Selected Historic Tornadoes

1871 and 1896 St. Louis, Missouri Tornadoes: The Eads Bridge, designed by Joseph Eads as the largest structure in the world at that time to be built of steel rather than iron, and the first long span bridge across the Mississippi, was directly hit twice by tornadoes; the 1871 tornado crossed the bridge at the site of construction of the bridge’s Illinois side; nearby, a locomotive was lifted and overturned, indicating a tornado of maximum intensity; as the main span of the bridge was under construction, Eads revised the design to include enough extra bracing to withstand severe winds; 25 years later, the bridge was struck by a tornado of similar intensity, with winds estimated at over 200 mph, driving a 2-by-10-inch wooden board through the side of a 1/2-inch thick metal beam; the bridge experienced no major damage, however, and is still in use today.

March 18, 1925 Tri-State Tornado: traveled over 200 miles, averaging 60 mph overall forward motion, passing through Missouri, Illinois, and Indiana; 689 fatalities.

April 11, 1965 Palm Sunday Tornadoes: 51 tornadoes were spawned by thunderstorms, resulting in 256 fatalities.

April 3–4, 1974 Super Outbreak Tornadoes: the largest outbreak of tornadoes observed to date in the United States; 147 tornadoes in 13 states resulted in 307 fatalities; the amount of land covered by these tornadoes in one 24-hour period was about half of the previous average total swath area for all the tornadoes occurring in a year.

May 6, 1975 Omaha, Nebraska Tornado: a very damaging tornado in terms of property loss (more than 2000 homes or businesses destroyed over a 200-block area of the city), but only 3 lives were lost, partly because of the Weather Service’s watch and warning system, augmented by local spotters, sirens, media announcements, and other emergency response measures established ahead of time. The path of the tornado was about 10 miles long and a third of a mile wide; the tornado spent about 20 minutes crossing the city, and had winds up to about 200 mph.

Tornado Myths

Field work by Institute of Disaster Research engineers after numerous tornadoes (Sources of Information), has largely debunked the following popular conceptions of tornadoes.

1. Tornado winds can be in excess of 500 mph. Detailed studies of the effects of individual tornadoes, and careful analysis of motion pictures of tornadoes, have led experts to conclude that about 250–275 mph is the maximum windspeed generated at ground level, and 90% of all tornadoes have maximum windspeeds of about 150 mph or less (or up to F2 on the Fujita Scale—see Tornado Scales).

2. It is not the rotating wind caused by a tornado but rather the partial vacuum or low pressure in the center of the tornado that causes buildings to explode. The pressure drop is not as great as usually thought, and most buildings leak enough air, even with windows closed (let alone broken, as they would be if wind or vacuum effects were severe), to allow the interior and exterior pressures to quickly equalize. Opening windows would help vent a building to reduce any pressure difference effects, but if the process of opening the windows exposed a person to greater risk of being in this vulnerable location as a tornado struck, the advice would be counterproductive.

3. Penetration of splinters and straw into boards indicates incredible wind speeds. Laboratory tests indicate that broom straws and toothpicks can become embedded at speeds as low as 70 mph.

Tornado Scales

The scale most commonly used by scientists and engineers in rating tornadoes is the F or Fujita scale, which was devised by Prof. T.T. Fujita of the University of Chicago. The F scale rates the intensity of a tornado by the appearance of damage. Most tornadoes are rated at F0, F1, or F2 on this scale (or up to about 150 mph). Estimated windspeeds are associated with each damage level as shown below.

**Fujita (F) Scale**

F5: Incredible; 251–318 mph; severe damage even to reinforced concrete buildings.

F4: Devastating; 207–260 mph; autos may be thrown; wood frame houses leveled.

F3: Severe; 158–206 mph; most trees blown down; roof and some walls of wood frame house blown off.

F2: Strong; 113–157 mph; roof of wood frame house blown off, walls remain.

F1: Weak; 73–112 mph; unsecured mobile homes destroyed, but lighter damage to other structures.

F0: Very weak; 40–72 mph; damage only to signs, trees, TV antennas, chimneys.
Tornado Shelter

The best tornado shelter areas are fully buried basements with concrete floors overhead. Next in preference are fully buried basements with reinforced concrete or reinforced masonry walls and wood floors overhead, or partially exposed walls of this type with a concrete floor overhead.

Areas near windows are the most dangerous. Interior aboveground spaces, in small rooms rather than longer span areas, excluding corridors with exterior doors at each end (which can become "wind tunnels"), are the best available aboveground areas in most buildings. The notion that the southwest corner of a building is much safer than other areas is now generally discredited.

Even if there is no basement, tornado shelter areas can be designed into a building. For a small additional cost, tornado resistant rooms, essentially closets with extra strong ceilings and walls, can be added to new building construction. Research conducted by the Institute for Disaster Research at Texas Tech University (see Sources of Information) has devised standard construction details for rooms of reinforced concrete block wall construction with reinforced concrete ceilings in a new house. (Such a room could also serve as a fire- or burglar-resistant security closet.)

While un-reinforced brick or block walls (which have no steel reinforcing bars) fall apart and create lethal debris at relatively low wind pressures, properly reinforced masonry can offer extremely high protection from tornadoes. Designs appropriate for some other types of buildings have also been devised by the Institute.

The overall structure of a building, in addition to specific shelter areas, can be reinforced by engineers to withstand high winds for costs typically ranging from a fraction of a percent to a couple percent of construction cost. This is most economically accomplished during design, prior to construction, but in many cases retrofits, such as added roof to wall or wall to foundation steel connection hardware, can be added at relatively low cost.

Buildings fully engineered to resist high winds consistently perform much better in tornadoes and high winds than marginally engineered or non-engineered structures. Buildings that typically have high vulnerabilities to tornadoes—although individual examples specially engineered for high winds may be exceptions—include the categories of mobile home, all metal prefab, wood frame, un-reinforced masonry, pre-cast concrete, and long span roof system (gymnasium, large industrial building, shopping center, etc.).

Tornado Watches and Warnings

A tornado watch is announced by the National Weather Service when conditions make it likely that a tornado will occur. Large areas of states may be included in these watches. Weather Service observations, refined in recent years with extensive use of radar, lead to watches being declared for less than 1% of all thunderstorms. About 500 to 1000 tornadoes occur in the United States annually.

A tornado warning is issued by a local National Weather Service Office when a tornado is actually sighted, or when one is positively identified on short-range radar.

Mobile Homes

Mobile homes are almost as vulnerable as signs, awnings, and tree limbs to high winds. At winds speeds much over 70 mph (common in ordinary windstorms, while tornadoes can generate much greater winds), severe damage associated with roof blowoff or bodily movement of the coach can occur.

This high vulnerability can be greatly lessened if tiedowns are properly installed. Steel straps or cables, strongly attached to soil anchors or concrete foundations embedded in the ground and also strongly attached to the coach, are always advisable and in many cases required by law. Combinations of vertical and diagonal ties are most effective, and the typical spacing is approximately 10 feet. Engineering studies have pointed out that variations in soil strength and in the connections of straps to coaches can lead to great differences in strength; thus more conservatively installation standards, such as closer spacing of anchors than is required by a code, may be advisable. A well-anchored mobile home may also be damaged by impact from a neighboring airborne coach; thus the best protection is provided when all of the mobile homes in a neighborhood are anchored.

Mobile home residents are usually advised to seek shelter elsewhere during tornado warnings, even if their units are strapped down, and these safer areas of shelter should be identified ahead of time. The ideal situation is for each mobile home park to have a very strong building (recreation building, for example) of reinforced masonry or reinforced concrete construction for use as a shelter.

Tornado Season

Most tornadoes occur in the warmer months from April through August, because most tornadoes are caused by thunderstorms, although the number of tornadoes in a winter month may be 20% of that of a peak season month.

The tornado season comes earliest in the Gulf Coast states, beginning in February, moving its way northward. The season begins in the Southeast Atlantic states in March, peaking in April; it begins in May in the Southern Plains and in June in the Northern Plains and Great Lakes states.

Sources of Information

Institute for Disaster Research, College of Engineering, Texas Tech University, Lubbock, Texas 79409. The Institute is a major source of tornado and other high wind engineering studies in the United States. Numerous publications are available from the Institute (publications list sent upon request), most of which are oriented toward engineers, building officials, architects, or contractors; information and consulting services on wind resistant building design and tornado shelters.

National Weather Service, National Severe Storms Forecasting Laboratory, Kansas City, Missouri 64106; data on tornadoes for forecasting and for use in scientific studies.

Tornado Safety, National Oceanic and Atmospheric Administration, Rockville, Maryland 20855; public information booklets and pamphlets.

Cooperative Extension Service, Kansas State University, Manhattan, Kansas 66506; pamphlets on what to do in case of tornadoes, emergency supply lists, and other useful information for the public.

Office of Public Affairs, Federal Emergency Management Agency, Washington, D.C., 20472; FEMA packages information from sources such as the above for distribution to tornado safety campaigns.