Wake turbulence: the effects and dangers by David Acton of National Air Traffic Services, abridged by Steve Uzochukwu

Wake turbulence (aka wake vortex), is quite different from the turbulence created by fixed-wing aircraft. There is some evidence that these vortices are more intense than those of fixed-wing aircraft of similar weight. The greatest chances of meeting wake turbulence are when flying in the circuit area, especially in the vicinity of a runway. Most wake turbulence incidents happen when a smaller aircraft is approaching to land behind a larger one, and some are fatal.

So how does turbulence affect microlights?

With low weights and lighter wing loadings, microlights are at risk from the turbulence generated by larger aircraft. When they operate around larger types, pilots must be aware of the danger. A close association even with a Cessna 150 can have undesirable consequences.

Before discussing wake turbulence in detail, it is important to understand the different effects of jet blast and propeller slipstream (propwash). These engine-generated effects are a hazard for a comparatively limited distance directly behind the aircraft.

At full power, the exhaust wake speed from a jet engine can typically be 150mph at 61m behind the aeroplane and 50–100mph well beyond this point. This is sufficient to invert something like a Cessna 150, especially if it is broadside on.

For a propeller-driven aircraft of the size of, say, an HS 748, the propwash on full power can reach 40kt (about 45m) behind the engine. Scaling this effect down, it can be seen that even the propwash from a Cessna is enough to upset a microlight close behind, so beware.

Wake turbulence (aka wake vortex), is quite different. It is generated by the wings of an aeroplane or the rotor blades of a helicopter and is a direct consequence of producing lift. Wake vortices are present behind every aircraft from the moment the nosewheel lifts off the runway until it touches down again. They are particularly severe when generated by heavy aircraft.

Wake vortices are caused by the pressure differential over the upper and lower surfaces of an aeroplane. With high pressure above and low pressure below the wing, the air tends to flow from the lower to the upper surface in an outward direction along the trailing edge, towards the top of the aeroplane.

This results in two counterclockwise cylindrical air masses (vortices) trailing behind from the wing or advancing rotor blade (Figs 1 & 2).

Typically the two vortices are separated by about three quarters of the aircraft’s wingspan, and in still air they tend to drift slowly downwards and either level off approximately 1000ft below the flight path of the aircraft, or on approaching the ground move sideways at a height approximately equal to half the aircraft’s wingspan and at a speed of 3kt (Fig 3).

In a light crosswind, the vortices will drift with the prevailing wind direction, and thus one vortex will remain virtually stationary (Fig 4).

Wind shear can also cause the two vortices to descend at different rates, and close to the ground it can cause one vortex to rise.

Atmospheric turbulence and high winds close to the ground hasten the decay of wake vortices, so light winds pose a higher risk. In these conditions vortices may stay in the approach and touchdown areas of airfields, or sink to the landing or take-off paths of succeeding aircraft.

Vortice strength depends on the aircraft’s gross weight, wingspan, airspeed and configuration. Tests have shown that the tangential speed can be as high as 171kt immediately behind, a rate of roll beyond the control capability of many light aircraft.

Vortex strength diminishes with time and distance, and atmospheric conditions can hasten the decay. The worst case is a large heavily laden aircraft flying relatively slowly in calm conditions.

Helicopters pose a serious hazard. Apart from the obvious dangers from the downsouth created while in the hover, the rotor also generates trailing vortices in forward flight similar to the wingtip vortices created by fixed-wing aircraft. There is some evidence that these vortices are more intense than those of fixed-wing aircraft of similar weight.

The exhaust wake speed from a jet engine can typically be 150mph at 61m behind it, and 50-100mph well beyond.
Remember, the bigger the aircraft the more turbulence it creates and the longer it takes to decay. So think in minutes not seconds, especially in calm conditions.

When operating from a parallel strip, always be aware of aircraft on the other runway, since in certain crosswind conditions the turbulence can drift across your intended flight path.

Departing immediately after a much heavier aircraft has landed is risky because wake turbulence will exist until the wings are off its wings and on its wheels. Also, departing from a crossing or intersecting runway can cause serious problems. Large or fast aircraft will often prefer to use the longer runway regardless of the wind direction.

When approaching to land, keep above the flight path of the aircraft ahead, and if this is not possible keep to one side of the approach, allowing for wind direction and thus turbulence drift. It is advisable to keep clear of any approach path to a busy runway until the final stages of approach, as you could be overtaken by a faster larger aircraft and find yourself in the descending wake vortex (Fig 3). When operating at an airfield with an ARTCC, the controller may instruct you to adjust your flight to take into account the wake vortex separation minima that ARTCC is required to apply.

The minima will be similar to those recommend in this article, but may also require you to position your microlight a certain distance behind other traffic. You may feel that the instructions are a little restrictive, but remember, the controller is aware of the entire traffic situation and concerned for your safety. NATS maintains a wake vortex database to monitor incident rates. All suspected wake vortex incidents should be reported immediately to NATS by radio and followed up after landing using form SRG 1423 Wake Turbulence Report Form. The form can be submitted to the CAA as an occurrence report if that would normally be required by CAP 382, for example if significant handling difficulties are experienced.

Reports (except those doubling as occurrence reports) should be sent to the Wake Vortex Analysis Team at wakevortex@nats.co.uk.

- A longer version of this article was originally printed in Flightline, Sept-Oct 1982, on pages 44-47.
- The BMAA Technical and Safety Departments would like to point out that while the thrust of this article has been about the dangers of the large and long-lasting effects of wake turbulence from GA/CAI, all aircraft of any size, including microlights, will generate wake turbulence which pilots must make allowance for.

Above Ulster Flying Club instructor Ken Crompton showed consume skill as always, putting down the Thruster safely after engine failure.

I've done the same thing a couple of times in other aircraft when I've had a strutter or low power on takeoff. You're better on the ground, even if it means perhaps rolling into the hedge, than losing all power and perhaps having a bigger accident in a less suitable place.

Simple checks during the takeoff roll should warn of potential problems. Rev counter showing normal? Sound and feel of the engine normal? Arspeed building as expected? If any are not, just stop.

A more difficult choice is when the partial failure happens in the air. Once I was taking off from Swansea in a flexwing on a very warm day when at 500ft, the Rotax 912 dropped onto two cylinders.

I then started to bounce around in the very strong thermals, and actually managed to gain some height though they were, to the test. Instead of crashing ahead or landing downwind, I then started to bounce around in the very strong thermals, and actually managed to gain some height and drift downwind at the same time.

More by luck than skill, I was able to make a glide approach to land into wind. On another occasion, again flying a flexwing, I did...
Don’t just kick the tyres

Inspect them properly, says Roger Patrick

Do you just glance at the tyres during your preflight, or do you check them properly?

While not the most glamorous part of any aircraft, they certainly deserve your attention during the pre-flight inspection, as a problem with the tyres can affect your takeoff and landing performance.

Most importantly, check the pressures regularly. These affect the rolling resistance of the aircraft, and also have an important bearing on its suspension.

If they look a bit flat, try pushing the aircraft, then pump them to the correct pressure and try again. It can be quite surprising how much of a difference that makes. Also remember that this is with an empty aircraft, so just imagine the difference once fuelled up and with pilot and passenger. Low tyre pressures make for a much longer takeoff roll.

The tyres are part of the aircraft suspension, and are one of the specific points checked during drop testing as part of the certification process. The tyre must not bottom during this test, for if it does then the loads in the undercarriage increase significantly, which can result in undercarriage failure.

Get the pressure wrong, and the suspension could behave quite differently from what the designer intended. The correct pressures should be in the aircraft operator’s manual.

Checking the tyre pressure also gives you an opportunity to examine the tyre’s overall condition.

Check that the wheel valve is not snugged within the wheel. If it is, that needs to be corrected, otherwise there is a chance that the valve will either leak or get completely pulled out next time you land, or apply the brakes in anger.

Also, if the valve has been pulled, it’s possible that the tyre may have slipped on the rim, which is a sign of low pressure.

A good idea is to add a creep mark to show any tyre slippage. This is simply a dab of white paint overlapping both tyre and wheel, which the two parts become misaligned, the tyre has slipped.

Look at the sidewalls and tread. Any cracking of the sidewall means it needs replacing. Cracking can be caused by running the wrong pressures, or simply the age of the tyre.

Tyre tread specifically is not always important, other than indicating how much wear there is on the tyre, but do look for cuts or abrasions. Also check the whole tyre for any bulges of the sidewall, and for overall symmetry. These issues are not always obvious if wheel spats are fitted, so take these off periodically to permit a proper look. It will also give you the opportunity to check the whole wheel arrangement and give it a good clean.

When replacing the tyres, use the same grade of tyre to ensure that the suspension is not adversely affected. Changing to a different make and size can have a significant effect on the weight and balance of the aircraft: a thin multi-rib tyre can be up to 2kg lighter than a heavily treaded one, making a 6kg difference for the whole aircraft, the equivalent of more than eight litres of fuel.

Finally, wheel balance. On aircraft this does not normally get checked, but it’s worth bearing in mind.

An out-of-balance wheel can cause vibration, which can be particularly noticeable just after takeoff. A slight vibration may also be caused by a wheel spinning in flight. If you suspect this, try applying the brakes while on the air, this will give you a pointer.

Also, an out-of-balance wheel will tend to settle in the same orientation after every takeoff, meaning that the same part of the circumference touches down first on every landing. In time, this can lead to a bald patch on the tyre.

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