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DOCUMENT TITLE
AERODYNAMICS 1

CHAPTER 12 – WAKE TURBULENCE

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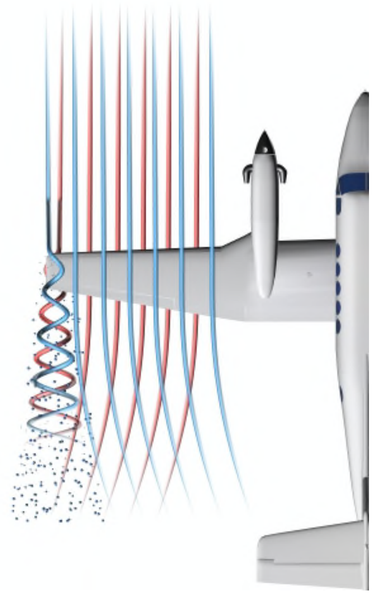
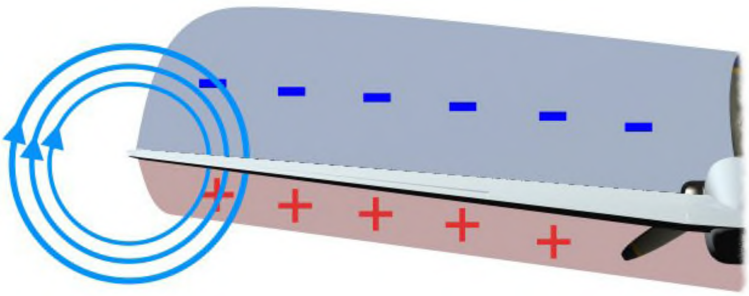
WAKE TURBULENCE & JET BLAST

INTRODUCTION



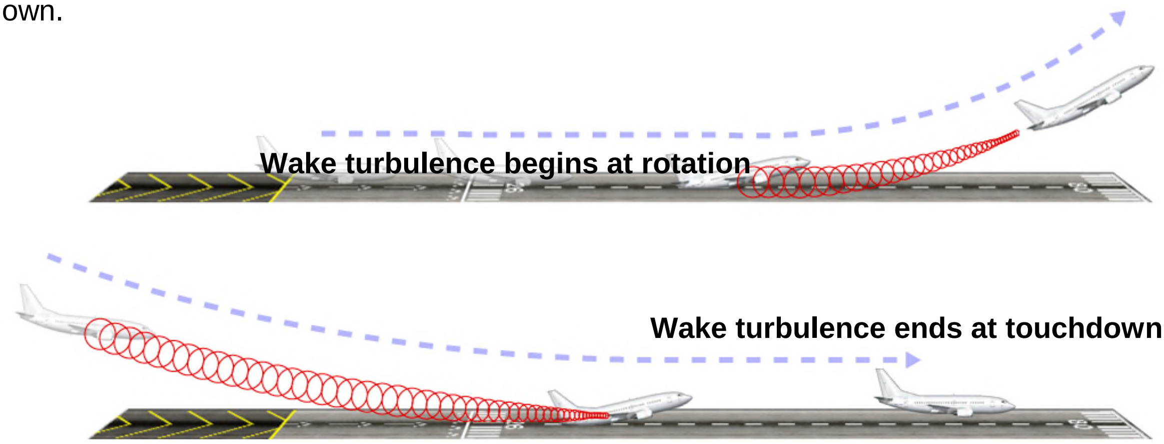
For an aircraft to fly, it must produce lift equal to the weight of the aircraft. Due to the pressure differential between the top and bottom surfaces at the wing tip, the air moves from the bottom to the top surface creating rotating vortices at the wing tip, known as induced drag.

The greater the weight of the aircraft, the greater the lift that is required and so the greater the vortex produced. At slow speed and high angle of attack, the pressure differential is large and so the vortices generated are large. Their strength is greatest when the aircraft is heavy and operating at slow speed.



Direction of the vortex flow at the wing tips

Wake turbulence begins when the aircraft rotates at take-off and is present until touch down.



This wake turbulence drifts down underneath the generating aircraft at a rate of approximately 500'/minute and then tends to level off at about 900' below the flight path. The area behind and below the preceding aircraft should be avoided but the strength of the vortex diminishes with time and distance. It would be best for a pilot to fly at or above a preceding heavy aircraft's flight path.

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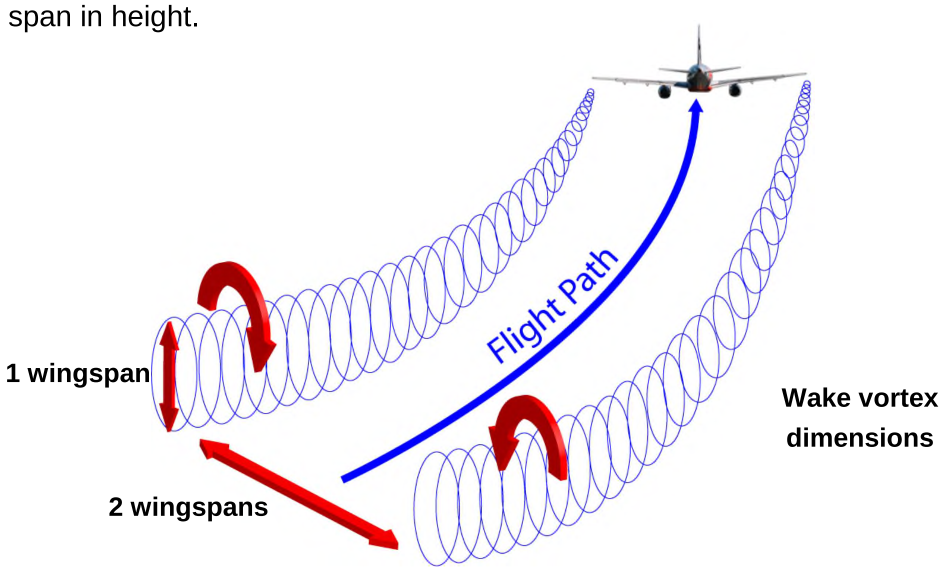
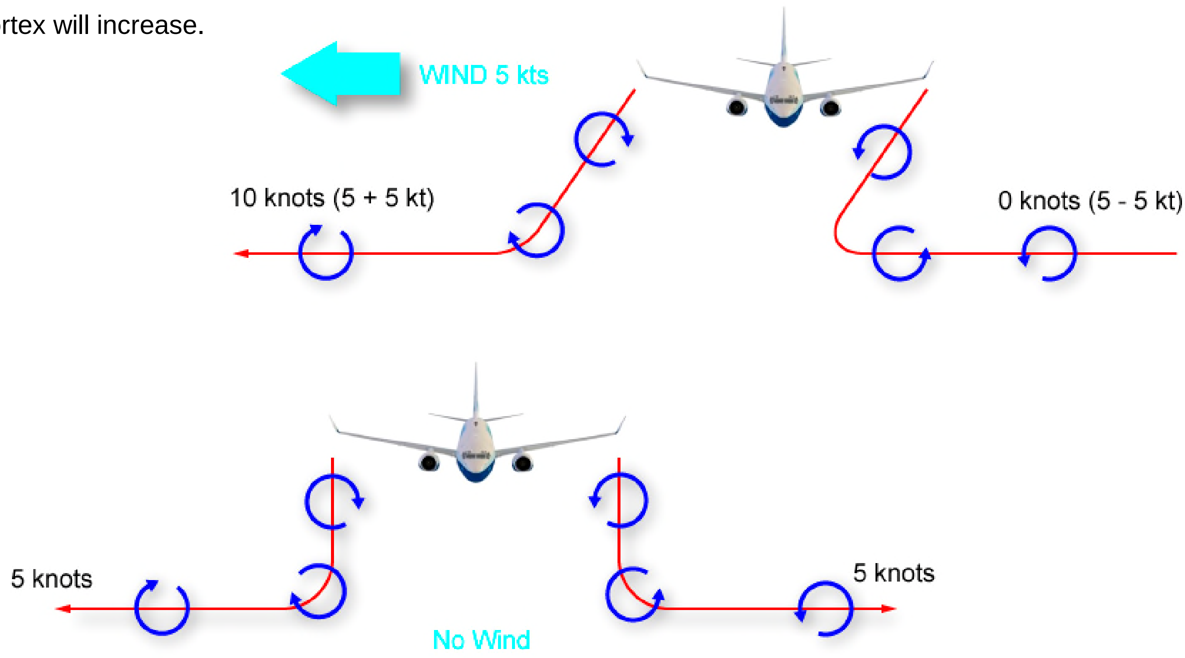
The area affected by wake turbulence covers approximately two wing spans in width and one wing span in height.



The vortices maintain this spacing as they drift with the wind.

When these vortices get close to the ground they start to move laterally outward over the ground at about 5kt. A crosswind has a marked effect on these vortices. The lateral movement of the downwind vortex will increase.



A light wind of 3 to 7kts can affect the upwind vortex by causing it to remain in the touchdown or take-off zone for a substantial time. By the same token, a light tailwind of less than 5kts can move the vortices of a preceding landing aircraft forward beyond the touchdown point.

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ATMOSPHERIC CONDITION EFFECTS

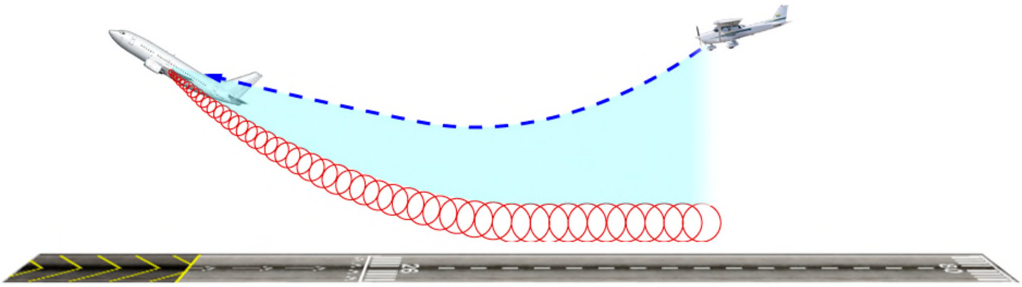
Atmospheric conditions can result in vortices:

1. Remaining in the touchdown area,
2. Drifting from aircraft operating on a nearby runway,
3. Sinking into the take-off or landing path from a crossing runway,
4. Sinking into the traffic pattern from other airport operations,
5. Sinking into the flight path of aircraft operating or crossing 500’ below or enroute.

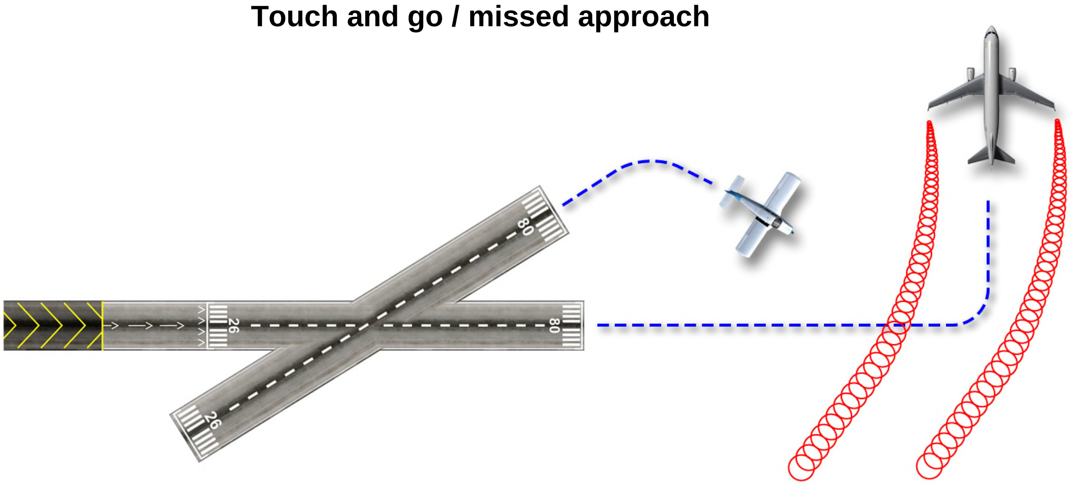
In stable conditions, the vortices can remain for up to three minutes but atmospheric turbulence and strong winds close to the ground can accelerate the dispersion of the vortices.

PRIMARY HAZARD

The primary hazard of encountering wake turbulence is induced roll. It is possible that the rolling moment induced by wake turbulence could exceed the controllability of the aircraft. This is especially so at low airspeed on the approach and after take-off and at the associated low altitude, which could lead to catastrophic results. To counteract this rolling tendency the wingspan and ailerons need to extend beyond the rotational diameter of the vortices. For this reason it is important that smaller aircraft (and hence smaller wingspan) avoid encountering the wake turbulence of preceding large and heavy aircraft.



Takeoff or landing hazard – Large aircraft
Touch and go / missed approach



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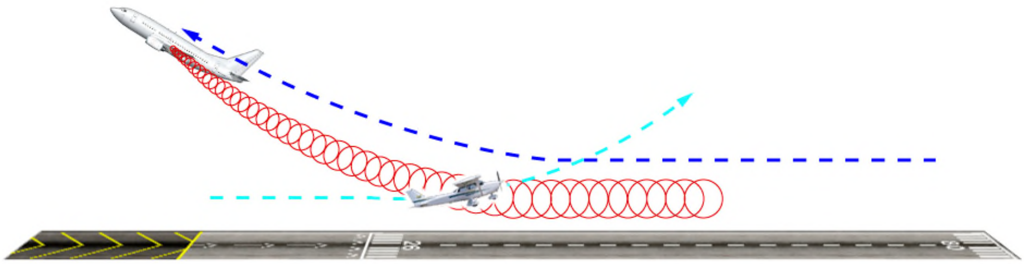
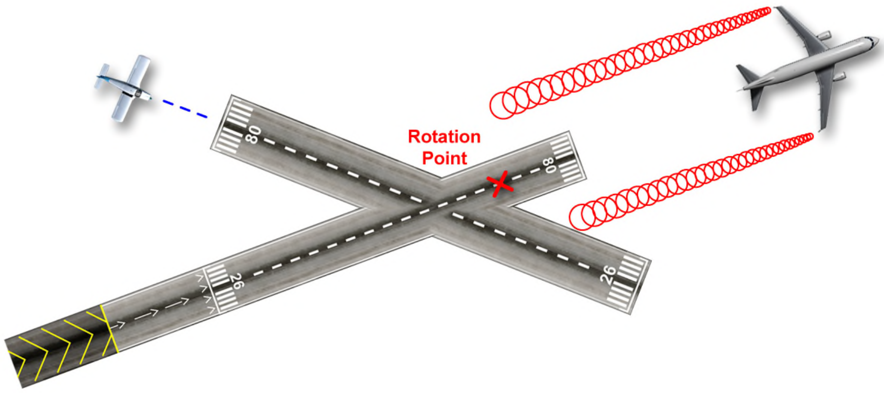
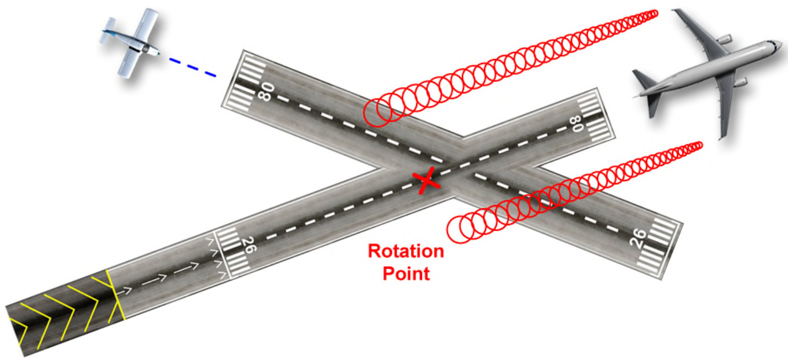
Crossing departure courses



Critical takeoff situation



No landing hazard



Landing hazard

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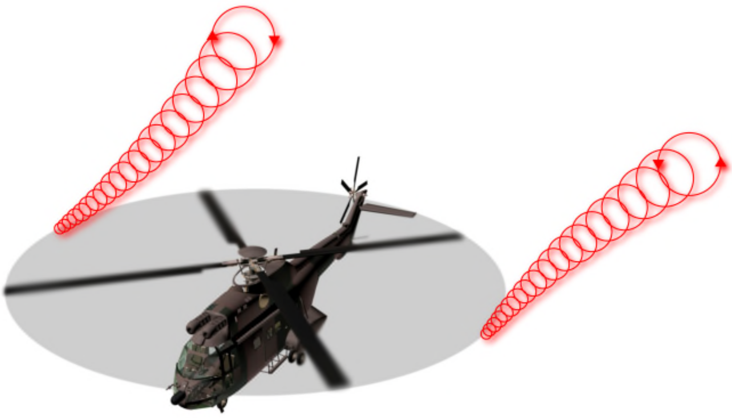
HELICOPTER ROTOR DOWNWASH

Helicopter rotor blades are rotating aerofoils producing lift. Because of lift production they generate vortices at their tips. These vortices are hazardous for a distance up to three times the rotor diameter and weight-for-weight helicopters generally generate more vortices than a fixed wing aeroplane. The vortices can be produced when hovering, in a hover taxi and need to be carefully avoided by a light aircraft pilot.



Helicopter wake vortices

JET BLAST

Large jet engines can produce significant turbulence behind them when operated at high thrust settings. This can occur when commencing to taxi as well as when on the runway for take-off. This turbulent air can extend for 500 metres behind a B747 and pilots of smaller aircraft need to take care when lining up to take-off behind a large aircraft and when approaching to land behind a departing aircraft using the same or an intersecting runway.

The suction generated in front of a jet engine and more so in Turbo-fan types, is quite substantial

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