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TORNADOES OF THE MIDDLE WEST

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(Read before the American Meteorological Society at Kansas City,
Mo., December, 1925.)

This meeting of the American Meteorological Society is the first ever held so near what is often designated the "Tornado Belt" of the United States. Were this one of the abnormally warm, "sticky" days that so often occur in spring at Kansas City and vicinity and if, in addition, the weather map this morning showed an area of low atmospheric pressure to the west or north, with pronounced differences in temperature between areas a few hundred miles southeast of here and those a few hundred to the northwest, there might be good reason for anxiously watching any black clouds above the southwest horizon. If this were an assembly of men whose chief knowledge of tornadoes had been gathered from highly sensational newspaper accounts of "Kansas cyclones" and if the icy hand of winter had not temporarily banished the conditions that give rise to this most spectacular type of storm that strikes inland America, the majority present might be excused for having a panicky feeling were the sky to become suddenly threatening.

Of the three big cities of the Middle West, Omaha, St. Louis and Kansas City, two have already been devastated by tornadoes that focused the attention of the nation. The St. Louis tornado of May 27, 1896, less than 300 miles east of here, caused the death of 306 persons and the destruction of property estimated at \$12,339,000, worth probably \$25,000,000 at present day valuations. The Omaha tornado of March 13, 1913, 200 miles to the northwest, killed 94 persons and destroyed property to the extent of \$3,500,000, and the terrible tornado of southern Illinois, 300 miles to the southeast, which struck last March 18, caused 742 deaths, the injury of 2,756 persons, and estimated property losses of \$16,500,000. Scarcely more than a year ago, on June 24, 1924, a tornado came so close to St. Joseph, hardly two hours ride by automobile from here, that excellent photographs of the cloud were

obtained from the roof of an office building in the heart of the city. Many tornadoes of violence probably equal to these have swept paths in recent years within a radius of 200 miles of Kansas City.

Lest I be accused of giving an undesirable reputation to this region and to Kansas, which has long been noted for the number of tornadoes it reports, I hasten to say that no destructive tornado has struck Kansas City since 1886. Kansas has suffered less loss of human life by tornadoes than eleven other states in the eight-year period, 1916-1923, according to the exhaustive study of tornadoes in the United States published by Mr. H. C. Hunter of the Climatological Division of the Weather Bureau. Alabama, Arkansas, Illinois, Indiana, Mississippi, Missouri, Oklahoma, and Texas each reported more than twice as many deaths as Kansas in this eight-year period, according to Mr. Hunter, yet none of them has as great reputation as a tornado state as Kansas. Property damage from these storms has also been greater in this period in a considerable number of states east of the Mississippi than in Kansas.

The spectacular nature of these storms and the possibilities of disaster, rather than the destruction actually wrought, accounts for much of the attention that has been given them. Threatening clouds have brought fear to men since the first man trod the earth long before the dawn of recorded history. When to these is added the unusual and almost unbelievable sight of a milky pendant or funnel boring its way down from an angry looking cloud a person seeing it for the first time is likely to be spellbound. As this writhing funnel strikes the earth and buildings are reduced to kindling in the twinkling of an eye, the terrible roaring, commonly described as resembling that of "a thousand railway trains crossing a trestle at the same time" is enough to strike terror to the stoutest of hearts, even if the destruction itself were not in evidence. In addition to this roar, a tornado commonly has a weird whistling sound described as resembling a siren, that has often been mentioned by observers. Most probably this comes from the enormous velocity of the wind about the vortex, which has been variously estimated at from 200 to 300 miles per hour.

The freaks of tornadoes are so numerous and curious as to be past belief. Accounts of miraculous escapes from death are common after every one that has been destructive. Instances of poultry being stripped of feathers, yet not killed outright, of straws driven into trees and posts, and of boards driven into trees or through buildings are well authenticated. Eight years ago the writer had occasion to investigate the effects of a tornado that had struck near Topeka, Kansas, and among other curious occurrences found an instance where a small railway station had been literally torn to pieces and blown away. A heavy seal weight from this station was picked up 100 feet away, resting on a pane of glass that had not even been cracked. A glass jar of fruit that stood on a shelf in the station was carried several hundred feet by the wind and let down, unbroken, among the debris. A coal shed of a country school in which a party of tourists had taken refuge from the storm

escaped with no damage while the outhouse, within two feet of the shed and of about the same construction, was blown entirely away and the nearby school house was demolished.

Mark Twain is credited with saying, "Much has been said about the weather, but nothing has ever been done about it"; which brings us to the question as to whether anything can or will be done to mitigate the effects of tornadoes. The genius of man has always triumphed over obstacles and there is no reason to think he will not ultimately strip the tornado of at least part of its terror.

Insurance is, of course, the most general protection against tornado damage. Wind storm insurance is common through the middle west, in fact many mortgage companies now require that buildings in the so-called tornado belt be insured against loss by wind as well as by fire where a heavy loan is written, but insurance of property damaged is small compensation for the loss of human life.

The "cyclone cellar" is still found in conjunction with numerous farm homes in Kansas and adjoining states. Though built primarily for the storage of fruits, vegetables and dairy products, it is found a safe and ready refuge for the farmer and his family, especially in an open country where the approach of a tornado can be seen for miles.

It would perhaps be too much to say now that a modern concrete, steel framed, reinforced office building or hotel could stand the full force of a tornado vortex, but, as far as records are available, there is no instance of such a building being completely wrecked by one. Some day, when a tornado strikes at the business center of a great city, as by the law of probability it surely will in course of time, there will be an opportunity to test the resistance of this type of structure and it may develop that man has builded better than he knew.

Mr. H. C. Hunter in his account of the Lorain, Ohio, tornado of June 28, 1924, (*Monthly Weather Review*, June, 1924, page 310) quotes Mr. E. H. Emery that "The Antlers Hotel, of steel construction, directly in the path of the storm, was not harmed beyond having one corner of the roof damaged." It is possible, of course, that, owing to some unaccountable freak of the storm, the wind force on this building was not as great as on others nearby that were wrecked and it may be a tornado of greater violence would have destroyed it, but it is a significant fact that a modern building was one of the few left standing in the path of the storm.

Immediately after the great tornado of March 18, 1925, in southern Illinois, a committee of the Western Society of Engineers went over the devastated district to observe the structural effects of the storm and determine what might be learned from the action of tornadoes on structures, and means of protecting these. Extracts of their report published in *Engineering News Record* of June 11, 1925, are especially pertinent to designers of buildings from the Alleghenys to the Rockies, a region of which few, if any, parts can be considered immune from tornado damage.

These engineers found undoubted evidence of the terrific wind veloc-

ity in this storm, but they also found just as strong evidence that had buildings in its path been constructed properly the destruction would have been much less, even near the center of the path. Several public school buildings in Murphysboro, Ill., in which many school children were killed, showed serious defects in construction that contributed materially to the failure of the structures and the toll of human life. These buildings were of the ordinary brick type found in thousands of mid-western cities. An expert examination of the wreckage revealed that joists had not been anchored to the sills or the roof to the joists and one building in particular was "Absolutely devoid of any adequate means of bonding the various parts together." Face brick, according to this report, had been laid without even the usual bonding to the common brick backing.

In contrast with this the Administration Building at Orient Mine No. 2, West Frankfort, Ill., a modern plant, resisted the storm very well. Many missiles were blown through the walls, doors, and windows. Partitions were blown down, skylights blown off, and roof flashings damaged, but the structure as a whole resisted the storm very well. Reinforced coal pockets 12 feet in diameter and 40 feet high, located in the central part of the tornado, were apparently uninjured. A concrete steel reinforced chimney 115 feet high did not fail, though it stood near a steel water tower, strongly braced and anchored, that was blown over. A number of concrete farm silos in the path of the storm were not damaged.

It is inevitable that as the Middle West becomes more thickly settled and its cities grow larger the toll of tornadoes, both in human life and property, will increase and disasters like that at Murphysboro will be repeated many times. There will be few large cities that will not have a sad record of devastation by wind storm in their history unless there is a better type of construction in home and public buildings than has been practiced in the past.

America is growing out of the age of flimsy buildings constructed for shelter and appearance only, but our legacy of these, which have so often proved death traps in case of fire or tornado, will remain with us for years to come. The fire risk long ago became so appalling we had to develop the concrete and steel building to overcome it in the congested districts of our cities.

In time we shall be compelled to give more serious attention to making our homes, schools and business blocks tornado proof or at least more resistant to the force of violent winds. Important steps in this direction have already been taken in many of the larger business buildings in recent years and have added but a small per cent to their total cost. The effectiveness of this precaution will eventually be demonstrated by the passage of a tornado over the business section of some large city.

The problem is one that architectural engineers must solve sooner or later, but the meteorologist's field is wide and increasingly useful in investigating these storms.