

The CN TOWER

Since it opened 21 years ago, the CN Tower has been a source of pride of accomplishment for Canadians. It is truly a wonder of modern design, engineering and construction. At a height of 553.33m (1,815 ft, 5 inches), it is the World's Tallest Building and Free-Standing Structure, an important telecommunications hub, and the centre of tourism in Toronto. Each year, approximately 2 million people visit the world's tallest building to celebrate its achievement, take in the breathtaking view and enjoy all of the attractions the CN Tower has to offer.



History

The Tower inspires a sense of pride, inspiration and awe for Canadians and tourists alike. However, its origins are firmly rooted in practicality.

During Toronto's building boom in the early 70's, a serious problem was developing. People were experiencing poor quality television. And it wasn't just the sitcoms. The pre-skyscraper transmission towers of Toronto stations were simply not high enough anymore.

As office buildings were reaching higher and higher, TV and radio reception began suffering from 'ghosting', or a weakening of clarity. Signals from Toronto and from Buffalo, New York were bouncing off the buildings. As a result viewers often saw a weaker station

superimposed over another. In effect, they were watching two shows at once. And this was before channel surfing allowed us to do this on purpose. It became clear that what we needed was an antenna that would not only be taller than any building in the city, but one that would be taller than anything that would probably ever be built.

In 1972, Canadian National (CN) set out to build a tower that would solve the communications problems, serve as a world class entertainment destination, and achieve international recognition as the world's tallest tower.

The Tower's microwave receivers are located 338 m (1,109 ft) above the ground in the radome (the donut-shaped collar at the base of SkyPod). The

important VHF, UHF and television equipment intrinsic to the Tower's purpose as a broadcast transmission facility are located here. Incoming signals are monitored and fed to the antenna for transmitting. Further up at 360 m (1,180 ft) is the centre of FM broadcasting in Toronto. CFNY, CHUM, CHFI, CKFM, Q107, CHIN, CJRT, CJEZ, CBC radio and City TV, CFTO-TV, TVO, CBLT, CFMT, Global, CBLFT, and CICA all use the Tower's superior transmission capabilities.



The transmission equipment, although powerful, is extremely sensitive. The radome, designed to protect it from the elements, is a teflon-coated fibreglass-rayon fabric which can hold the weight of an average adult male yet measures only 1/32 of an inch. Its balloon-like shape results from inflating the skin to five times its normal size then maintaining constant pressure.

CN Tower Construction

Breaking new ground

When engineers started to plan the foundation of the CN Tower, they were breaking new ground in more ways than one. Never before had anyone been faced with the task of designing a base so far into the ground and they came up against many construction challenges unique to this project.

After an elaborate series of tests on the soil to assess the condition of the bedrock and determine how it would react to changes in hydrostatic pressure, the work was ready to begin. On February 6, 1973, hundreds of people, engaged in a historic enterprise, moved in and started to carve out the launching pad for the World's Tallest Building.

They removed 56,234 metric tonnes (62,000 tons) of earth and shale before pouring a thick concrete and steel foundation 6.71 m (22 ft) deep on a base of hand-and-machine-smoothed shale. Supporting the World's Tallest Building is a tall order and by the time it was finished the y-shaped foundation contained 7,046 cubic metres (9,200 cubic yards) of concrete, 453.5 metric tonnes (500 tons) of reinforcing steel and 36.28 metric tonnes (40 tons) of thick, tensioning cables. The thoroughness and speed with which the foundation was laid is noteworthy. The complete foundation was in place just four months after the first spade of earth had been turned.

Building the Tower inch-by-inch

Once the foundation was ready, work began on the Tower's 335 m (1,100ft)

concrete shaft a hexagonal core with three curved support arms. 1,537 people worked round the clock for 40 months to pour the concrete and raise the Tower inch by inch.



24 hours a day, five days a week, concrete was poured into a massive mold or "slipform". As the concrete hardened, the slipform, supported by a ring of climbing jacks powered by hydraulic pressure, moved upwards, gradually decreasing in size to produce the Tower's gracefully tapered contour.

The CN Tower contains 40,538 cubic metres (53,000 cubic yards) of concrete and ensuring its integrity was vital to a construction project of this magnitude. In order to maintain consistency, all concrete used in the Tower had to come from the same source. Workers mixed every ounce of the concrete on site, continuously testing and re-testing it and then reinforcing it with a unique system of post-tensioning.

Day-by-day, concrete was poured and the Tower began its slow ascent over Toronto. As its shadow lengthened, it was already a major topic of conversation among Canadians and a subject of intrigue in international media. When the slipform was

completed on February 22, 1974, it had become the tallest building in Canada.

Building a seven-storey building at 1,100 feet

In August of 1974, workers began building, the Towers crowning glory, the SkyPod, a seven-storey building that would eventually house two observation decks, 360 Revolving Restaurant, Horizons, the GLASS FLOOR and various technical areas. This construction in the sky involved lifting 318 metric tons of steel and wood brackets up the sides of the Tower using 45 hydraulic jacks and miles of steel cable. To build the observation level, workers bolted brackets to tensioned steel bars and placed concrete in the wooden frames, then placed a three-foot-high compression ring around the outside.



The radome (the donut-shaped collar at the base of SkyPod), protects the Tower's sensitive microwave equipment and is essential to its intrinsic purpose as

a broadcast transmission facility. All of the important VHF, UHF and television equipment is located here. Incoming signals are monitored and fed to the antenna for transmitting. The radome is designed to protect this equipment from the elements but still enable it to receive transmissions. The radome is a teflon-coated fibreglass-rayon fabric which can hold the weight of an average adult male yet measures only 1/32 of an inch. Its balloon-like shape results from inflating the skin to five times its normal size then maintaining constant pressure.



Creating the two-storey Space Deck, the World's Highest Public Observation Gallery, involved Cantilevering a concrete platform around the top edge of the Tower. A glass wall was suspended from the overhang of its roof, banking inwards at the bottom and completely enclosing the upper storey.

When the concrete part of the Tower was completed, Torontonians bid farewell to the familiar CN Tower crane which had worked tirelessly for almost four years. But its replacement was equally impressive--Olga, the giant Russian Sikorsky helicopter



commissioned to assemble the Tower's antenna, the slim, stacked broadcasting receptor rising 350 feet from the shaft. Before it could start lifting pieces of the antenna into the sky, the helicopter dismantled the crane in eight sections. After that, Olga lifted the 36 pieces of the antenna into place with remarkable precision. As the helicopter raised each piece of the antenna, fearless workers helped manoeuvre and bolt the new piece into place in gusting winds and



freezing temperatures. Amazingly, the entire operation lasted only 3 1/2 weeks and by the end, Olga had executed 55 lifts.

Keeping the Tower on the straight and narrow



As the Leaning Tower of Pisa has shown, tall slender buildings have a tendency to incline or, in the case of the CN Tower and other buildings in the northern hemisphere, twist counter-clockwise. When planning and building tower-like structures, engineers must ensure that they have the ability to remain within plumb (a method of measuring vertical nature). After 21 years, the CN Tower is within 2.79 cm (1.1 inches) of plumb, a testimony to the technological advancements employed by its engineers.

CN Tower engineers attached two optical plumbs specially designed to keep tall buildings straight to permanent mounts on the tower and suspended a 113.4 km steel cylinder from an aviation cable in the Tower's core. As well, several permanent survey stations are

located at remote locations, equipped with surveyor's transit.

Building the World's Tallest Tower

At 9:52 a.m. on March 1, 1975, Olga, the huge Russian Sikorsky helicopter placed the 44th and final piece of the antenna mast on top of the CN Tower bringing its official height to 553.33 m (1,815 ft, 5 inches). At that point, the Guinness Book of World Records named it the World's Tallest Free-Standing Structure, a title unsurpassed since that day. In 1996, the designation was officially changed to World's Tallest Building and Free-Standing Structure.

Worldwide, Canada's CN Tower is recognized as a magnificent feat of modern design, engineering and construction. The CN Tower was conceived from a need for a broadcast transmission facility and evolved into an internationally recognized Canadian landmark. Canadian National (CN) provided the initial proposal for the Tower in 1968 and worked with an international consortium of experts to develop the final model in 1972. The three curved legs of the final model are remnants of an initial design which called for three towers linked by structural bridges.

Although there are many magnificent freestanding structures in the world, the CN Tower was the first of its size and type and a major achievement for Baldwin and Franklin Architects, the Toronto firm which provided the initial design and construction of the Tower. When it was built, it revolutionized engineering and today remains a symbol of human ingenuity pioneered by Canadians. Not only did the firm

accomplish a major feat of engineering, but in their time, they pushed forward the boundaries of science and technology.

Going up

Each year about 1.6 million people visit the CN Tower and they are whisked to the SkyPod by high-speed elevators in just 58 seconds. In March, 1997, the Tower improved this service by introducing two new elevators providing not only an increased passenger capacity of 1,600 people an hour, but also a brand new view of downtown.

Finding space for the two new elevators was not a problem. The Tower's original engineers anticipated increased attendance and left room for additional elevators. However, there was an emergency staircase located in the space. To install the elevators, the staircase had to be relocated and still remain accessible at all times. It was dismantled from the North face of the Tower and moved bit by bit into the hollow interior of the Tower where it remains today. The reconstruction involved adding an additional nine steps to the staircase, bringing the total number of steps to 2,579 and setting a new world record.

One of the world's safest structures

In addition to its numerous world record titles, the CN Tower can claim an excellent safety record. When people visit a structure of such height, they are naturally apprehensive and concerned about safety. A number of innovative, built-in safety features and a diligent workforce helps to put people's fears to rest. Here are some of the highlights of our safety program:

- Elevator control --The CN Tower's six high-speed elevators are linked to their own elaborate control system. In the event of a power failure, five 450 KW diesel generators supply emergency power within 10 seconds. If the elevator exceeds a certain speed or starts to fall, the most can drop is 1.83 m due to plodding devices which automatically jam into the elevator shaft.
- Wind resistance -- Like all tall, narrow buildings, the Tower sways in extreme wind conditions but it can withstand winds of up to 260 mph (418 kph) and two ten-ton swinging counterparts, mounted on the antenna, ensure that it never exceeds acceptable conditions. The



armour-plated windows on the observation levels and restaurant were carefully designed for extreme wind tolerance with outside panes of 95 cm thickness and inside panes of 64 cm thickness. The resistance of various parts of the Tower in winds of 100 mph are as follows:

Dynamic Peak:

SkyPod - 1ft., 7 inches from centre
Space Deck - 3ft., 4 inches from centre
Antenna - 6ft., 8 inches from centre

Fire safety --The CN Tower has had a perfect record against fire due to a carefully conceived design, interior monitoring system and diligent security force. In the event of fire, emergency generators supply power for the elevators and other devices. Emergency fire pumps send water to the top of the Tower at a rate of 2,273 litres a minute. Two reservoirs containing 68,190 litres of water are also maintained in the SkyPod.

Capturing history for future generations

At the CN Tower's official opening on October 1, 1976, a time capsule was sealed to commemorate the day. It contains a letter from then Prime Minister Pierre Trudeau, letters from each provincial Premier, letters from school children, copies of the three daily newspapers, Canadian currency and To The Top, a video about the Tower's construction. To this day, the capsule and its memories remain safely tucked away inside the walls of the Tower on the indoor observation levels.



The Straight Goods: The Facts at a Glance.

If you're only looking for a quick answer to your question, or you're trying to settle a bet, this is the best place to start your search.

- The CN Tower was built by the Canadian National Railway.
- Opened to the public on June 26, 1976
- Official opening on October 1, 1976
- Original cost: \$63 million
- Adjusted cost (1997 dollars): \$250 million
- Total construction time: 40 months
- Number of construction workers: 1,537
- Total weight of the Tower: 117,910 metric tonnes (130,000 tons)
- Volume of concrete: 40,523.8 cubic metres (53,000 cubic yards)
- Reinforcing steel: 4,535 metric tonnes (5,000 tons)
- Structural steel: 544.2 metric tonnes (600 tons)
- Number of elevators: 6 (including 2 which officially opened March 20, 1997)
- Speed of elevators: 6 metres/second (20 feet/second)
- Slow speed of elevators (in high winds): 1.5 metres/second (5 feet/second)
- Attendance: about 1.8 million per year
- Total staff (off season): approximately 400
- Total staff (peak season): approximately 550
- Maximum sway in 190 km/h winds with 320 km/h gusts (120 mph winds with 200 mph gusts):

- Antenna: 6 ft., 8 in. from centre
Sky Pod: 3 ft., 4 in. from centre
Tower Sphere: 1 ft., 7 in. from centre
- Windows: Double-pane armour-plated
- Thickness of windows: Outer pane - 9.5 mm (3/8 inch), inner pane - 6.4 mm (1/4 inch)
- Capacity of 360, The Restaurant at the Tower: 400 people
- Time it takes to revolve once: 72 minutes
- Capacity of Horizons Café: 500 people
- Broadcast Facilities: UHF, VHF Television; FM Radio; Microwave Transmissions; Fixed Mobile Systems
- Companies that broadcast from the Tower:
 - CBC Channel 5 & 25, CFMT 47, CFTO 9, City 57, Global/CIII 41, TV Ontario 19, LOOK Communications (Digital), CHFI/Rogers, CFNY FM, CHIN FM, CHUM FM, CILQ FM, CJEZ FM, CJRT FM, CKFM FM, Bell Canada, Cantel, Motorola, TTC
- Thickness of The Glass Floor: 2 1/2". Layers, from the top down:
 - 3/16" scuff plate (replaced annually)
 - Two 1/2" layers of clear tempered glass, laminated together
 - A one inch layer of air (for insulation)
 - Two 1/4" layers of clear tempered glass, laminated together
 - Size of each panel: 42" by 50"
 - Load tests are performed annually on each panel to ensure safety.