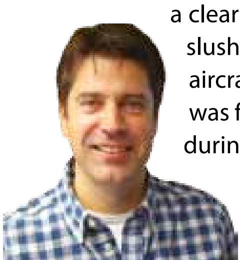
Water/slush on the runway and What every tower controller should know about it

by Gerard van Es, Senior Consultant, NLR-ATSI, The Netherlands.

Analysis of accidents that occurred in the last 20 years has shown that the risk of overrunning the end of the runway on runways covered by liquid contaminants such as water or slush is about 10 times higher than on a dry runway.

The hazardous effect of water/slush on aircraft field performance was first brought into prominence after the accident to the BEA Airspeed Ambassador aircraft at Munich in 1958 in which 23 people were killed. The increasing prevalence of tricycle undercarriages and higher aircraft operating speeds in the late 1950s were associated with this new hazard to aircraft operations. In the early 1960s investigations on the effects of water/slush covered runways were carried out in the United States, the United Kingdom and France. Tests were conducted using catapult-driven test carriages as well as actual aircraft. These early tests gave a clear picture of what water and slush on the runway do to an aircraft that takes off or lands. It was found that the acceleration during take-off was reduced due to the drag effects on the tyres displacing the water or slush and drag due to impingement of the spray on the aircraft thrown up by the tyres. It was shown that this drag increased with increasing water/slush depth. It was also discovered that there was a possibility of loss of engine power, system malfunctions and structural damage due to spray ingestion or impingement. Also directional control problems were found when crosswind conditions existed. Furthermore the problem of very low braking friction between the tyres and surface was identified in which aquaplaning of the tyres played an important role. The problem of water/slush on the runway is more acute for turbine engine aircraft than for piston engine aircraft because of their higher ground speeds and their increased susceptibility to ingestion and impingement due to their design.

Let us have a look at some typical numbers of the effect of water/slush on take-off performance. Just 13 mm (0.5 in.) of slush can subject a large jumbo jet to a drag that is equal to approximately 35% of the thrust of all its four engines. This number increases to 65% for 25 mm (1 in.) of slush making



Gérard van Es

works as a Senior Advisor flight safety and operations for the NLR-Air Transport Safety Institute - Amsterdam, the Netherlands. He is currently involved in the European working group for the prevention of runway excursions.

Now I understand the importance of good information about the water on the RWY; at least for me it saved an expensive pair of shoes...

Some examples

(1) On 14 August 2005, a British Airways Regional Embraer 145 overran Runway 27L at Hannover by 160 metes after flying a stable approach in daylight but then making a soft and late touchdown on a water-covered runway. Dynamic aquaplaning began and this was followed by reverted rubber aquaplaning towards the end of the paved surface when the emergency brake was applied. The aircraft suffered only minor damage and only one of the 49 occupants was slightly injured.
http://www.skybrary.aero/index.php/E145,_Hanover_Germany,_2005_(RE_HF_WX)

(2) On 10 November 2010, a Kingfisher Airlines ATR 72 made an excessively steep and unstabilised tailwind approach in light rain to runway 27 at Mumbai in visual daylight conditions. After touching down late, the aircraft was steered off the side of the runway when it became obvious that an overrun would otherwise occur. The Investigation found that ATC had failed to advise of water patches on the runway and aquaplaning had occurred. It also found that without aquaplaning, the available distance from the actual touchdown point would have been sufficient to stop the aircraft in.
http://www.skybrary.aero/index.php/AT72,_Mumbai_India,_2009_(RE_HF)

(3) On 24 November 1998, a KLM uk Fokker 100 overran runway 20 at Southampton after a late and fast daylight touchdown in rain was followed by poor braking. The Investigation found that the assessment of the runway as 'wet' passed by ATC prior to the incident was correct but that sudden heavy rain shortly before the aircraft landed had caused a rapid deterioration to somewhere between 'wet' and 'flooded'. Slow drainage of water from the runway was subsequently identified and the runway was grooved.
http://www.skybrary.aero/index.php/F100,_Southampton UK,_1998_(RE_HF_WX)

a take-off impossible. In general for a multi-engine transport aircraft, just 13 mm (0.5 in.) of water/slush can increase the take-off distance by some 30-70%.

Additionally, there is another potential hazard associated with taking off and the presence of slush. There is possibility that the slush will be taken into the air on probes and in wheel wells and then freeze quickly as air temperature drops in the climb.

Slush can have an adverse effect on the landing performance too. Braking can be difficult because aquaplaning is likely to occur on water/slush covered runways. This will increase the landing distance compared to a dry runway. However, although it sounds strange a thicker layer of water/slush can be better for landing performance than a thin layer. The drag generated by the water/slush helps to stop the aircraft. The more water/slush you have on the runway the higher drag on the aircraft. This also applies to rejected take-offs and can lead to strange performance restrictions when taking off from water/slush covered runways. For instance more water/slush can give lower take-off weight penalties. Not all aircraft manufacturers account for these affects during the landing.

There is another important difference between an aircraft taking off and one landing on a runway contaminated with water/slush. The former can assess the situation before and during the early stages of the take-off roll whereas the latter has just a few seconds to complete a much more subjective assessment. Night operations can make both judgements much more difficult. S

CONSIDERATIONS FOR CONTROLLERS

- For pilots it is extremely important to have the most accurate, complete and up-to-date information regarding the runway condition and weather conditions that could influence this (e.g. heavy rain showers).
- Controllers should realise the potential impact of a water/slush covered runway has compared to a wet runway. There is a big difference in influence on operational safety between a wet runway and a water/slush covered runway.
- Air traffic control plays an important part in this information provision. There have been cases in the past in which incorrect or outdated information regarding the runway condition was provided by the controller to the pilots, leading serious incidents.
- Controllers almost always rely on the aerodrome operator to provide information on the runway surface condition. Inaccuracies in these reports are always possible and difficult to identify by the controller. During daytime the controller might observe areas with water puddles or slush on the runway and inform the crews about this.
- Any 'pilot reports' passed to subsequent aircraft by ATC in respect of water or slush should be accompanied not only by how old they are but by an 'unofficial' comment as to whether it appears from the Tower as though the situation has materially changed.