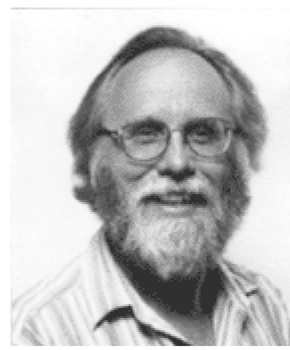
Structural Impact of Wind and Tornadoes

Luncheon Presentation Tuesday, Nov. 30, 2004

By W.C. Boyce, APEGM Staff

A Shelf Cloud

Approximately 30 people attended the APEGM PD Committee presentation by Mr. Jay Anderson of Environment Canada, on the impact of wind and storms on structures, held at the Holiday Inn South. Mr. Anderson is Manager of the Warning and Preparedness Program at the Prairie and Arctic Storm Prediction Centre located in Winnipeg.



Jay Anderson

An amateur astronomer since the early 60's, Jay Anderson is a graduate in astronomy and physics from the University of British Columbia; and is now a senior meteorologist with Environment Canada in Winnipeg, Manitoba. In his career of more than 30 years with Environment Canada, Jay has been a public forecaster; satellite meteorologist; marine forecaster; mountain forecaster; sever weather meteorologist; shift supervisor; and most recently, Manager of the Warning Preparedness Program for the Prairies based at the Prairie and Arctic Storm Prediction Centre in Winnipeg.

Mr. Anderson has published studies of winter and summer storms and thunderstorm forecasting techniques, and local impacts of climate change. Jay has also been studying and writing about the world's climatology for eclipse chasers ever since the late 1970's. Currently, Jay is compiling a database of severe weather events on the Prairies, since the arrival of European settlers in the 1800s. Occasionally, when the mood strikes and the weather permits, Jay has been known to indulge in a little tornado chasing.

Tornado: *a narrow (10 – 1000 m) vortex in contact with the ground and the base of a convective cloud.*

Since the 1860s, there have been over 1800 confirmed tornadoes on the Prairies. Twelve of these storms were within the City of Winnipeg; with one death reported in 1900. The peak period for tornadoes on the Prairies is the first week of July, with the peak day being June 30th. Most tornadoes in Manitoba and the Prairies fall into the F0 category of the Fujita Damage Scale (please see the following chart).

Tornado Strength and Frequency				
Fujita Category	Maximum Wind Speed (km/h)	Damage	Frequency	Example
F0	115	light	83%	common
F1	180	moderate	11%	Broadview, SK 1997
F2	250	considerable	4%	Moose Jaw, SK 1995
F3	330	severe	1.8%	Edmonton, AB 1987
F4	420	devastating	0.9%	Rosa, MB 1977
F5	510	unbelievable	0.4%	Benson, SK 1935 ?

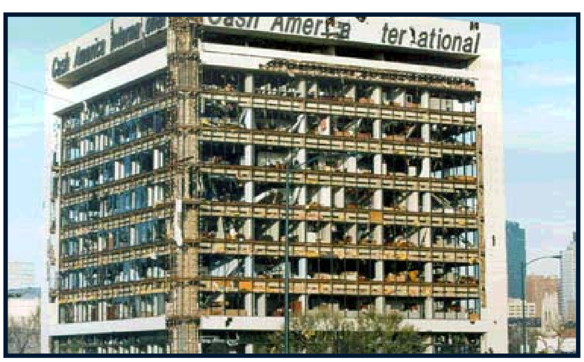
Tornadoes of F3 and higher, although uncommon, cause the most damage to property and loss of life. However, any tornado is a danger to both life and property.

Typical funnel-cloud tornado – Birtle 1994

Rosa, MB – July 1977
F4 tornado – 3 fatalities

Birtle, MB – July, 1994
F3/F4 Tornado
Severe damage to buildings and surrounding trees.
Fortunately, no fatalities.

Tornadoes also strike cities (eg: Edmonton, 1987) causing severe damage to buildings.



Between 60 and 70% of businesses damaged by a tornado never recover.
In 2004, there were only three tornadoes in Manitoba due to our cooler summer.

Convective windstorm: *a strong gust or short-duration wind that descends from a convective cloud (microburst, downburst, plough wind, derecho, macroburst, bow echo)*

- Probably more common than tornadoes
- cover large areas with speeds up to 200 km/h
- more commonly: 120 - 150 km/h
- frequent at night when warnings are not heard

Often, windstorms will have a series of microbursts (areas of intense high winds) associated with them. There are both Dry and Wet Microbursts.

Damage tracks in a corn field show the shape and size of a microburst.

Dry Microburst – A Shelf Cloud

- June 20, 1995
- Squall Line moved through Southern Manitoba
- Damage from Lake Manitoba to south of Morden/Winkler
- Significant damage to tents at Red River Ex.
- Grosse Isle (160 km/h)

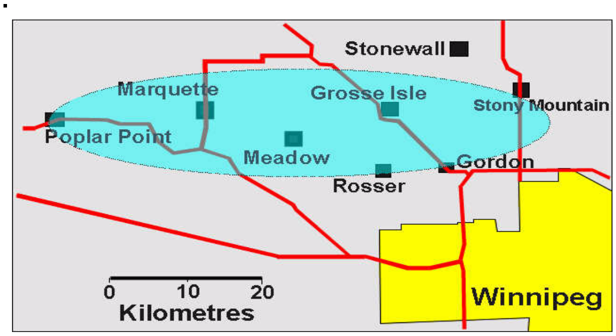
Wet Microburst

- Pakwash, ON July 18, 1991
- Estimated wind 200 km/h
  (Cat 3 Hurricane Force Winds)
- Could have impact on eastern Prairies

This wet microburst in the Pakwash, ON area is one of the best documented in the world. The storm, which lasted over an hour, devastated an area 75 km wide by 200 km long, flattening almost every tree in the region.

The Hydro Blowdown – September 5, 1996

This storm, with sustained winds of 100 km/h, ran approximately 75 kms from Poplar Point to Stony Mountain. It is believed that microburst gusts of 150 – 180 km/h in the storm were responsible for



bringing down one of the hydro towers. The additional strain of this tower failure, plus the sustained winds of 100 km/h, caused the collapse of additional towers along the line. Power from the north was interrupted for two weeks.

Structural Impacts of Winds and Storms

- The greatest outward (or uplift) wind pressures occur around windward walls, roof corners, eaves, and ridges.
- The damage due to wind typically involves the removal of wall cladding and roof coverings at these locations.
- There is no substantial difference between wind damage from tornadoes and from hurricanes
- Building damage initiates from wind pressure breaching the building, not from low barometric pressure
- The wind typically enters the building through broken windows or doors
- Openings on the windward side of a building increase the internal wind pressures, resulting in additional uplift on the roof

Wood frame building failures

- Main failure points
  - wall/foundation,
  - wall stud/bottom plate,
  - roof joist/top plate, and
  - rafter/top plate.
- Survey after survey in the US has shown that wind-induced damage is greatly increased because of construction code violations

Metal Clad Buildings

- Inward buckling of overhead doors frequently led to loss of roof and wall corner cladding.
- Openings in the windward side of a metal building resulted in increased interior wind pressures, especially when there were no openings on the remaining building faces
- Open bays "catch" the wind, causing increased wind pressures on cladding.
- Similar failure initiation points in metal structures have been noted in hurricane damage.

Weak points in construction

- Unreinforced concrete block masonry is vulnerable to lateral wind loads
- A common failure point on roof systems occurs where the roof membranes are attached to edges and corners

- Another failure initiation point is due to the lack of attachment between insulation board and the roof deck – insulation board must be applied while the bitumen is warm in order to bond properly

Flying or Falling Debris

- A significant factor in all wind-induced damage is the effect of flying debris
- On the Prairies, falling trees are often the main source of damage

Damage to a small home caused by a modest 100 km/h windstorm

Building codes

- Building codes often do not adequately reflect the climatology of a region

Attached garages are a weak point in a house's design and magnify the damage done to a house when struck by high winds, especially if the doors are left open.

In Winnipeg, structures should be built to withstand a wind of at least 130 km/h. Winds of 100 km/h have a return period of only three or four years.

The audience was very appreciative of Mr. Anderson's presentation. In particular, they appreciated seeing some of the dramatic film clips showing the effects of winds associated with tornadoes and hurricanes on buildings and other structures.

The Professional Development Committee would like to thank Mr. Anderson for his time in preparing and making this presentation for the APEGM members. We would like to wish him well in his retirement next year.