A safe heliport may not make a safe vertiport

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Advanced air mobility (AAM) is an emerging sustainable transportation alternative using small aircraft for cargo, passenger, medical and emergency purposes. The aircraft are known as vertical takeoff and landing (VTOL) aircraft. VTOLs will take off and land at new infrastructure, called vertiports.

Figure 1: 1:300 Scale model of Vancouver General Hospital in RWDI's Davies Boundary Layer Wind Tunnel instrumented with Cobra probes to measure the mean and fluctuating wind speed above an existing heliport.

To date, investments have been made to fund the development of VTOLs. Investment is also needed for vertiports to enable VTOL operations. In the meantime, existing heliports provide an opportunity to meet the early infrastructure needs in a cost-effective way to test the commercial feasibility of the AAM market.

However, a safe heliport may not make a safe vertiport, especially when the heliport is in an urban area. Careful consideration needs to be given to the wind flow features relative to the performance capabilities of the aircraft using the heliport.

Impacts of Wind Flows in Urban Areas on VTOL Performance

Wind flows in urban areas are highly dependent on:

- urban densities,
- surrounding natural topography,
- urban topography,
- building features, and
- the combination of buildings.

Even if flow conditions were considered as part of the design of the heliport, they should be re-assessed to ensure it will make a safe vertiport. The performance capabilities of VTOLs are very different to those of helicopters. The smaller size and weight of VTOLs makes them more susceptible to wind in cities, including:

- changes in wind speed,
- changes in wind direction,
- shear,
- turbulence level, and
- vorticity.

These urban wind characteristics may compromise the stability of the VTOL resulting in uncomfortable rides for passengers. They may also cause increased power needs for VTOLs during approaches and departures.

Flight Parameters

A combination of flight parameters is considered when selecting the preferred approach and departure paths for different types of helicopters landing at a heliport. These parameters include:

- performance capabilities of the helicopters in crosswinds,
- noise levels as a function of descent angle,
- speed, and
- visual cues.

These parameters are very different for VTOLs. This means the preferred approach and departure paths for VTOLs will be different and need to be assessed accordingly.

Figure 2: VTOL above helipad.

Impact on Rotors

Another concern is that multiple rotors on an VTOL operating in an urban environment may experience significant changes in wind direction, mean wind speed, and pitch angle. They may also experience moderate changes of vertical turbulence across rotors as the aircraft is descending or ascending in an urban area.

The lower the VTOL in the urban layer, the higher the likelihood that a rotor on one side of the VTOL will experience flow conditions markedly different from a rotor on the other side. These variable conditions change in time and in space. The VTOL may maintain control during these fluctuating conditions, but it will come at the expense of passenger comfort and power consumption.

How to Ensure a Heliport is Safe for VTOL Operations

Prior to converting a heliport to a vertiport, a wind assessment should be conducted to ensure safe, comfortable conditions during VTOL operations. Wind conditions are quantified through instrumenting a physical model of the heliport and its surroundings and measuring them directly in a boundary layer wind tunnel where the low altitude flow features are reproduced with high fidelity.

“Red flag” or problematic wind conditions are identified, measured, and then compared to the performance capabilities of the VTOL. The wind tunnel measurements are subsequently combined with long-term meteorological conditions representative of the site. This is to determine how often VTOL operations may be limited by unfavorable wind conditions.

The wind assessment will help inform the approach and departure paths. It will also help inform operational limits to ensure ride quality for passengers and energy management for operators.