ATMOSPHERIC ENVIRONMENT SERVICE

A WALL PENETRATION MAP OF CANADA

by

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Abstract

Maps of directional wall penetration for Canadian cities are given, based on hourly weather data for periods of several years.

Introduction

The amount of moisture that is absorbed by the walls of a building during a storm is dependent on many factors, such as the porosity of the building materials, the workmanship involved during construction, and the shape of the building. This makes it difficult to determine the severity of wall penetration from meteorological data alone. However, there are some general facts indicating that the severity of penetration caused by a storm can be roughly determined from its duration and its average wind speed.

Rain penetration is approximately proportional to the pressure difference between the sides of the wall (super-pressure)[1]. The pressure difference is proportional to the square of the wind speed. However, this is strictly true only when the wind direction is perpendicular to the wall surface. Wind tunnel studies[2] have shown that winds deviating up to thirty degrees from the perpendicular continue to exert considerable super-pressure. At larger angles, the super-pressure declines rapidly and turns into suction. The amount of precipitation that falls during a storm will not be a major influence if it is in sufficient quantity to saturate the wall surface[3]. Finally, a well-built wall should be capable of showing little or no penetration when exposed to a storm lasting less than twelve hours. Thus penetration will be due primarily to rainstorms that last twelve hours or more with winds that maintain a constant direction.

A numerical index for the severity of such a storm could be obtained by squaring the hourly wind speeds and summing them. However, as the wind speeds were found to remain in a rather narrow range of values, the square of the mean speed for the entire storm can be used instead.

Procedure

This method was applied to ten cities in Canada by examining the hourly weather data of every station. For each of the eight cardinal directions the duration and average wind speed were found for all storms in which twelve or more hours of continuous precipitation were recorded, and the wind remained within thirty degrees of the given direction. As it is likely that most storms suffer temporary shifts of wind or lapses in precipitation, non-consecutive failures in the hourly data for both of these factors were allowed. To find the severity of each storm, its duration was multiplied by the square of its average wind speed. The storm values were then summed by direction for each station for its period of record and yearly directional averages calculated. These directional averages are shown as roses in Figures I and II.

As an example, Toronto had only two such storms from the southwest between 1953 and 1972, with mean wind speeds of 13.7 and 23.7 km/h and durations of 12 and 15 hours respectively. Thus the total wall penetration index is $13.7^2 \times 12 + 23.7^2 \times 15 = 10{,}677.63$ and the annual index is 533.882 km^2/h. This is rounded in Table I to 500 km^2/h.

Analysis

Figures I and II contain a number of very interesting features. Victoria and Vancouver are both exceptional in having their wall penetration chanelled almost completely into one direction. It is evident that wall penetration will be of concern only for eastern walls in Vancouver and southeastern walls in Victoria. Calgary, Winnipeg and Toronto will experience only mild problems, fron one or two directions.

The easterly storms off the Atlantic are clearly the only major cause of wall penetration in the eastern provinces. Although buildings in most cities in these provinces will need special protection from one direction only, buildings in areas with extreme maritime conditions such as Newfoundland will experience major problems from most directions.

Finally, it should be pointed out that for most buildings in these cities the local geography (nearby streets, buildings and trees) may either obstruct or funnel the winds, causing major deviations from the results given here.

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TABLE 1

ANNUAL WALL PENETRATION (IN UNITS OF 100 KM^2/H)

STATION	PERIOD	N	NE	E	SE	S	SW	W	NW
Victoria, B.C.	1953–1972	3	23	34	611	0	13	24	15
Vancouver, B.C.	1953–1972	0	191	972	218	0	0	6	10
Calgary, Alta.	1953–1972	246	15	26	26	0	0	41	377
Winnipeg, Man	1953–1972	302	208	114	85	0	0	34	81
Toronto, Ont.	1953–1972	124	88	229	50	0	5	1	21
Montreal, Que.	1953–1972	141	399	44	151	0	78	37	16
Quebec City, Que	1957–1966	13	959	761	0	0	70	50	0
Halifax, N.S.	1953–1972	327	947	1,474	226	0	103	15	35
Sydney, N.S.	1953–1972	642	423	918	753	0	243	1	90
St. John's, Nfld.	1953–1972	1,403	1,350	815	749	0	696	127	528

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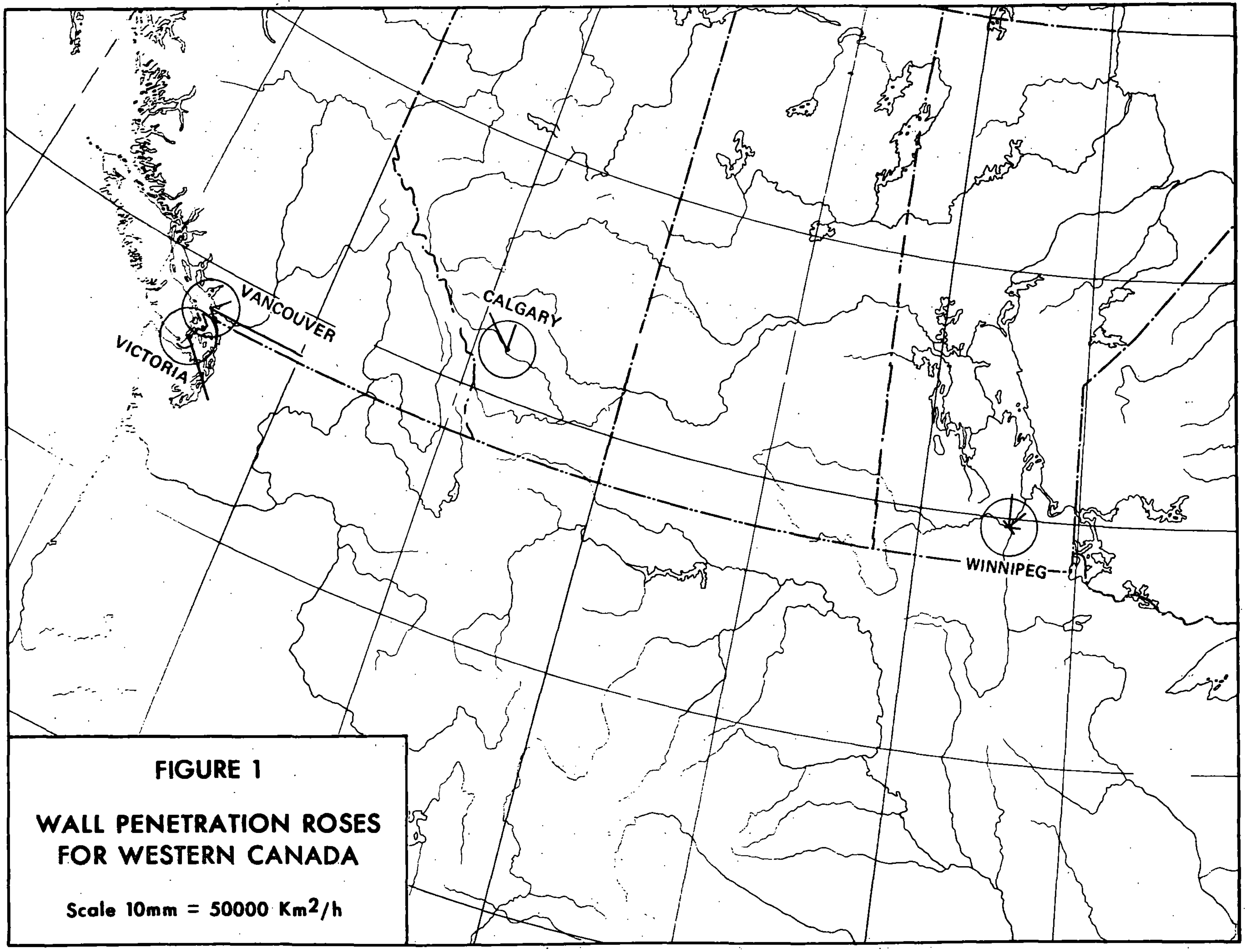

FIGURE 1

WALL PENETRATION ROSES FOR WESTERN CANADA

Scale 10mm = 50000 Km^2/h

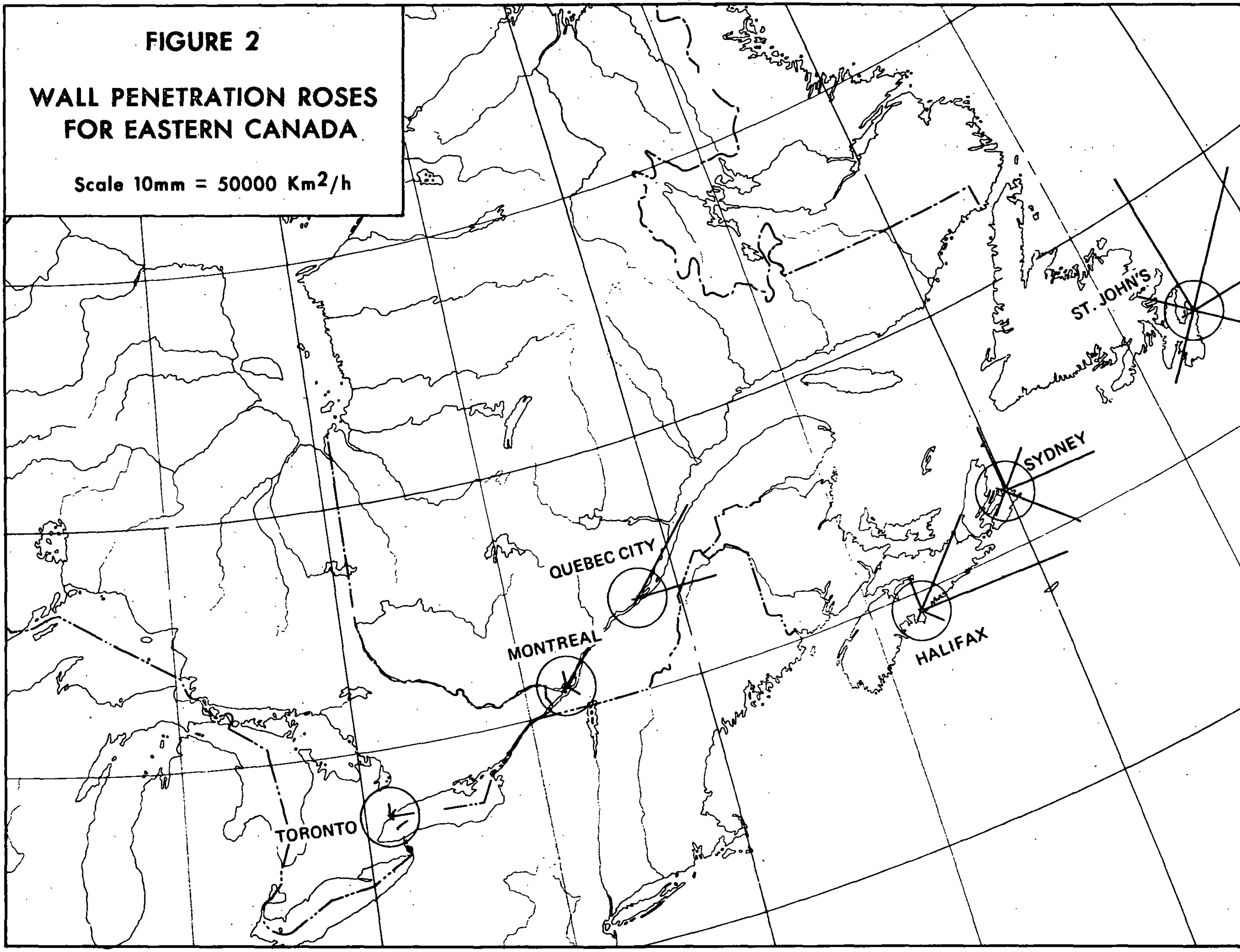
FIGURE 2
WALL PENETRATION ROSES FOR EASTERN CANADA
Scale 10mm = 50000 Km2/h
ST. JOHN'S
SYDNEY
QUEBEC CITY
HALIFAX
MONTREAL
TORONTO