U.S. Department
of Transportation
**Federal Aviation
Administration**

# Advisory Circular

**Subject:** TIEDOWN SENSE

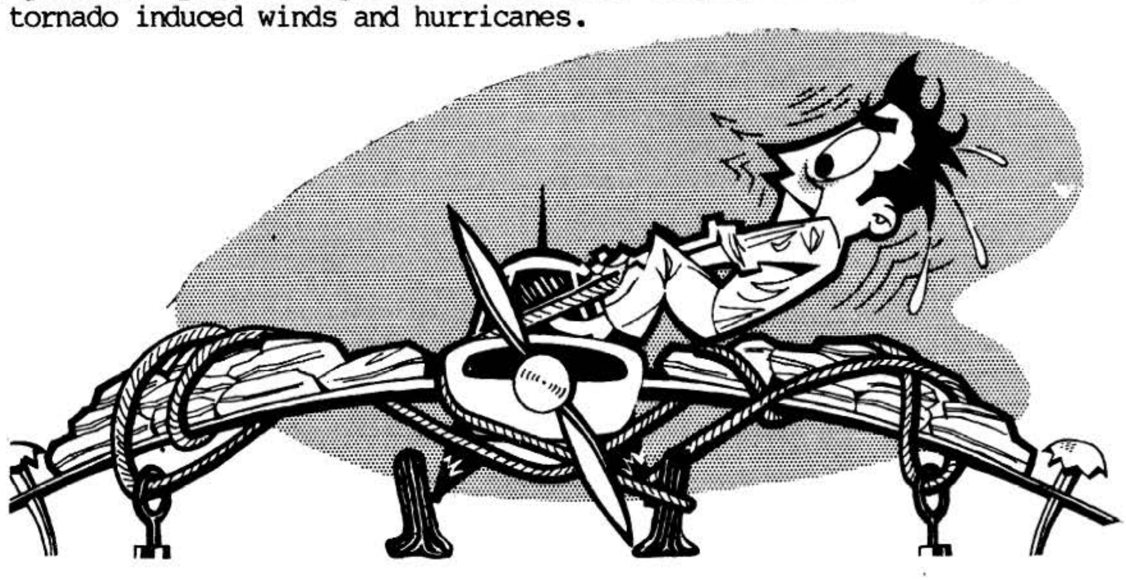
**Date:** 7/12/83
**Initiated by:** AWS-340

**AC No:** 20-35C
**Change:**

1. PURPOSE. This advisory circular provides updated information of general use for aircraft tiedown techniques and procedures.

2. CANCELLATION. AC 20-35B, TIE-DOWN SENSE, dated April 19, 1971, is canceled.

3. BACKGROUND. Each year numerous aircraft are needlessly damaged by windstorms because of inattention to weather forecasts, negligence, or improper tiedown procedures. Windstorms may be broadly classified as cyclonic storms or low pressure systems, regional or localized terrain induced winds, thunderstorms or tornado induced winds and hurricanes.



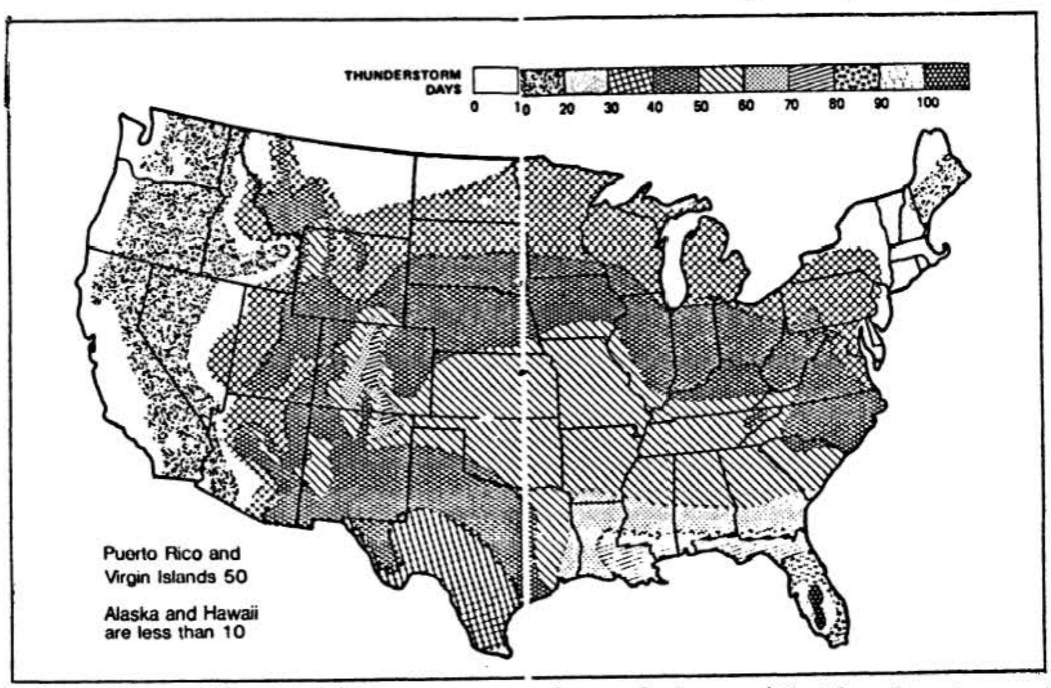
4. STORMS.

a. Cyclones. Cyclones are the lows of the weather maps. In the United States the name does not suggest any degree of intensity in the purest meteorological sense and is applied to moderate as well as intense storms. Winter storms are atmospheric disturbances that may become intense low pressure systems churning over tens of thousands of square miles. In our northland the severity of these storms makes them seasonal threats. These intense low pressure systems combine winds sometimes as strong as 90 mph with snow and cold temperatures. The National Weather Service (NWS) issues timely watches and warnings against the hazards of winter weather so that persons in the alerted area may take precautionary measures.

b. Regional or Localized Terrain Induced Winds. Geography is a factor in producing local and sometimes strong winds due to peculiar or unique terrain effects. The Santa Ana winds of Southern California, or the winds in Boulder, Colorado, are examples of infrequent localized winds that are generally forecast far enough in advance to minimize the potentially damaging effects upon parked aircraft.

c. Thunderstorms. Individual thunderstorms may measure from less than 5 miles to more than 30 miles in diameter, and may occur both in isolation and as a part of larger weather systems. In some places and seasons thunderstorms recur almost daily at almost the same time. In other places they occur rarely or irregularly. Some last a few minutes and on other occasions a succession of related events may last most of the day. The significant features of thunderstorms are high wind velocity, lightning, intense precipitation and hail. All these are variable features that appear in many combinations. Strong straight-line winds accompany thunderstorms more often than tornadoes and may be as damaging to persons and property as small tornadoes. Strong and shifting winds along thunderstorm gust fronts have been associated with tragic accidents to commercial aircraft.

## Average number of *Thunderstorm days* per year




The map above shows the yearly average number of days with thunderstorms based on observations in the U.S. A thunderstorm day is considered any day during which one or more thunderstorms occur. It should be realized, however, that there are local variations which do not show on this map because of the sparsity of observations from some areas. July and August are the months with the greatest number of thunderstorms over most sections of the U.S. while December and January have the least number.

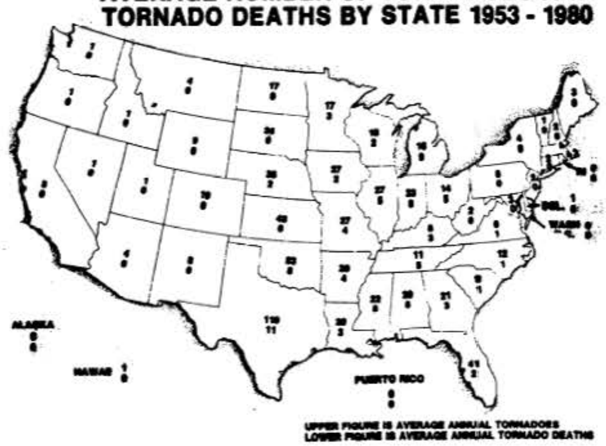
d. Hurricanes. Compared to the great cyclonic storms of the Temperate Zone, hurricanes are of moderate size and their worst winds do not approach tornado velocities. Their winds exceed 70 mph and may reach 200 mph, and their lifespan is measured in days or weeks, not minutes or hours. No other atmospheric disturbance combines duration, size, and violence more destructively. Hurricanes are a threat to the Gulf and East Coast during the hurricane season from June through November. Decaying tropical storms may on rare occasions move inland and dump flash-flood producing rainfall over California and the desert Southwest. Timely detection of and warning against hurricanes has been the task of the NWS for nearly a century.

(1) Hurricane Camile slammed into the Northern Gulf Coast near Christian, Mississippi, on the night of August 17, 1969. Camile's 200 mph winds produced a devastating tidal storm surge of nearly 25 feet just east of where the center made landfall. Camile ranked as one of the most destructive storms ever to strike the U.S. Total damage was about 1.4 billion dollars with 256 deaths credited to the hurricane along the Gulf Coast. The remnants of the dying storm produced killer flash floods in Virginia.

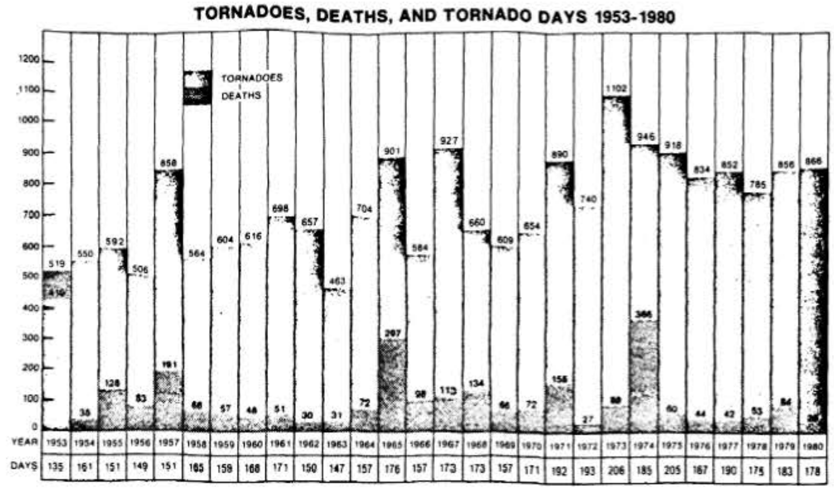
(2) Hurricane Frederic in September 1979 brought 160 mph winds and 12-foot tidal storm surges to a densely populated area in and near Mobile, Alabama. Destruction was widespread and damage was estimated at more than 2 billion dollars. Precise forecasts and warnings, together with prompt local action, permitted about a quarter of a million people to evacuate to safe areas. The loss of life was extremely low -- five people died. President Carter credited the low death toll of Hurricane Frederic to accurate and timely warnings coupled with orderly and extensive evacuation.

e. Tornadoes. Tornadoes are fearsome storms that usually move from the southwest. The more severe tornadoes move at forward speeds of about 60 mph accompanied by winds of 200 mph or more. Since the tornado core is rarely larger than .6 mile in diameter, destructive winds generally last at one place for less than a minute but practically all structures and much of the natural environment can be destroyed by severe tornadoes in just a few seconds. More intense than the worst hurricanes, tornadoes command much attention because of their sudden and violent onslaught and occasional sharp alteration in path. Storm forecasting and warning operations (including weather advisories to the aviation public) help reduce the harmful effects of storms.

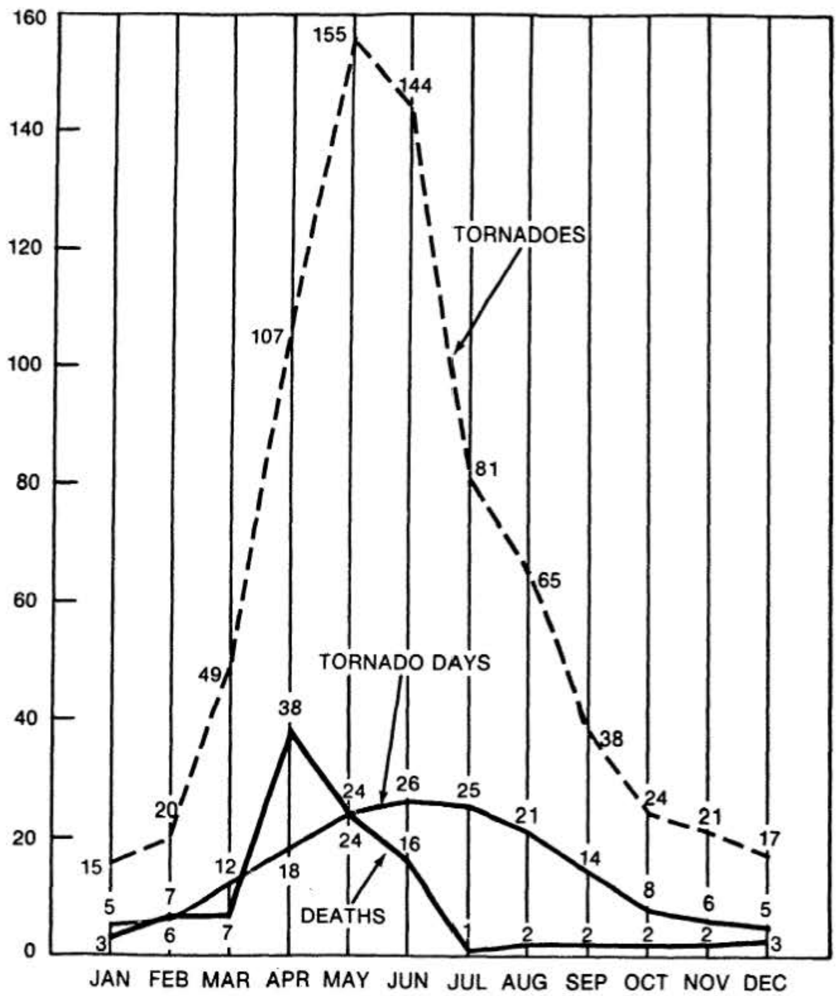
**AVERAGE NUMBER OF TORNADOES AND TORNADO DEATHS BY STATE 1953 - 1980**



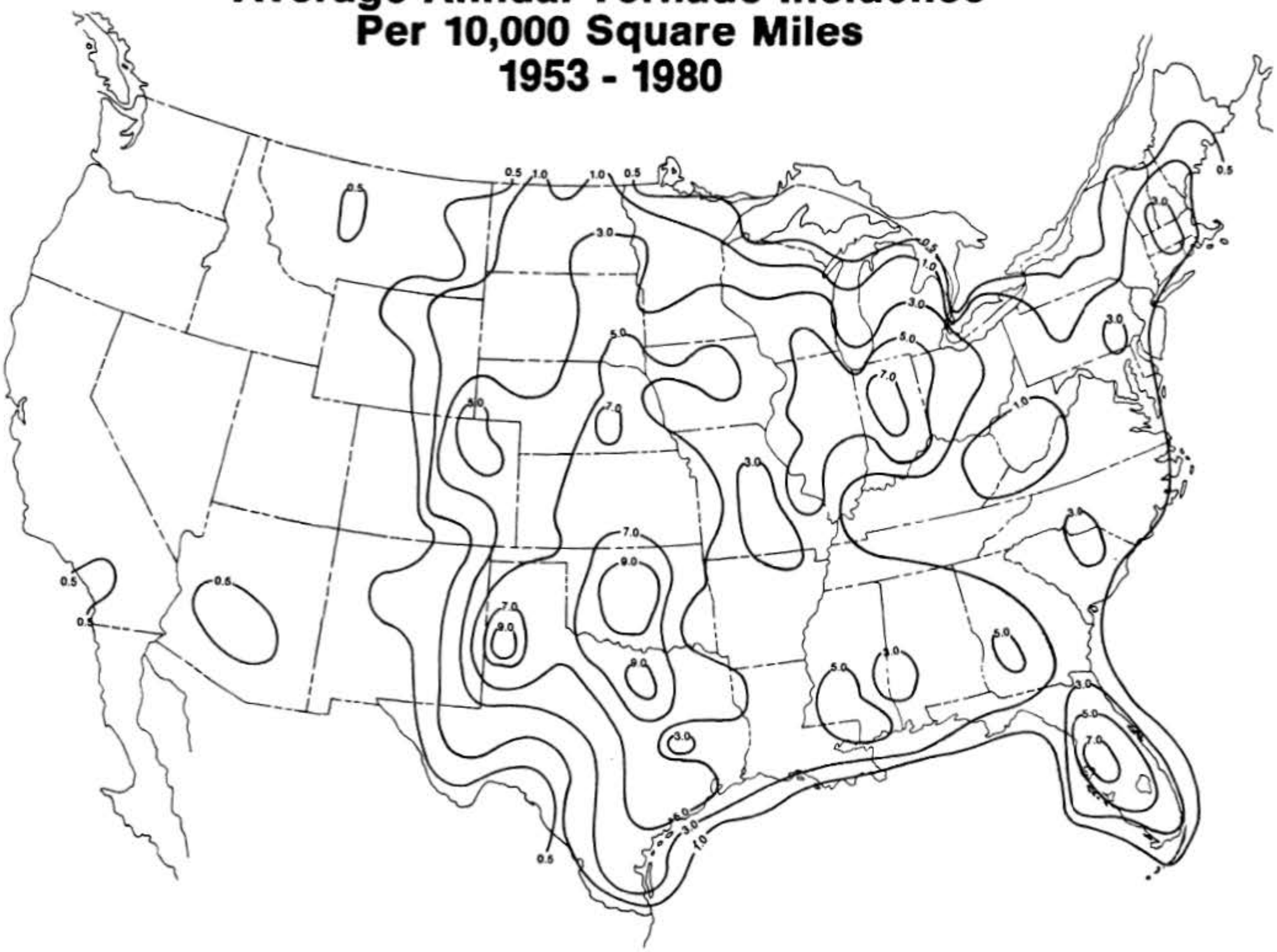
TORNADOES, DEATHS, AND TORNADO DAYS 1953-1980




## TORNADO INCIDENCE BY MONTH 1953-1980

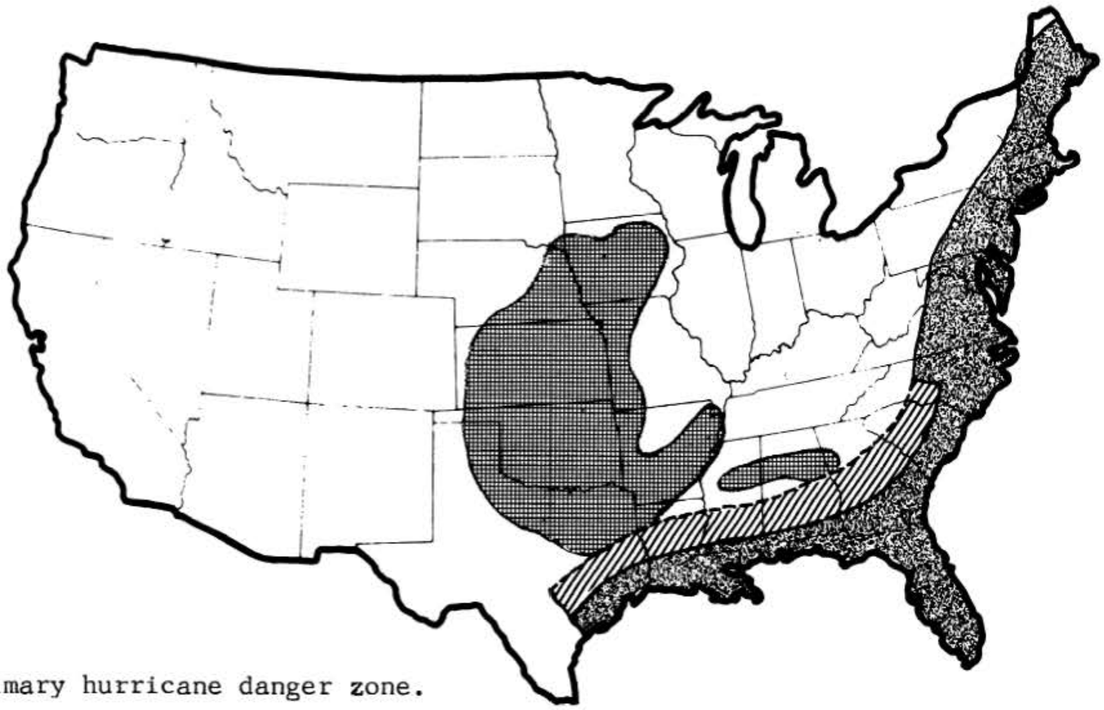


## Average Annual Tornado Incidence Per 10,000 Square Miles 1953 - 1980



## MONTHS OF PEAK TORNADO ACTIVITY

STORM BELTS

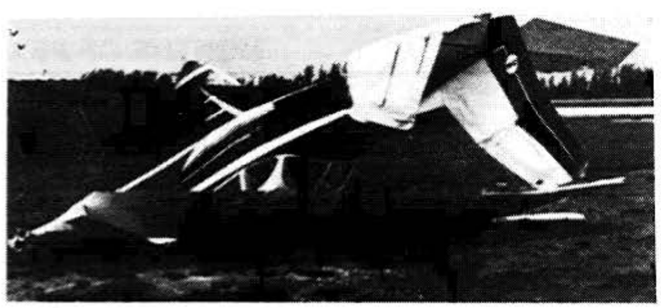


Primary hurricane danger zone.

Fringe area.

Tornado belt.

HURRICANE DAMAGE



5. PREVENTING WINDSTORM DAMAGE. The best protection against windstorm damage is, of course, to fly the aircraft out of the impending storm area provided you have sufficient warning time. The next best protective measure is to secure the aircraft in a stormproof hangar or other suitable shelter. The remaining alternative is to assure that the aircraft is tied down securely. When securing your aircraft, it is considered good practice to fasten all doors and windows properly, thereby minimizing damage inside the aircraft. Engine openings (intake and exhaust) for both reciprocating and gas turbines should be covered to prevent entry of foreign matter. Pitot-static tubes should also be covered to prevent damage or entry of foreign matter. Make sure your neighbor's aircraft is also tied down.

6. ADVANCED PLANNING. It is the mission of the NWS to help mitigate the threat to life and property from natural hazards through the issuance of tornado and severe thunderstorm watches and warnings. NWS meteorologists at the National Severe Storms Forecast Center (NSSFC) monitor atmospheric conditions utilizing information from many sources and locations. When hazardous conditions are anticipated or detected, watches or warnings are issued.

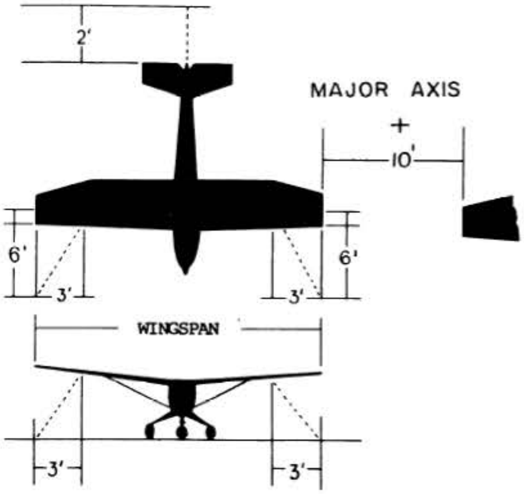
a. Watches are issued by the NSSFC to indicate when and where severe thunderstorms and/or tornadoes are most likely to occur. Watches are usually issued for areas about 140 miles wide, 200 miles long and generally 2 to 4 hours in advance of severe weather. Listen to the National Oceanic and Atmospheric Administration (NOAA) weather radio (162.400-162.550MHZ) continuous broadcasts for the latest weather information directly from NWS offices, and use commercial radio or television for further information.

b. Warnings are issued by local NWS offices when severe thunderstorms or tornadoes are indicated by weather radar, weather observers or trained spotters. A warning describes an imminent risk from a tornado or severe thunderstorm in a relatively small area such as one or several counties. The key to damage avoidance or reduction is to be routinely weather conscious.

c. Be prepared for the worst conceivable windstorm conditions: pouring rain, gusty winds ranging from 30 mph and up, for example intermittent sheets of water blowing across the runways, ramps, and parking areas, and lack of hangar facilities. With such conditions in mind, aircraft owners and operators should plan in advance by learning their aircraft manufacturer's instructions for tiedown; location and/or installation of tiedown rings for attachment of tiedown ropes; any special instructions for securing nosewheel type aircraft vs. tailwheel type aircraft; and manufacturer's charts and graphs denoting aircraft weights and relative wind velocities that would make varied tiedown procedures necessary for pending weather emergencies.

7. TIEDOWN FACILITIES. Any aircraft parking area should be equipped for three-point tiedowns. Aircraft should be tied down at the end of each flight to preclude damage from sudden storms. The direction in which the aircraft are to be parked and tied down will be determined by prevailing or forecast wind direction.

a. Aircraft should be headed into the wind, or as nearly as possible, depending upon the locations of the fixed parking area mooring points.

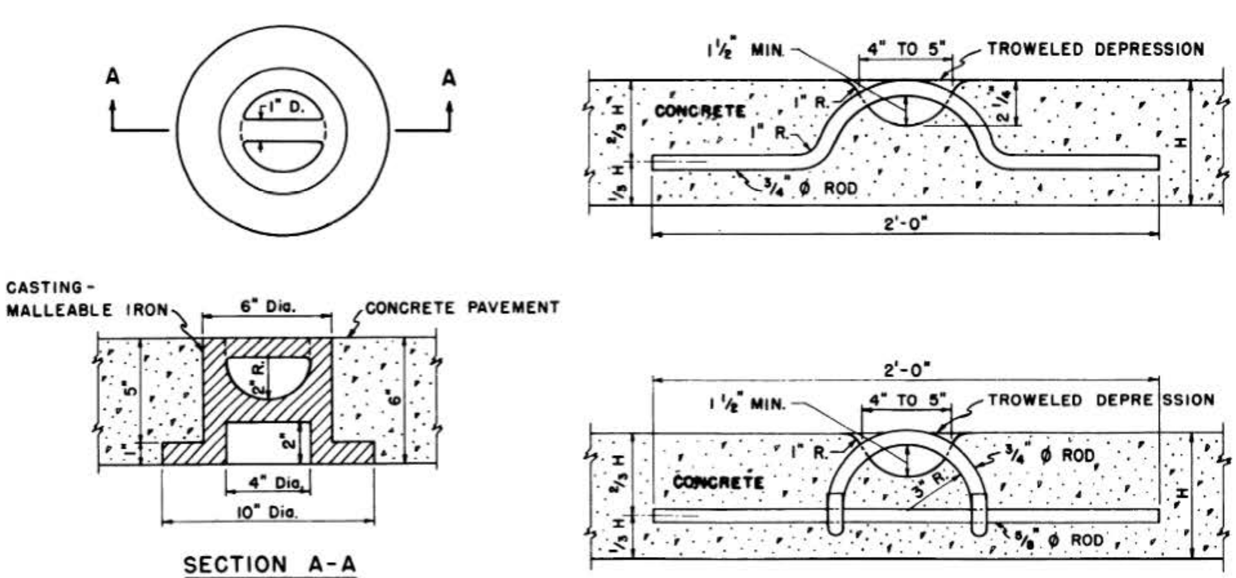



b. Spacing of tiedowns should allow for ample wingtip clearance. Spacing should be equal to the major axis (wingspan or fuselage length) of the largest aircraft usually operated plus 10 feet.

c. After the aircraft is properly located, lock the nosewheel or the tailwheel in the fore-and-aft position.

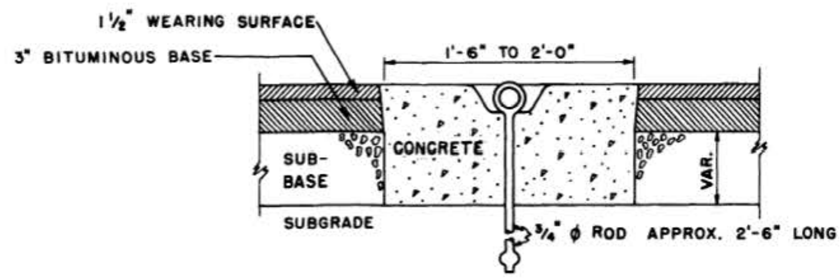
(1) Tiedown anchors for single-engine aircraft should provide a minimum holding power (strength) of approximately 3,000 pounds each. The type of anchors in use varies depending upon the type of parking area— whether for a concrete paved surface, a bituminous paved surface, or an unpaved turf area. Location of tiedowns are usually indicated by some suitable means, either white or yellow paint, or a painted tire which has been fastened into the ground, or surrounding the tiedown anchor with crushed stone. The tiedown anchor eye should not protrude more than 1 inch above ground.

## TIEDOWN ANCHORS FOR CONCRETE PAVED AREAS

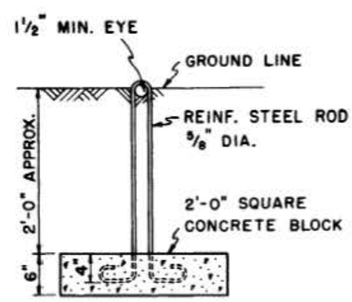



SECTION A-A

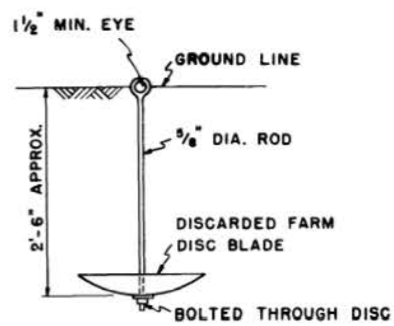
## TIEDOWN ANCHOR FOR BITUMINOUS PAVED AREAS



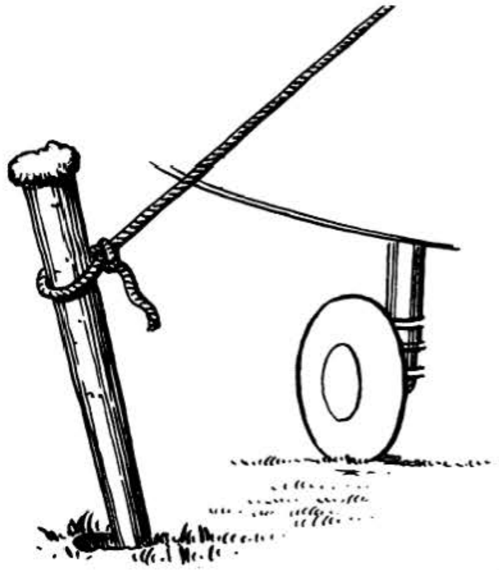

## TIEDOWN ANCHORS FOR TURFED AREAS




ROD AND BLOCK ANCHOR




MUSHROOM TYPE ANCHOR



**DON'T** depend on wooden stakes.

(2) Stake-driven tiedowns such as depicted above will almost invariably pull out when the ground becomes soaked from torrential rains which accompany hurricanes and some thunderstorms.

(3) Tiedown ropes capable of resisting a pull of approximately 3,000 pounds should be used. Manila ropes should be inspected periodically for mildew and rot. Nylon or dacron tiedown ropes are preferred over manila ropes. The objection to manila rope is that it shrinks when wet, is subject to mildew and rot, and has considerably less tensile strength than either nylon or dacron.