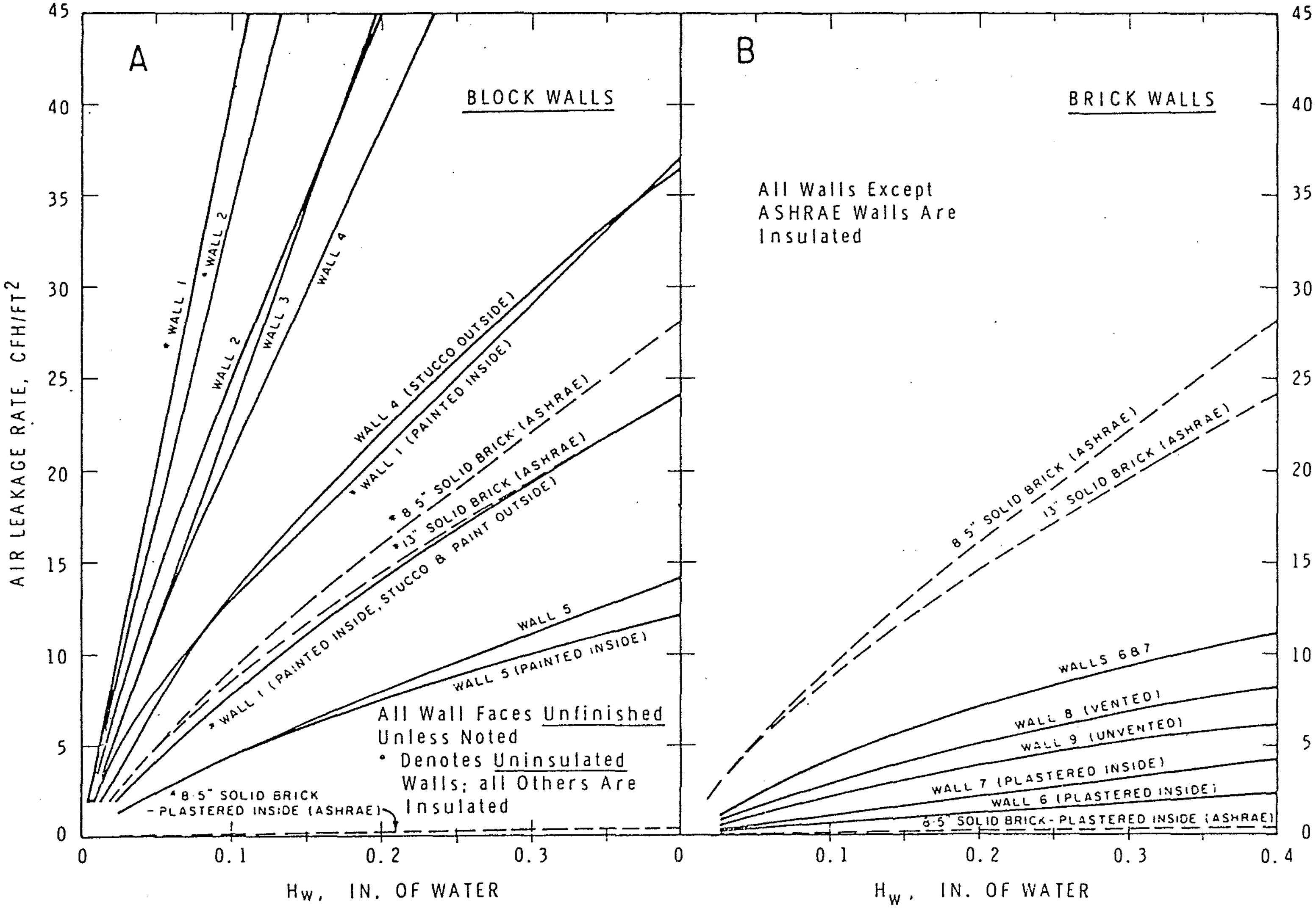


FIGURE 2 AIR LEAKAGE CHARACTERISTICS

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