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A BRIEF SURVEY OF ICEFALL IN SOUTHERN ONTARIO

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by

Andrew Gilbert and Douglas Pitcher

Atmospheric Environment Service

PROJECT REPORT NO. 5

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1. Introduction

The fall of ice from buildings and towers has long been a matter of concern to engineers. However, in recent years, with the increase in the heights of these structures, this problem has increased in magnitude. Published reports on ice accretion provided little relevant information on icefall. In order to determine icefall patterns and damage, a survey of various structures was conducted in southern Ontario. *

2. Collection of Data

The data were obtained by personal interviews with engineers and various other personnel who had actually observed icefall from these structures.

3. Data on Structures

See Table No. I

4. Data on Individual Towers

C. B. C. – T. V. Tower, Toronto

This tower is five hundred feet high, self supporting, unheated, and shaped like the Eiffel Tower in Paris. It is located in Downtown Toronto and the ice buildup on it seems to be less than would be expected if it were in the country. It is believed that the warmer air over the city tends to melt the ice formed from the freezing precipitation, so that the pieces of ice remain smaller. Icefall is found to be confined mainly to the center of the tower. The outer cross members of the unusual shaped tower break up the ice falling from the top of the tower.

* The study was conducted by A. M. Gilbert and D. H. Pitcher, two summer students working in the Climatological Research Section of the Canadian Meteorological Service.

C. F. T. O. - T. V. Tower, Toronto

Icefalls from this tower are common. Several pieces as long as two feet have sailed as far as six hundred feet. Ice on guy lines build up to four inches thick before falling. One piece from the tower measured $1\frac{1}{2}$" X 4" X 9". A piece this size would weigh a little less than two pounds.

C. H. C. H. - T. V. and C. K. D. S. - F. M. Towers, Hamilton

Ice is deposited on the eleven-hundred-foot tower by freezing precipitation with winds from the east or northeast. Southwesterly winds blow ice to the northeast. Ice pieces glide up to four hundred feet from the tower, depending on the strength of the wind. Pieces as large as four feet long by one inch thick, weighing approximately fifteen pounds have been blown from the tower. Damage has occurred in the form of broken branches and a dented car roof.

C. F. P. L. Towers, London

Most ice is deposited on the tower with east to northeast winds and when it falls off, the pieces descend almost vertically. Some ice has fallen from the guy wires. Icefall from the six-hundred-foot tower has frequently broken through the tar and sand roof of a nearby building.

C. K. C. O. - T. V. and C. F. C. A. - F. M. Towers, Kitchener

Ice falls from these towers with southwesterly winds, drifting some distance to the northeast. Ice pieces, three to four feet long are frequent; and often pieces six inches or greater in diameter fall from the guys. Ice has dented and bent air ducts, and broken boards reinforcing the roofs of buildings.

C. K. V. R. - T. V. Tower, Barrie

Ice has fallen from this tower in sheets up to ten feet in length and one eighth of an inch thick. The ice usually falls in an easterly direction. In strong winds, ice may be carried over one hundred feet from the tower. In one case the roof of a convertible was broken by falling ice; the building's roof has often been dented causing leakage.

C. B. C. - T. V. Tower, Hornby

The worst icing generally occurs above the four hundred foot level of the tower. Ice usually falls to the east and within two hundred feet of the tower. One ice piece, twelve feet long hit transmisslon

lines, marking them; while another piece six inches square was found seven hundred feet from the tower. Damage to ventilators and to the tar paper covering of a copper pipe are indicative of large amounts of icefall. Little buildup takes place on the guys because ice is shaken off by their continuous motion. (see photos)

C. H. I. C. - A. M. Tower, Brampton

This one-hundred-and-fifty-foot tower has a small tuning hut beneath it, the eaves of which have been broken off by icefalls. Six-feet-by-six-inch pieces of the quarter inch corrugated asbestos on wood roof have been broken off.

Toronto Dominion Centre, Toronto

This is a rectangular fifty-six storey building with a smooth glass and steel surface. Easterly winds with driving rains and updrafts deposit ice sheets near the top of the building. Ice accretion is peeled off the smooth sides and usually falls more than twenty feet from the base, although on occasions pieces of ice have glided up to two hundred feet from the building. The roof of a convertible was broken by falling ice in one case.

5. Data on Smaller Towers and Other Structures

Although several smaller towers were inspected, little information was gathered because most were unattended. Two towers had ice buildup, one of which caused damage. Two others which were under one hundred feet high had very limited buildup. Ice accretion, therefore, occurs on many of the smaller towers, but the hazards are not as great as with fall from high towers.

Another problem is the lack of documentation about the icefall during the actual ice storm. Since there are few observers near a tower during an ice storm, it is difficult to determine whether large amounts of ice fall during the storm, and hence whether the hazard from icefall is more dangerous during the storm or after it.

The subject of icefall from church spires was investigated briefly. It was found that since the spires are connected to heated structures, the ice melts quickly and there is little problem from icefall.

6. Icefall Patterns

Wind directions, both during and after a storm, determine the pattern of icefall around a tower. This is especially well illustrated at the C. H. C. H. Tower at Hamilton, where northerly to easterly winds during freezing precipitation storms build up the ice, mainly on those sides

of the tower. After the storm the ice is blown off by subsequent warmer southwesterly winds. In Table No. I it is noted that three of the tall towers and the Skylon had falls to the east or northeast, or had winds during the icefall which would tend to blow the ice in those directions.

Another factor which would alter the icefall pattern was the tower itself. Ice which formed on one side of the tower by a northwest wind would be blown away from the tower when the wind reversed its direction. However, if the wind stayed in the same direction, ice which broke away from the tower would be blown into the tower, breaking the ice up and making it fall to the base of the tower. This would give a probable ground pattern for falling ice as shown in Figure II.

7. Summary

This survey had several weak points, an important one being the inability of witnesses to give actual dates of icefalls. Hence it was impossible to document the actual wind directions during icefalls and other pertinent data.

However, with the knowledge now accumulated, the normal icefall patterns from large towers in southern Ontario may be predicted. The ice is accreted during storms of freezing precipitation with winds from the northeasterly to easterly directions. After the storm, the wind shifts to the southwest and the temperature increases slightly. The ice is blown off, often in large pieces (up to twelve feet in length) and falls some distance away. On some cases the ice glides, like a paper dart, over large distances, occasionally further than the height of the tower itself. This makes icefall dangerous to people and property.

TOWER, Location	Height	Exposure	Observed Ice Fall		Damage Reported		Observed Direction of Fall	Wind Direction during Ice Fall	Maximum Distance fr Tower Ice n been seen
			Yes	NO	Yes	NO			
C.B.C. – T.V., F.M. A.M., 354 Jarvis St., Toronto	≈ 500 ft.	City	X			X	None	Not Noticed	30–40 ft.
C.F.T.O. – T.V., McCowan Rd., Toronto	815 ft.	Open	X			X	Random	Not Noticed	600 ft.
C.H.C.H. – T.V., and C.K.D.S.–F.M., Hamilton	1093 ft.	Open Country	X		X		N.E.	S.W.	450 ft.
C.F.P.L. – T.V., London	1000, 600 ft.	Open	X		X		---	S.W. to W.	---
C.K.C.O. – T.V., and C.F.C.A. – F.M., Kitchener	600, 190 ft.	Open	X		X		---	S.W.	500 ft.
C.K.V.R. – T. V., Barrie	≈ 700 ft.	Open	X		X		E.	---	100+ft.
C.B.C. – T.V., Hornby	643 ft.	Open	X		X		E.	---	700 ft.
C.H.I.C. – A.M. – 2 Ellen St., Brampton	150 ft.	Town	X		X		---	N.E.	30 ft.
C.H.I.C. – A.M. – Hornby	6---150 ft.	Open		X		X	---	---	---
C.K.S.L. – A.M. – London	5---174 ft.	Open		X		X	---	---	---
City Works Communications Tower, Oakville	130 ft.	On Roof		X		X	---	---	---
D.O.T. Antenna, Oakville	4---100 ft.	Open	X			X	---	---	---
Bell Microwave Tower, Barrie	240 ft.	Open	X			X	---	---	---
C.H.M.L. – A.M., 848 Main St. E., Hamilton	90 ft.	City	X			X	---	---	---
Metropolitan United Church, Toronto	Spire	City		X		X	---	---	---
Simpsons Tower, Toronto	473 ft.	City		X		X	---	---	---
Toronto City Hall, Toronto	327 ft.	City	X			X	---	---	---
Toronto Dominion Centre, Toronto	740 ft.	City	X		X		---	---	200 ft.
Skylon, Niagara Falls	803 ft.	Open	X			X	N.E. & E.	---	---

Table No. 1

FALLING ICE REPORT

Structure

Toronto-Dominion Centre Building,
Toronto, Ontario.
(owned by "Fairview Corporation Ltd.")

Description of Structure

A 56 storey, 740 ft. building, rectangular shape, with some towers and observation stations on top of the building. Sides vertical, no breaks or obstructions for entire height.

Frequency of Ice Falls

Once/season, for two season of operation

Normal Ice Fall Pattern and Associated Weather Conditions

Easterly winds with driving rains and updrafts deposit ice sheets near top of building. Sheets fall off building and drop more than 20 feet from building and land on adjacent buildings and street. Ice has fallen out to Bay and Wellington (approx. 200 feet from base of building). Light sheets of ice on glass, and heavier icing on mullions. This ice (from mullions) falls further from the building than the light sheets from the windows. The heating from the building keeps ice buildup to small amounts.

Unusual Ice Fall Patterns and Associated Weather Conditions

No ice forms on roof due to unusual wind patterns. Wind on building creates updraft which keeps air on roof relatively still. Wind only blows on roof when the air below is calm.

Damage Reported

Illegally parked convertible's roof smashed by falling ice.

Information From:

Date: June 24th, 1969.

FALLING ICE REPORT

Structure

C. B. C. - T. V. - F. M. - A. M. Tower,
354 Jarvis Street,
Toronto, Ontario.

Description of Structure

≈ 500 ft. self supporting, unheated steel tower. Large amounts of latticed steel in center of tower. Buildings surround all but south side of tower.

Frequency of Ice Falls

1 - 2 times/season

Normal Ice Fall Pattern and Associated Weather Conditions

Into center of tower, ice broken by steel work. Normal weather conditions during fall - sunny, temperature warm, light winds.

Unusual Ice Fall Patterns and Associated Weather Conditions

Some ice fell 30-40 ft. to south of tower base, with higher winds. One occurrence 4-5 years ago.

Damage Reported

This tower, due to its Eiffel tower shape means ice falling from top easily hits ironwork below and breaks up.

Information From:

Date: June 17th, 1969.

FALLING ICE REPORT

Structure

C.H.C.H. - T.V. and C.K.D.S. - F.M. Towers,
Hamilton, Ontario

Description of Sturcture

Two towers, a) 1093 ft. latticed steel tower, guyed at 5 levels, 3 sides.
b) smaller tower, tubular steel 18" across, guyed at 7 levels, 3 sides.

Frequency of Ice Falls

2 times/year

Normal Ice Fall Pattern and Associated Weather Conditions

Ice usually forms with N.E. winds, blows off with S.W. winds.
Ice falls 450 ft. from tower depending on wind velocity.
Pieces sized - 1" X 4' X (2" -4") from main tower
1" X 4' X (8" -10") from circular tower
Ice may fall straight down.

Unusual Ice Fall Patterns and Associated Weather Conditions

Damage Reported

Tree branches cracked, one car roof dented.

Information From:

Date: June 25th, 1969

FALLING ICE REPORT

Structure

C. F. P. L. - T. V. Towers, (Channel 9),
London, Ontario

Description of Structure

2 Towers: a) 1000 ft. tower, tubular steel, guyed wires (4 sets of 4).
Built in 1961 or 1962.
b) 600 ft. tower, tubular steel, guy wires (3 sets of 3)
Built in 1953.

Roofs of buildings nearby are built of tar and sand.

Frequency of Ice Falls

Several times annually

Normal Ice Fall Pattern and Associated Weather Conditions

Most ice falls straight off, or with S.W. to W. winds.
Some ice flies off guy wires.

Unusual Ice Fall Patterns and Associated Weather Conditions

Damage Reported

Roof of tar and sand broken frequently by ice falls, probably from smaller towers.

Usual precautions of not parking near tower during and after ice storms.

Information From:

Date: July 8, 1969

FALLING ICE REPORT

Structure

C.K.C.O. - T.V. and C.F.C.A. - F.M. towers,
Kitchener, Ontario (Baden Hill)

Description of Structure

2 Towers a) 190 ft. tower, 15 ft. antenna, built in 1948.
b) 600 ft. tower, 100 ft. antenna, built in 1956.
Tower guyed at 4 levels, guys 1400 ft. long. See diagram in "Unusual Ice Fall..."

Frequency of Ice Falls

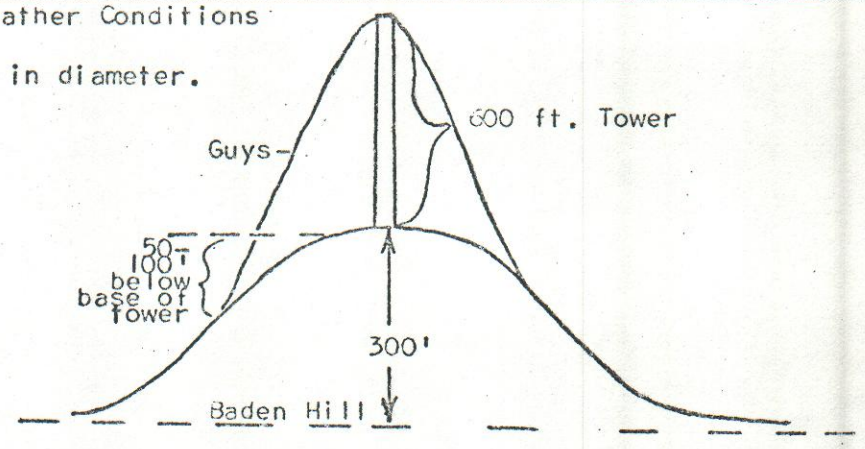
Annually - Jan., Dec. and around March (e.g. at mild times of winter, end and beginning).

Normal Ice Fall Pattern and Associated Weather Conditions

Freezing rain, most severe when wind is from east. Ice falls usually with S.W. wind. Drifts slightly with wind. Ice found 500 ft. from tower base, attributed to guys though 3 to 4 ft. sections from tower proper frequent.

Unusual Ice Fall Patterns and Associated Weather Conditions

Much ice falls from guys, ice 6" + in diameter.



Damage Reported

Air ducts bent and dented, boards laid on roof of buildings broken.

Information From:

Date: July 8, 1969

FALLING ICE REPORT

Structure

C.K.V.R. – T.V. Tower,
Barrie, Ontario.

Description of Structure

≈ 700 ft. tower, guyed at 10 levels, on 4 sides.
Tower 11+ years old.

Frequency of Ice Falls

Several times/season

Normal Ice Fall Pattern and Associated Weather Conditions

After storm, when temperature rises ice from guys usually falls.
Slabs from tower proper are 10 ft. long, 1/8" thick.
Ice usually falls in easterly direction, but some falls all around.
In heavy wind ice falls 100+ ft. from tower.

Unusual Ice Fall Patterns and Associated Weather Conditions

Damage Reported

Car roof (convertible) smashed 20 ft. from guys.
Building roof hit often, causing leaking.

Information From:

Date: June 19th, 1969

FALLING ICE REPORT

Structure

C.F.T.O. - T.V. Tower,
McCowan Rd., Toronto.

Description of Structure

815 ft. tower (889.5 ft. with antenna) guyed 7 levels in 3 directions.

Frequency of Ice Falls

Every year.

Normal Ice Fall Pattern and Associated Weather Conditions

Four inch diameter pieces of ice fall from guy wires. Pieces of ice approximately 2 ft. long have sailed 600 ft. from tower. Ice often has crystalline structure due to wind effects on ice foramtion. Fall has random distribution

Unusual Ice Fall Patterns and Associated Weather Conditions

Damage Reported

None.

Information From

Date: June 19th, 1969

FALLING ICE REPORT

Structure

C.B.C. - T.V. Tower, 8th line road,
Hornby, Ontario.

Description of Structure

643 ft. steel tower, guyed from 4 points. Lattice steel in tower construction. Small tuning hut beneath tower, transmission building 450 ft. to E. of building.

Frequency of Ice Falls

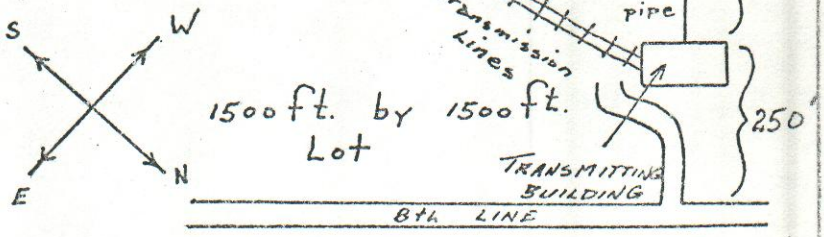
Every season.

Normal Ice Fall Pattern and Associated Weather Conditions

Ice falls east of tower within 200 ft. of base. Some fall to other sides, but much of this goes unnoticed. Most falls closer than 200 ft. as there is a tar-paper-covered copper pipe with more holes in it due to ice fall near the tower than 200+ ft. from it.
Worst icing occurs above 400 ft. level of tower. Weather conditions during fall:--During mild spells after sleet storms and usually quite soon after storm unless there is an immediate spell of cold weather.

Unusual Ice Fall Patterns and Associated Weather Conditions

Ice can fall 200-700 ft. from tower. One piece of ice 12 ft. long has hit transmission lines marking them.
One piece of ice 6" x 6" glided 700 ft. from tower to edge of road in one case.

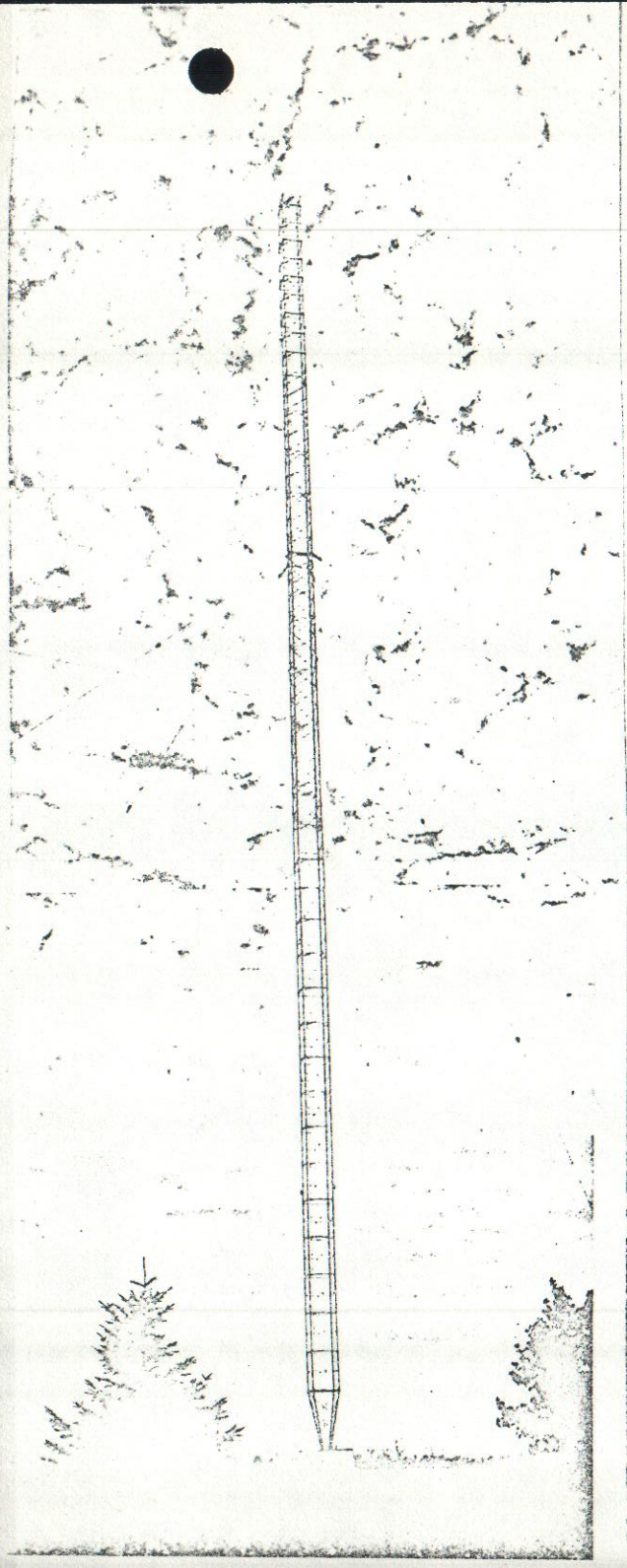


Damage Reported

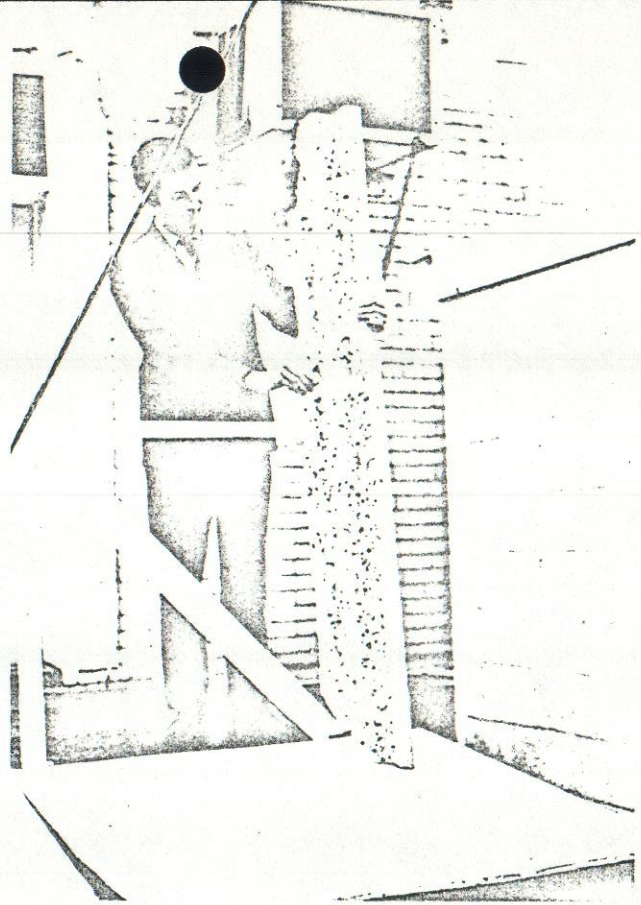
Aluminum ventilators on tuning hut below tower bent and dented by falling ice. Falling ice makes holes in tar-paper-covered pipe. (Note: Only holes in tar paper, not in copper pipe) This pipe was recovered with tar paper in 1948. Guy wires are trembling almost continually due to wind and this enables ice to fall off almost as soon as it freezes, i.e. no accumulations of ice have been observed on the guy wires. Ice has never been known to hit building and do any damage.

Information From:

Date: June 18, 1969.

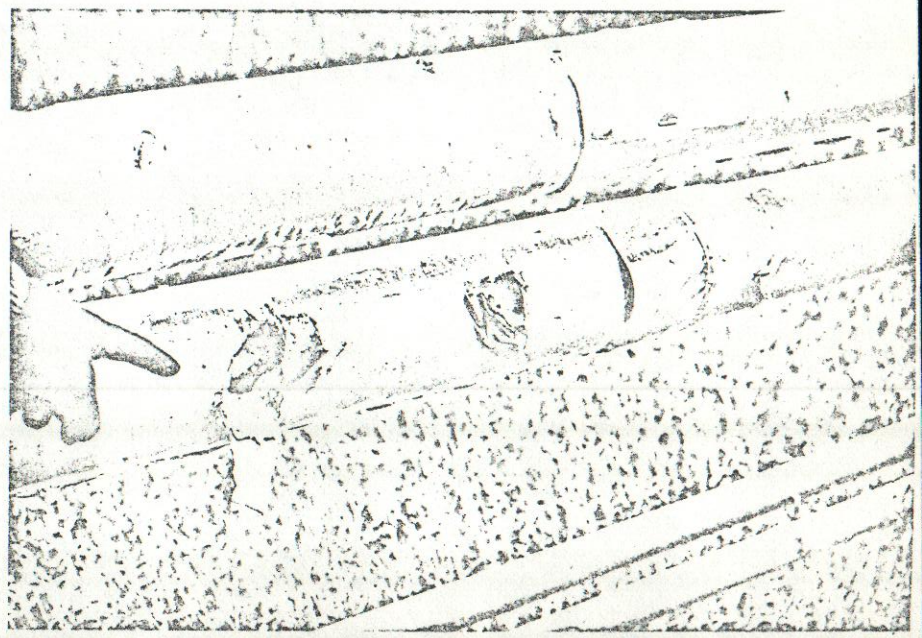


C.B.C – T.V. tower.
Hornby.



Damaged roof pieces, C.H.I.C.
A.M., Brampton.

Holes in tar-paper cover
of pipe - C.B.C., Hornby.



FALLING ICE REPORT

Structure

C.H.I.C. - A.M. Tower,
2 Ellen St.,
Brampton, Ontario.

Description of Structure

150 ft. radio tower, guyed at 3 levels. Tower next to house, with a small shack beneath tower.

Frequency of Ice Falls

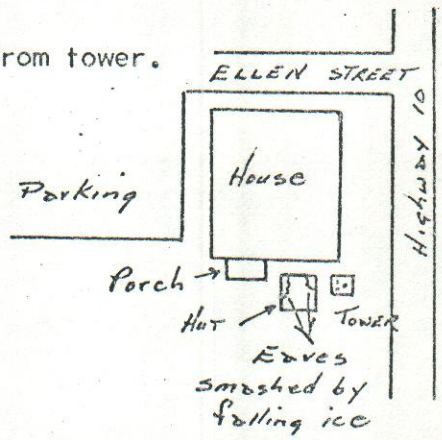
Several times/season

Normal Ice Fall Pattern and Associated Weather Conditions

Light falls during light N.E. winds with overcast conditions, moderately low temperatures (30° - 34°F). Ice forms varied with wind direction.

Unusual Ice Fall Patterns and Associated Weather Conditions

2 ft. long slabs to east and north of tower, up to 30 ft. from tower.



Damage Reported

Some falls smashed corrugated asbestos roofing at eaves of small shack. Roofing was 5 ft. x 1/2 ft. x 1/4 inch, unflexible corrugated asbestos.

See photographs.

Information From:

C.H.I.C. chief engineer

Date: June 18th, 1969.

FALLING ICE REPORT

Structure

C.H.I.C. main transmition towers, North of Hornby, Ontario.

Description of Structure

6 150 ft. towers, guyed at 3 levels, all in open field.

Frequency of Ice Falls

Unknown

Normal Ice Fall Pattern and Associated Weather Conditions

Unknown. Tower visited only twice weekly.

Unusual Ice Fall Patterns and Associated Weather Conditions

Damage Reported

No damage reported.

Information From:

C.H.I.C. chief engineer.

Date: June 18th, 1969.

FALLING ICE REPORT

Structure

Communications radio tower, on roof of Oakville Works Dept. Headquarters, Oakville, Ontario.

Description of Structure

Radio tower, guyed, 100 ft. tower on 30 ft. building.

Frequency of Ice Falls

Few, if any.

Normal Ice Fall Pattern and Associated Weather Conditions

Unusual Ice Fall Patterns and Associated Weather Conditions

Damage Reported

Information From:

Head of City Works Engineers.

Date: June 18th, 1969.

FALLING ICE REPORT

Structure

C.K.S.L. Radio Towers,
London, Ontario.
(16th Concession Westminster Township of Wellington)

Description of Structure

5-174 ft. Towers, Small tuning huts below towers, building 150 ft. from towers.

Frequency of Ice Falls

Normal Ice Fall Pattern and Associated Weather Conditions

None seen, but in January 1968 towers were coated with ice.

Unusual Ice Fall Patterns and Associated Weather Conditions

Damage Reported

Information From:

Date: July 3, 1969.

FALLING ICE REPORT

Structure

D.O.T. Transmitting and Receiving Antenna, Between Hornby and Oakville, 20 miles west of Toronto.

Description of Structure

4 towers, 100 ft., guyed. Near road and building.

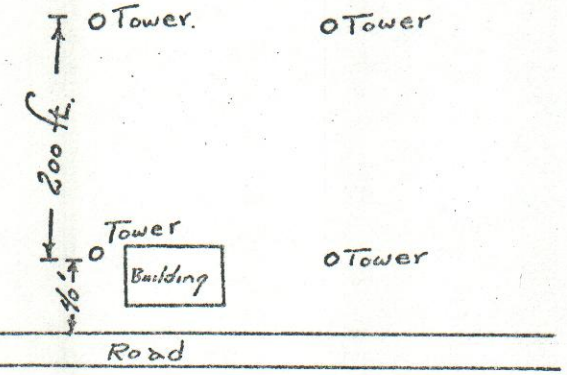
Frequency of Ice Falls

3 minor storms/season

Normal Ice Fall Pattern and Associated Weather Conditions

Little fall, no known pattern or weather conditions.

Site:



Unusual Ice Fall Patterns and Associated Weather Conditions

Damage Reported

Information From:

D.O.T. personnel on site.

Date: June 18th, 1969.

FALLING ICE REPORT

Structure

Bell Telephone Microwave Tower,
Barrie, Ontario.

Description of Structure

Self-supporting tower, 240 ft. high, building directly beneath tower.

Frequency of Ice Falls

Yearly.

Normal Ice Fall Pattern and Associated Weather Conditions

After storms ice falls fairly close to tower.

Unusual Ice Fall Patterns and Associated Weather Conditions

None noticed.

Damage Reported

None: Ice doesn't harm roof. (Note: A bolt fell from tower once and did damage to roof whereas ice does not seem to harm roof.)

Information From:

Date: June 19, 1969

FALLING ICE REPORT

Structure

C.H.M.L. - A.M. Radio,
848 Main St. E.,
Hamilton, Ontario.

Description of Structure

60 ft. tower on roof of building, Total height is 90 ft.

Frequency of Ice Falls

1-2 times/season

Normal Ice Fall Pattern and Associated Weather Conditions

Ice build-up 1/4" to 1/2" thick.

Unusual Ice Fall Patterns and Associated Weather Conditions

Damage Reported

None.

Information From:

Date: June 25th, 1969.

FALLING ICE REPORT

Structure

Metropolitan United Church,
Queen & Church Sts.,
Toronto, Ontario

Description of Structure

Large church with tower.

Frequency of Ice Falls

None.

Normal Ice Fall Pattern and Associated Weather Conditions

None from tower or church, but house has falls from abutment.
Nothing serious.

Unusual Ice Fall Patterns and Associated Weather Conditions

Damage Reported

None in 20 years.

Information From:

Date: June 25, 1969

FALLING ICE REPORT

Structure

Simpson's Tower,
Bay & Queen St., Toronto, Ontario.

Description of Structure

473 ft. building, open on Bay and Queen Streets, but buildings surround it on 2 other sides.

Only open one year, so data sparce.

Frequency of Ice Falls

Only open one season.

Normal Ice Fall Pattern and Associated Weather Conditions

Icicles had to be broken off by men to prevent risk to pedestrians below.

Unusual Ice Fall Patterns and Associated Weather Conditions

Damage Reported

None.

Information From:

Date: June 24th, 1969.

FALLING ICE REPORT

Structure

Toronto City Hall,
Toronto, Ontario.

Description of Structure

See tourist information.

Frequency of Ice Falls

Seasonally,

Normal Ice Fall Pattern and Associated Weather Conditions

Icicles falling straight down, melted by sun. Little pattern observable.

Unusual Ice Fall Patterns and Associated Weather Conditions

Damage Reported

None.

Information From:

Date: June 24th, 1969.

FALLING ICE REPORT

Structure

Concrete tower, rotating restaurant on top,
Niagra Falls, Ontario.
(see attached information)

Description of Structure

See information.

Frequency of Ice Falls

Normal Ice Fall Pattern and Associated Weather Conditions

Ice falls from spire had observation deck closed for several days.
Falls mainly to north-east and east side of building.

Unusual Ice Fall Patterns and Associated Weather Conditions

Damage Reported

None.

Information From:

Date: June 25th, 1969.

ACCOPRESS®

25071 –	BLACK / NOIR	– BG2507
25072 –	BLUE / BLEU	– BU2507
25078 –	RED / ROUGE	– BF2507
25075 –	GREEN / VERT	– BP2507
25074 –	GREY / GRIS	– BD2507
25073 –	R. BLUE / BLEU R.	– BB2507
25079 –	X. RED / ROUGE X.	– BX2507
25070 –	YELLOW / JAUNE	– BY2507
25077 –	TANGERINE	– BA2507

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