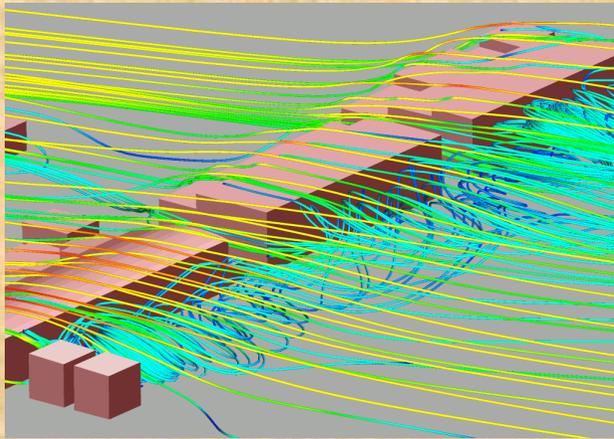




LOW LEVEL WIND EFFECT AT AIRPORTS

— INFORMATION FOR PILOTS AND
PLANNERS OF NEW BUILDINGS

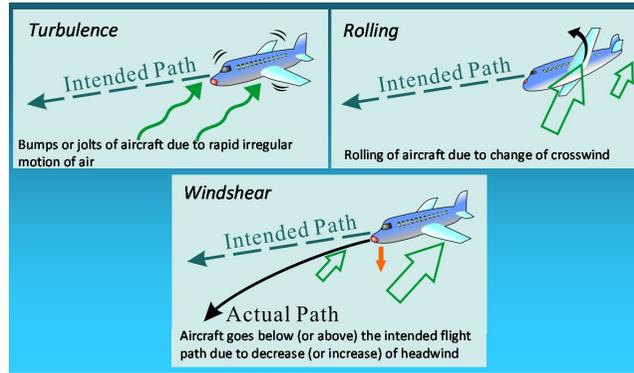


Simulation of air particles flowing over and around a building



What is low level wind effect?

Low Level Wind Effect refers to significant airflow disruption due to buildings and other man-made structures close to the runway, leading to turbulence and possibly windshear under certain wind conditions.

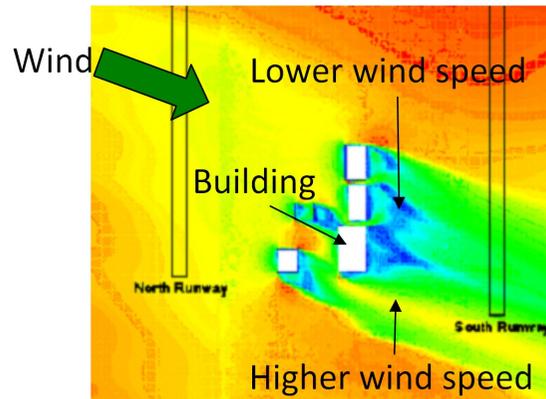


Low level wind effect on aircraft

Why is there low level wind effect?

As the air flows over a building, depending on the background wind speed and direction, the stability of the atmosphere and the size of the building, the air may be blocked, flow over or around the building.

This is similar to the occurrence of waves and vortices downstream of a stone in a river.

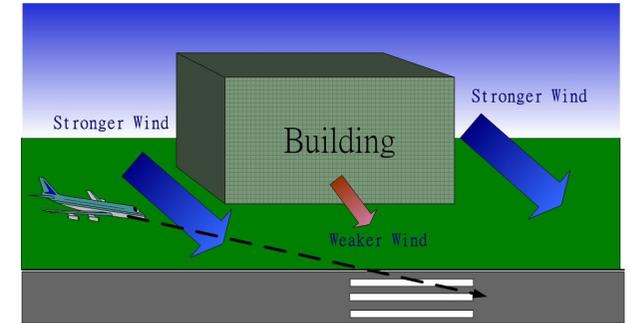


Simulation of airflow over buildings (bird's eye view)

If the building is rather close to the flight path and it is sufficiently large, it may bring about rapid fluctuations of the wind that are perceived to be wind changes (headwind/crosswind changes) and/or turbulence by the pilots.

How will low level wind effect affect takeoff and landing?

When the low level wind effect causes the crosswind component to fluctuate, pilots may experience control difficulties during take off and landing. Under such conditions, directional control would be more challenging on a wet runway.



Strength of the crosswind encountered by the aircraft varies due to low level wind effect

Where are the possible locations of low level wind effect at the Hong Kong International Airport (HKIA)?

The hot spots of low level wind effect are downwind of major buildings. Pilots should be aware when landing on HKIA RWY 25R in strong southwesterly/southerly/southeasterly winds that there is the possibility of encountering building-induced turbulence and windshear.



Hot spots of low level wind effect in strong southwesterly/southerly/southeasterly winds

Similarly, there is the possibility of encountering building-induced turbulence and windshear when: (a) landing on RWY 25L in strong northwesterly/northerly winds; or (b) landing on RWY 07R in a background northwesterly/northerly winds of about 15 knots or more.



Hot spots of low level wind effect in strong northwesterly/northerly winds

How are pilots warned of the low level wind effect at HKIA?

Possibility of significant low level wind effects at HKIA have been promulgated in the Hong Kong Aeronautical Information Publication (AIP). In addition, windshear warnings may be issued to pilots by the forecasters of the Hong Kong Observatory.

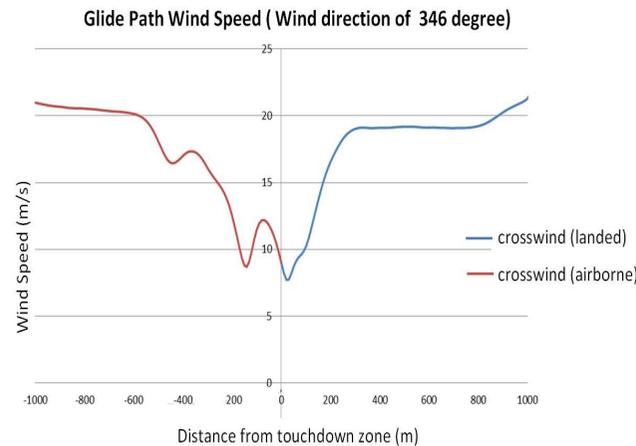
How to study the low level wind effect at HKIA?

For sustainable development of the airport, new buildings and infrastructures will be constructed inside and around HKIA. To evaluate whether the new buildings and infrastructures would lead to low level wind effect, their dimensions and distances from the runway would be studied. If they are found to be large and/or close to the runway, further wind study would need to be conducted by the building owner at the planning stage using numerical simulations before the structures are built. The numerical model so employed has to be calibrated, i.e. its results are found to be proven by comparison with wind tunnel

measurements, pilot reports and the available meteorological observations. It is used to simulate the airflow disturbances over the runway when the winds blow over and around the buildings and infrastructures under consideration. If necessary, the existing buildings around the new building would need to be included in the simulation because of possible interaction of the airflow disturbances arising from different buildings.

How to assess and minimize the low level wind effect of new buildings at HKIA?

Based on the experience^[1] of overseas airports, it was established that **crosswind changes of 7 knots or more** in short intervals in a background crosswind of 25 knots could cause difficulties in landing.



Crosswind profile of numerical simulation

Results of the numerical simulations would be compared against this threshold. If the 7-knot criterion is violated, i.e. the crosswind change is more than 7 knots over short distance along the flight path/runway, mitigation measures would need to be considered to

[1] Nieuwpoort, A.M.H., J.H.M. Gooden, and J.L. de Prins, "Wind criteria due to obstacles at and around airports", NLR-CR-2006-261, May 2008.

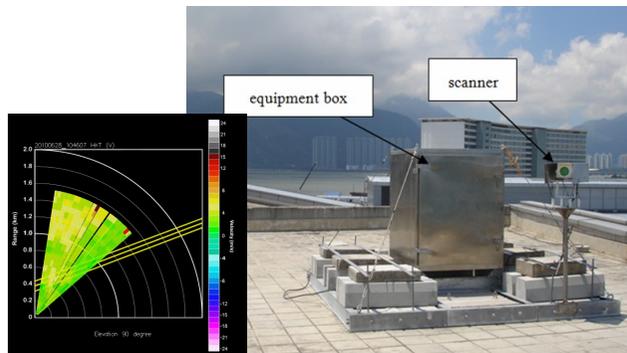
minimize the effect of the new building on the wind, such as changing the building's dimensions, appearance, and provision of warnings. The results and possible ways to mitigate the effect of the new structure will be discussed at the Low Level Wind Study Working Group which coordinates the work for more detailed understanding of the low level wind conditions at HKIA and to enhance air traffic safety based on the findings of the low level wind conditions. If pilots encounter low level wind effect, please report the event to ATC or fax / email a pilot report to the Observatory.

How was the criterion established?

The criterion, namely crosswind change of 7 knots or more in short intervals in a background crosswind of 25 knots (commonly called the "7-knot criterion"), was established based on the pioneering work of Schiphol airport in Amsterdam, the Netherlands. The matter of low level wind effect was first brought up back in 1995, when in a short period, a number of pilots reported turbulent gusts during approach and rough landings on a particular runway at Schiphol including three missed approaches on one day. Investigations were then conducted on these cases and it was suggested that an engine test-run facility, which was constructed in 1992 near the runway, was the cause of the issue. Subsequent wind tunnel study by National Aerospace Laboratory (NLR) discovered trailing vortices and wake downwind of the test-run facility. The measurements were used in simulated approaches and identified that the wake played a major role in these cases. In 2006, a larger-scale study was conducted by NLR which involved pilots in the assessment. The study re-affirmed the validity of the 7-knots criterion. Based on the experience of Amsterdam Schiphol Airport, the Aerodrome Meteorological Observation and Forecast Study Group (AMOFSG) of International Civil Aviation Organization (ICAO) has a plan to include the "7-knot criterion" in the Doc 8896 (Manual of Aeronautical Meteorological Practice) to assist States in the planning of buildings at aerodromes.

What are the future enhancements for the detection of low level wind effect?

The low level wind effects occur over a very small area and have high temporal and spatial variations. Ways to detect and alert them in real-time are being studied by the Observatory. As part of this study, a short-range LIDAR was set up on a trial basis for a few months in the last few years to observe the wind fluctuations caused by the buildings. Further studies will be conducted to explore if an appropriate algorithm could be developed to alert the low level wind effect in real-time.



Short-range LIDAR & its wind measurement imagery (inset)

Low Level Wind Study by Organisations

Organisations embarking on studying the low level wind effect of proposed new buildings or infrastructures at the airport shall contact the Hong Kong Observatory beforehand.

Further information

Aeronautical Information Publication (AIP):
http://www.hkacg.gov.hk/HK_AIP/AIP/GEN/HK_GEN3.5.pdf

Hong Kong Observatory Web Site:
<http://www.weather.gov.hk/aviation>
Email: outreach@hko.gov.hk
Fax: (852) 2311 9448

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