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European Union Aviation Safety Agency

Research Project Runway Micro Texture - Final Dissemination Event

This project is funded from the European Union's Horizon Europe research and innovation programme

08/05/25

14:30-17:00 CET

Disclaimer

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Welcome to this webinar!

This webinar is the final dissemination event of this research project

This project has received funding from the European Union’s Horizon Europe research and innovation Programme

European Commission

The EC delegated the contractual and technical management of this research action to EASA

EASA contracted NLR as Consortium lead for the implementation of the research action following a public tender procedure

EASA-managed projects are addressing research needs of aviation authorities and are an important pillar of the EASA R&I portfolio

The agenda

Time	Title, Speaker
14:30 - 14:35	**Welcome to the webinar** EASA
14:35 – 14:45	**Research scope and objectives** EASA
14:45 – 15:30	**Overview of the project implementation and key results** NLR
15:30 – 15:50	**Benefits from the project, planned follow-up actions** EASA
15:50 – 16:50	**Questions and answers** Participants, project team
16:50 – 17:00	**Concluding remarks** EASA

Note: this webinar will be recorded and made available at the EASA website after the event.

Question and Answers

→ For sending questions and comments, please use the slido app, which is also accessible through WebEx:

- www.slido.com
- event code: 3314881
- passcode: moffgi

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Research Scope and Objectives

This project is funded by the European Union's Horizon 2020 Programme

Why

- Runway excursion is one of the main key safety risk areas for commercial air transport, business aviation and non-commercial operations with motor-powered aircraft
- Wet runways are contributing factors
  - Macro-texture and micro-texture of runway surface are very important to ensure good braking performance
    - Macro-texture refers to visible roughness of the pavement surface
    - Micro-texture refers to the roughness of the individual stones that form the macro-texture

Why

- → Macro-texture can be measured through simple methods such as the ‘sand and grease patch’
- → CFME mainly assess the effect of macrotexture
- → For micro-texture there are neither minimum requirements nor an established method for determining and monitoring micro-texture characteristics

Deliverables

- → Correlation of measured micro-texture characteristics with aircraft braking performance
- → Recommend runway-microtexture threshold values, below which a runway becomes ‘slippery wet’
- → A practical guide, which could be used by aerodrome operators, competent authorities and accident investigation bodies on using surface laser scanners for assessing runway micro-texture

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Overview of the project implementation and key results

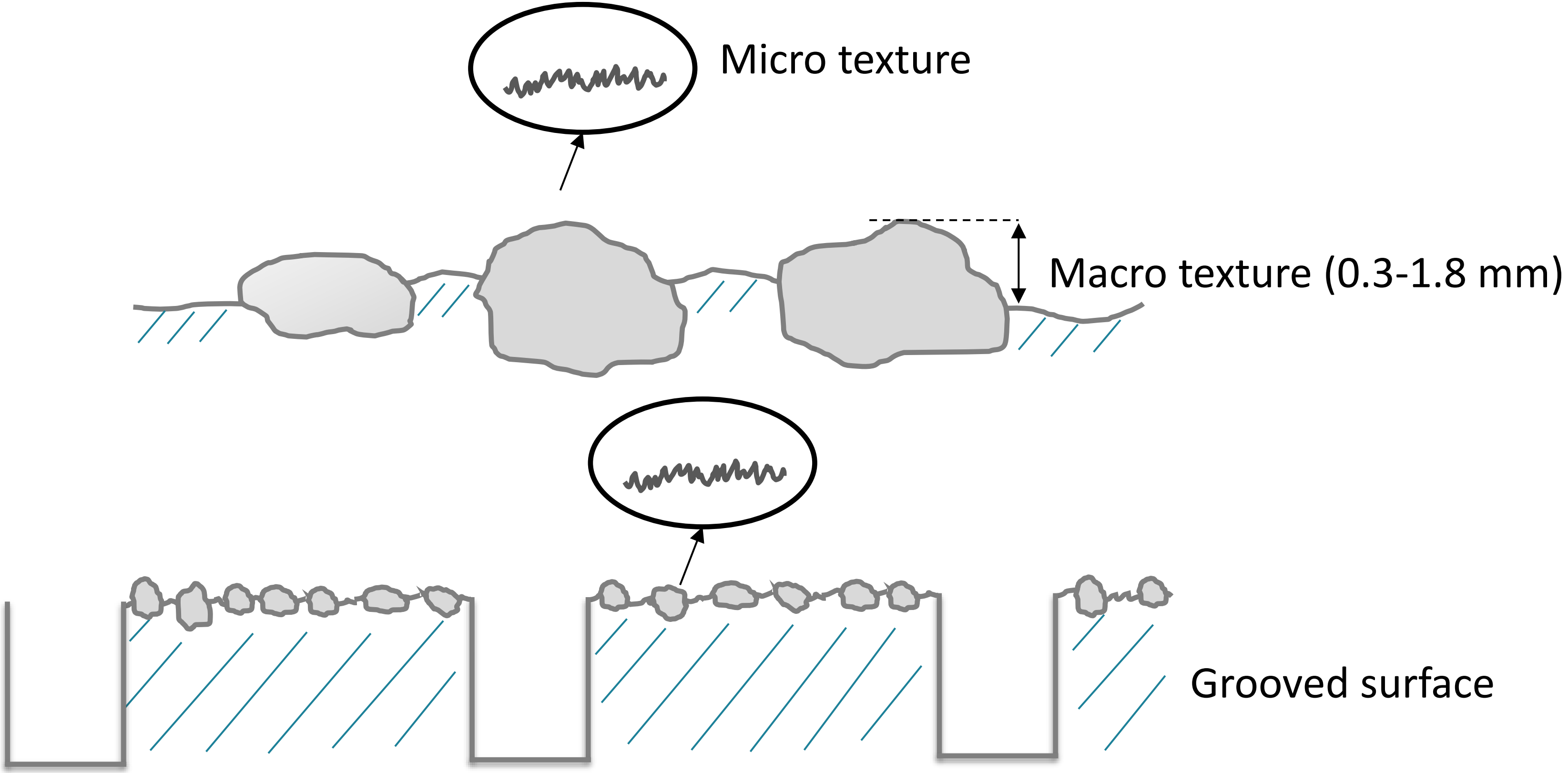
This project is funded by the European Union's Horizon 2020 Programme

Basics of wheel braking

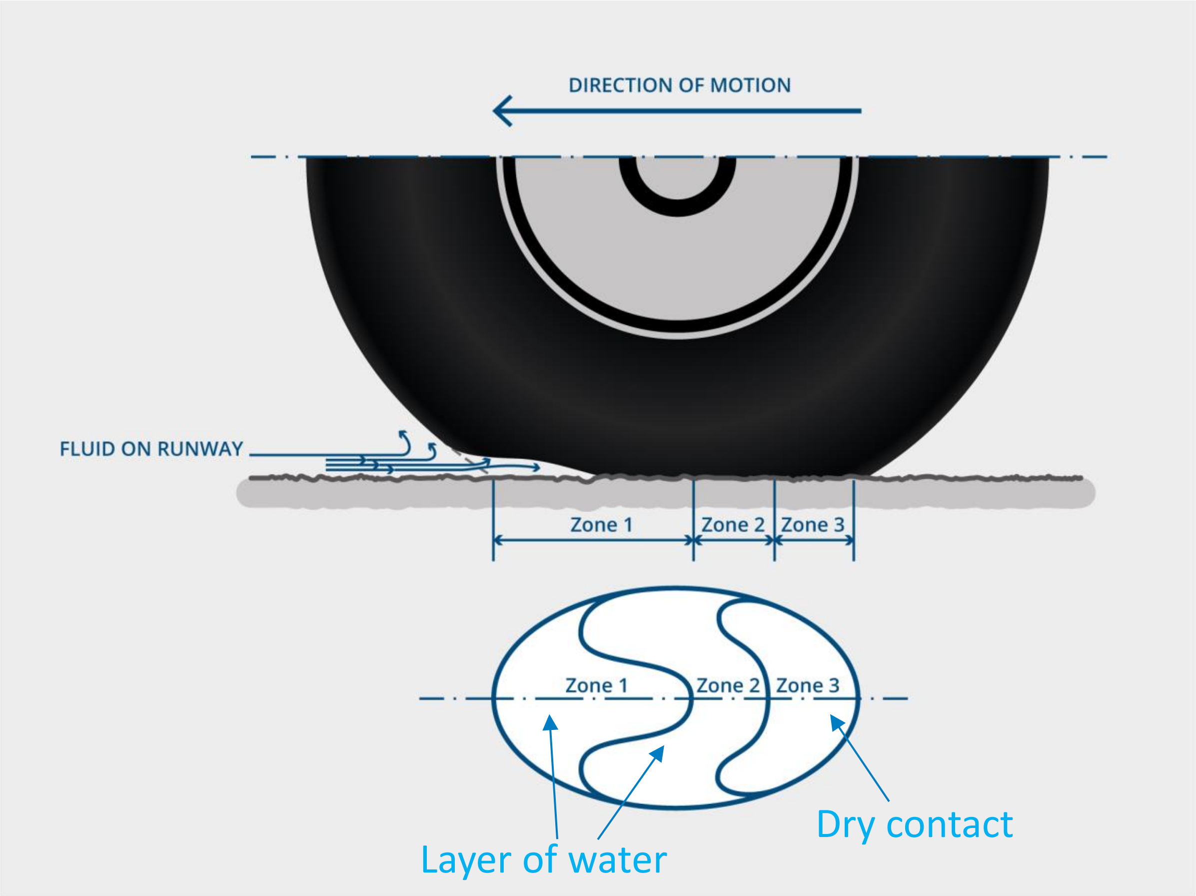
Wet runway wheel braking forces

- Runway texture (macro and micro)
- Speed
- Tyre pressure
- Antiskid
- Wetness
- Loading
- Surface temperature

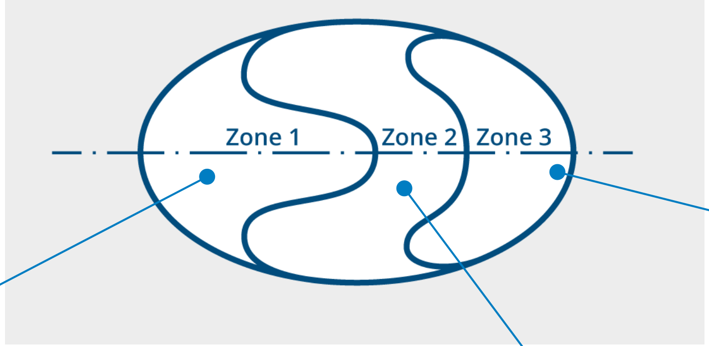
Micro texture versus macro texture



Tyre footprint on wet surface



What is happening in tyre-surface contact area?



- Dry contact area;
- Friction is generated here.

- Dynamic hydroplaning;
- Increases with lower macro texture and speed;

- Viscous hydroplaning;
- Increases with smoother micro texture;
- Present down to very low speeds.

Slippery wet runways

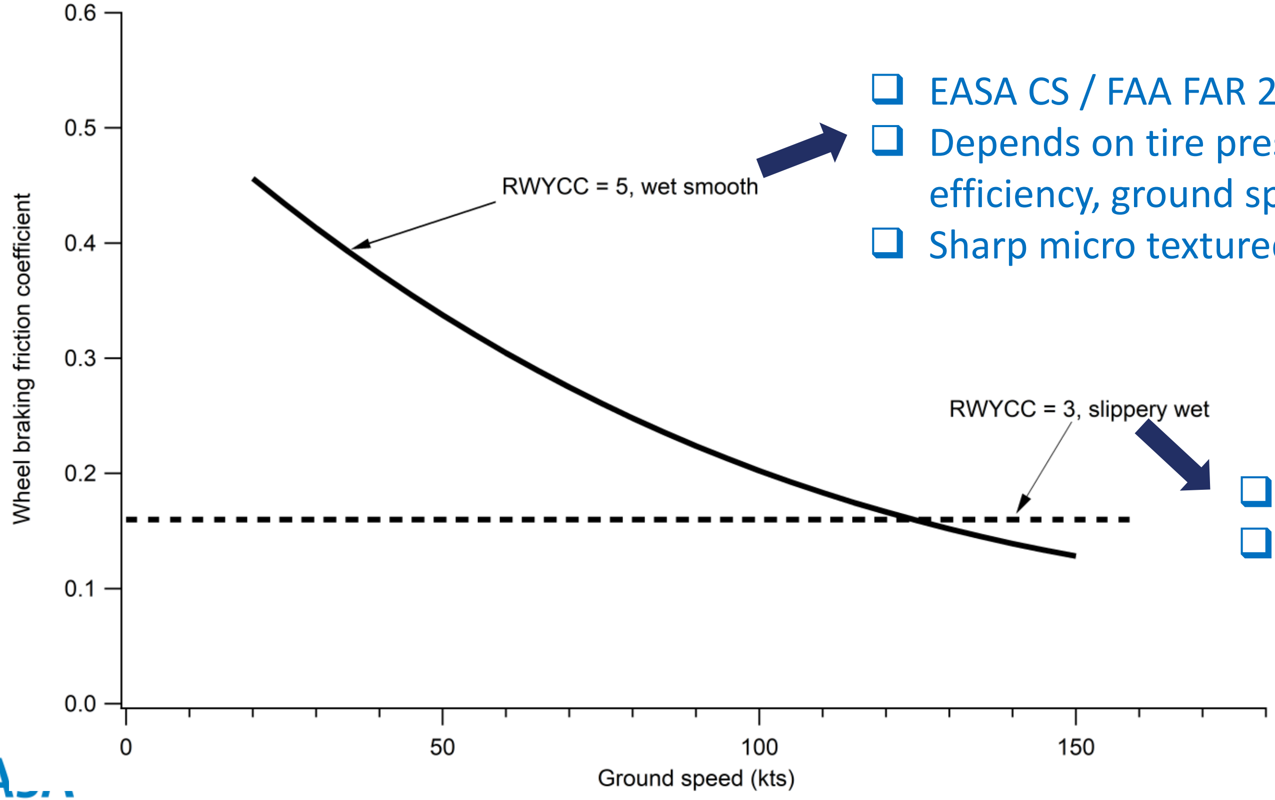
Slippery wet runway definition

<u>EASA</u> : *'Slippery wet runway' means a wet runway where the surface friction characteristics of a significant portion of the runway have been determined to be degraded.*

Runway Condition Assessment Matrix

RUNWAY CONDITION CODE	RUNWAY SURFACE CONDITION DESCRIPTION	REPORTED BRAKING ACTION
6	Dry	Dry
5	Wet (Smooth, Grooved or PFC) or Frost 3 mm (0.12 inches) or less of: Water, Slush, Dry Snow or Wet Snow	Good
4	Compacted Snow at or below -15°C OAT	Good to Medium
3	Wet (Slippery), Dry Snow or Wet Snow (any depth) over Compacted Snow Greater than 3 mm (0.12 inches) of : Dry Snow or Wet Snow Compacted Snow at OAT warmer than -15°C	Medium
2	Greater than 3 mm (0.12 inches) of: Water or Slush	Medium to Poor
1	Ice	Poor
0	Wet Ice, Water on top of Compacted Snow, Dry Snow or Wet Snow over Ice	Nil

RCAM Assumed braking friction in performance calculations – example



- EASA CS / FAA FAR 25.109(c) and (d)
- Depends on tire pressure, anti-skid efficiency, ground speed
- Sharp micro textured surfaces

- Constant
- Depends only on anti-skid type

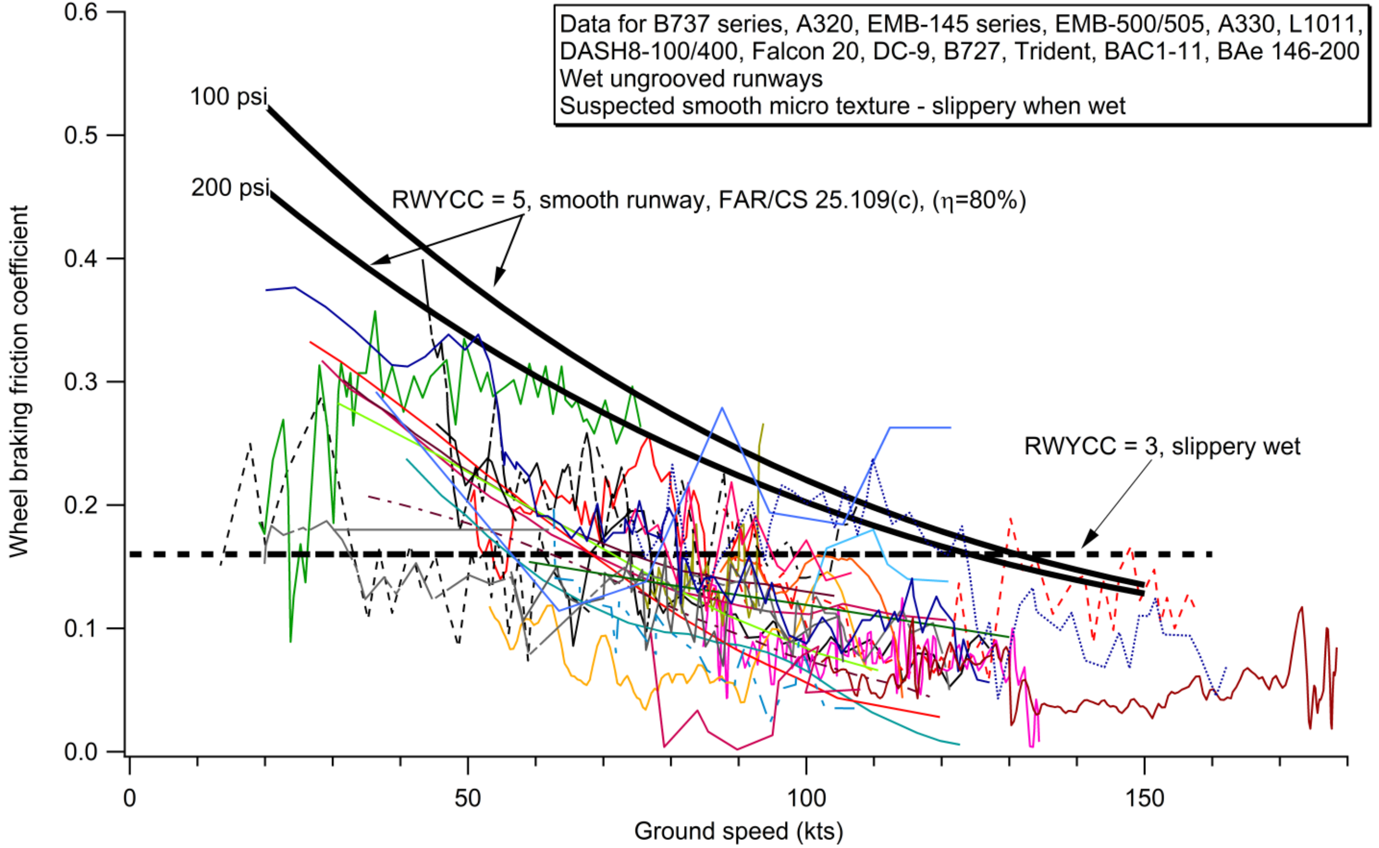
Slippery wet runway braking performance

- TALPA ARC proposed to relate *slippery wet* to braking performance **medium**;

- Wheel braking friction coefficient μ_{EFF} **chosen** for this level is:

  - **0.16 (**fully modulating anti-skid system);
  - **0.10 (**quasi modulating anti-skid system).

Braking on slippery wet ungrooved runways



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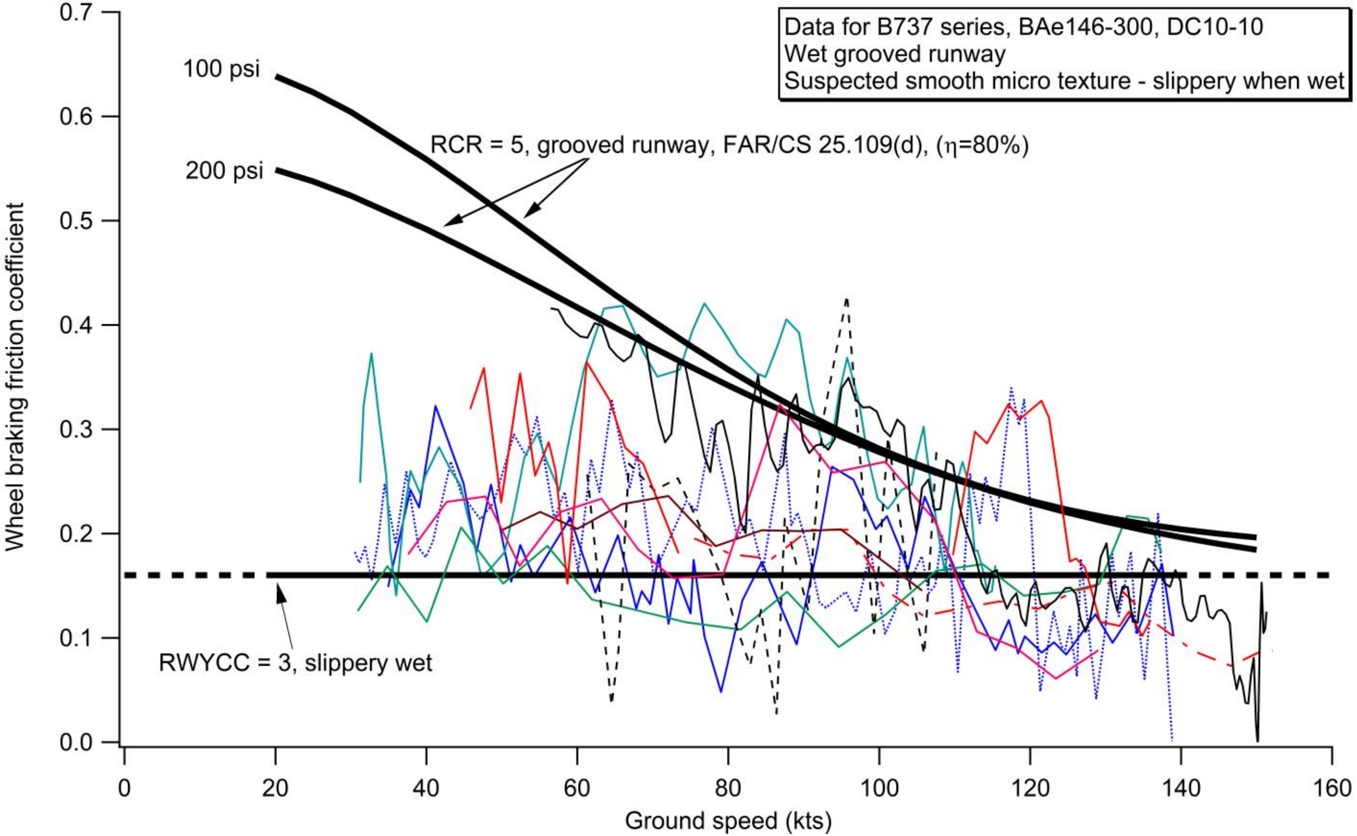
Braking on slippery wet grooved runways



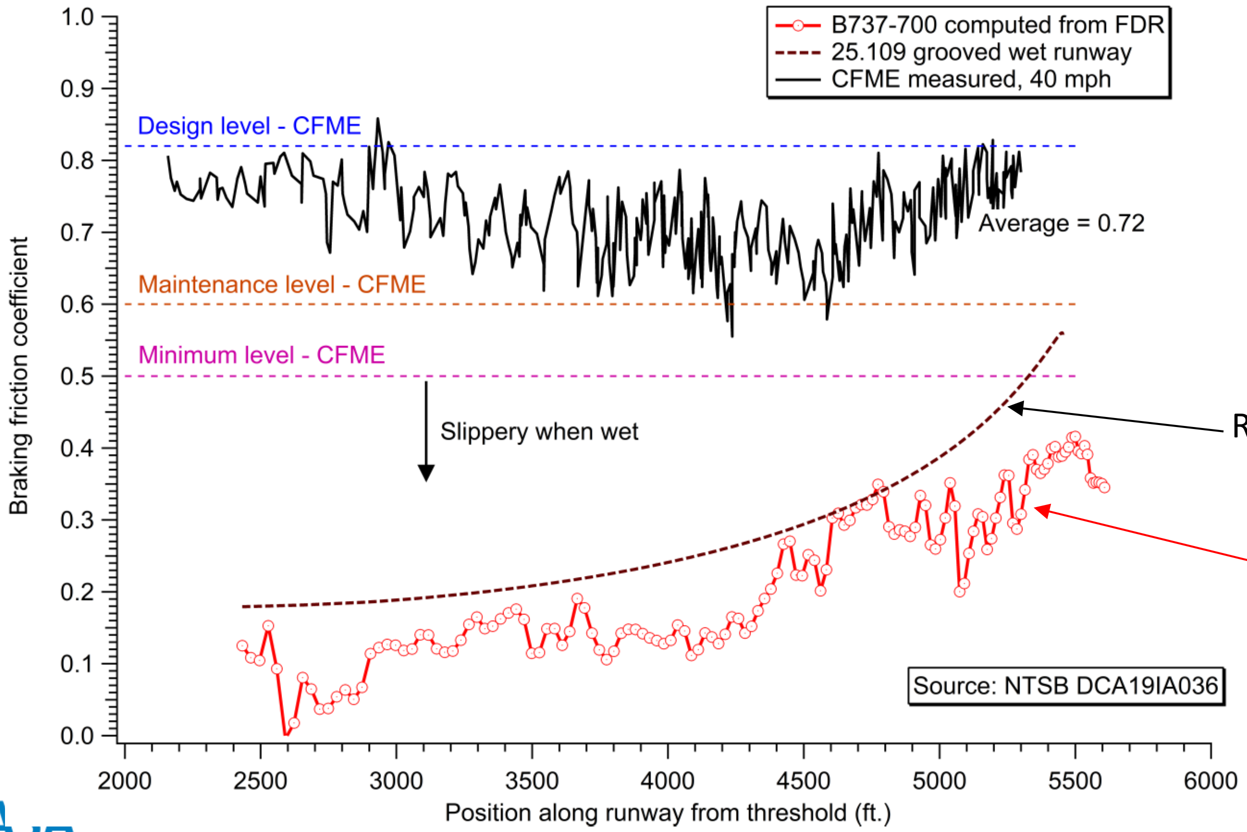
Braking friction levels on slippery wet runways

- → μ_{EFF} can be up to 80% **lower** than assumed for RWCC 5;
- → Sometimes lower μ_{EFF} than for snow/ice covered runways;
- → Differences in μ_{EFF} mainly caused by variations in texture along a given runway:
  - → Micro texture is dominant (smoother than assumed in 25.109)
  - → Viscous hydroplaning

Current assessment of slippery wet runways

- CFME compared to Minimum Friction Level MFL
  - *CFME can give optimistic results*
  - *MFL arbitrarily chosen based on experience and highly scattered data*
- Observation by aerodrome maintenance personnel
  - *Subjective*
- Pilot reports
  - *Subjective (e.g. thrust reversers will mask true braking performance)*
- Realtime onboard analysis of braking performance
  - *Promising but requires wet runway with friction limited braking*
  - *Equipped aircraft needed that land on your aerodrome*

Example CFME results in a B737 overrun



RWYCC = 5 (grooved rwy)

Aircraft achieved level

What causes slippery wet runways?

- Smooth micro textured runway surfaces are believed to be responsible for slippery wet runways:

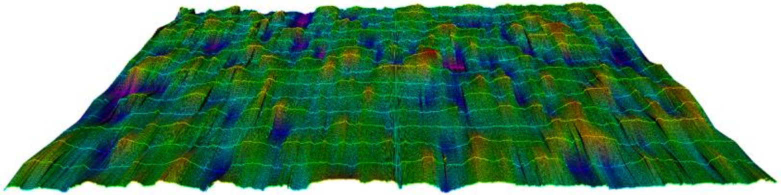
  - Due to normal wear of runway surface;
  - None visible rubber build-up after touchdown zone (reduces micro texture);
  - Use of fog seal/rejuvenators to repair runway surface (can reduce micro texture).

How to assess runway micro texture?

High Resolution surface laser scanner

Source: NLR

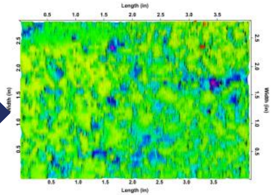
Scan ‘area’



Basic approach EASA project

Runways

Surface scans



Algorithms

Micro texture parameter

Threshold for slippery wet runway

EASA project tasks

- Literature survey;
- Testing:
  - Flight tests on wet runways
  - Surface tests
- Development of algorithms to deduce micro texture parameters from surface laser scans;
- Development of slippery wet runway threshold;
- Guidance material.

Testing activities

Testing activities

→ Flight tests on wet runways:

→ Collect wheel braking friction data on different runways surveys;

→ Surface tests:

→ Use laser scanner on a variety of surfaces;

→ Tests using **British Pendulum Tester (BPT)** on same surfaces.

↳ BPT indicative for micro texture characteristics

Flight test aircraft


Baks
MAGYAR


PH-LAB

Test runs at Twente airport – Falcon 2000

Surface tests

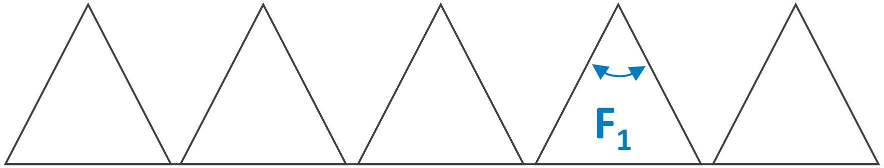
- → Measurements using BPT and high resolution surface laser scanner;
  - → All locations used for flight testing;
  - → Additional surfaces including taxiways, road surfaces, rubber deposited surfaces, fog sprayed surfaces and very smooth surfaces
- → BPT provides additional test data used for correlation and validation.

British Pendulum tester & laser scanner

Micro texture characterisation

Micro texture representation – ESDU model

Assume protrusions in micro texture are triangular with vertex upward

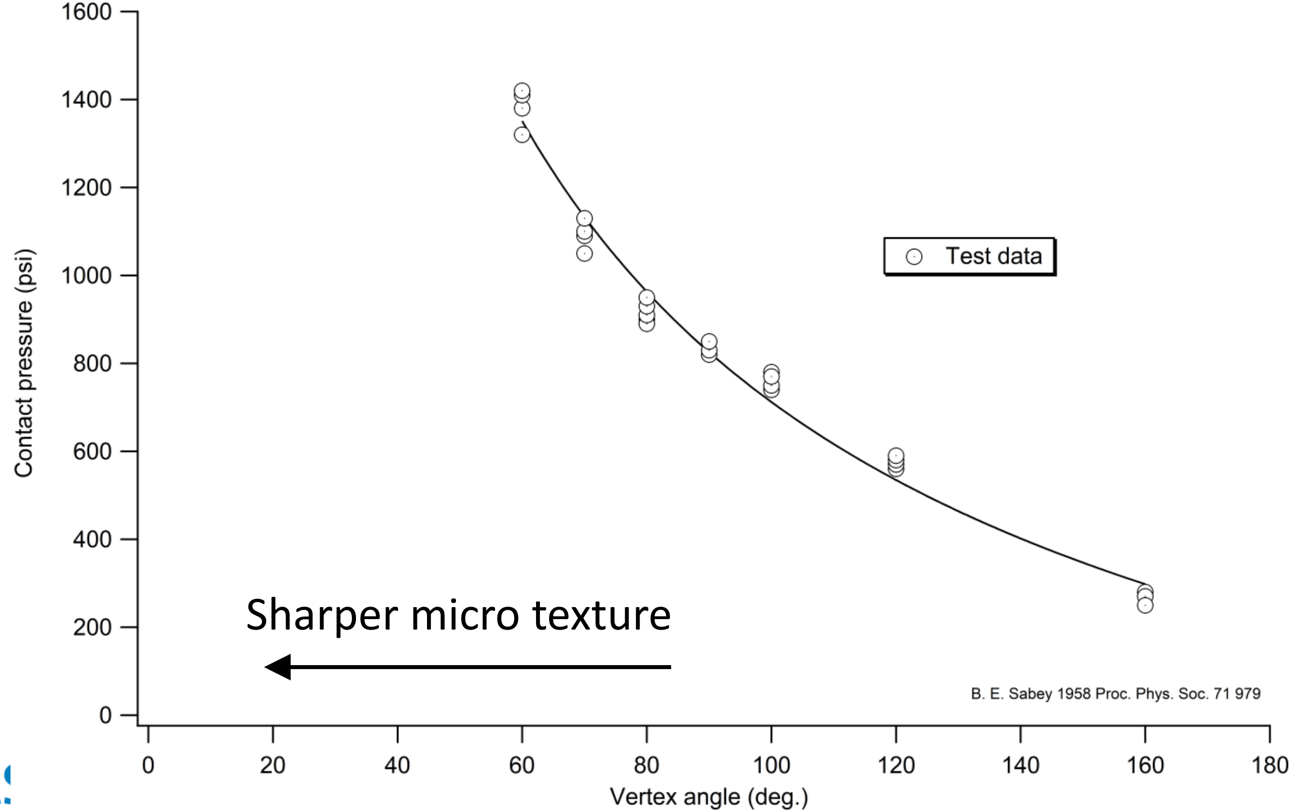


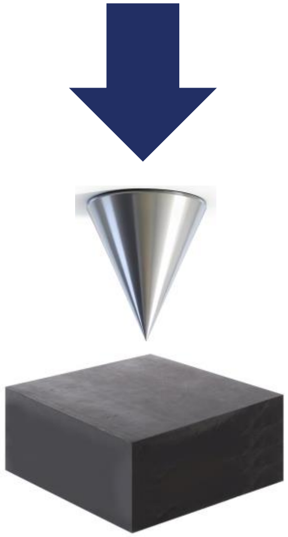
Assume a micro texture parameter related in some way to angle of vertex
F_1

- On a nearly complete **sharp** surface **$F_1 = 0$**
- On a perfectly **smooth** surface **$F_1 = \pi$**

F_1 = Balkwill parameter (micro texture sharpness)

Example: Pressures beneath metal cones pressed into rubber





ESDU models for micro texture sharpness

- Vertex angle (F_1) determines contact pressure between surface and tyre;
- High contact pressures needed to reduce viscous hydroplaning;
- ESDU (*Ken Balkwill*) developed models for deducing F_1 from BPT and aircraft wheel braking friction test data;
- Models are semi-empirical.

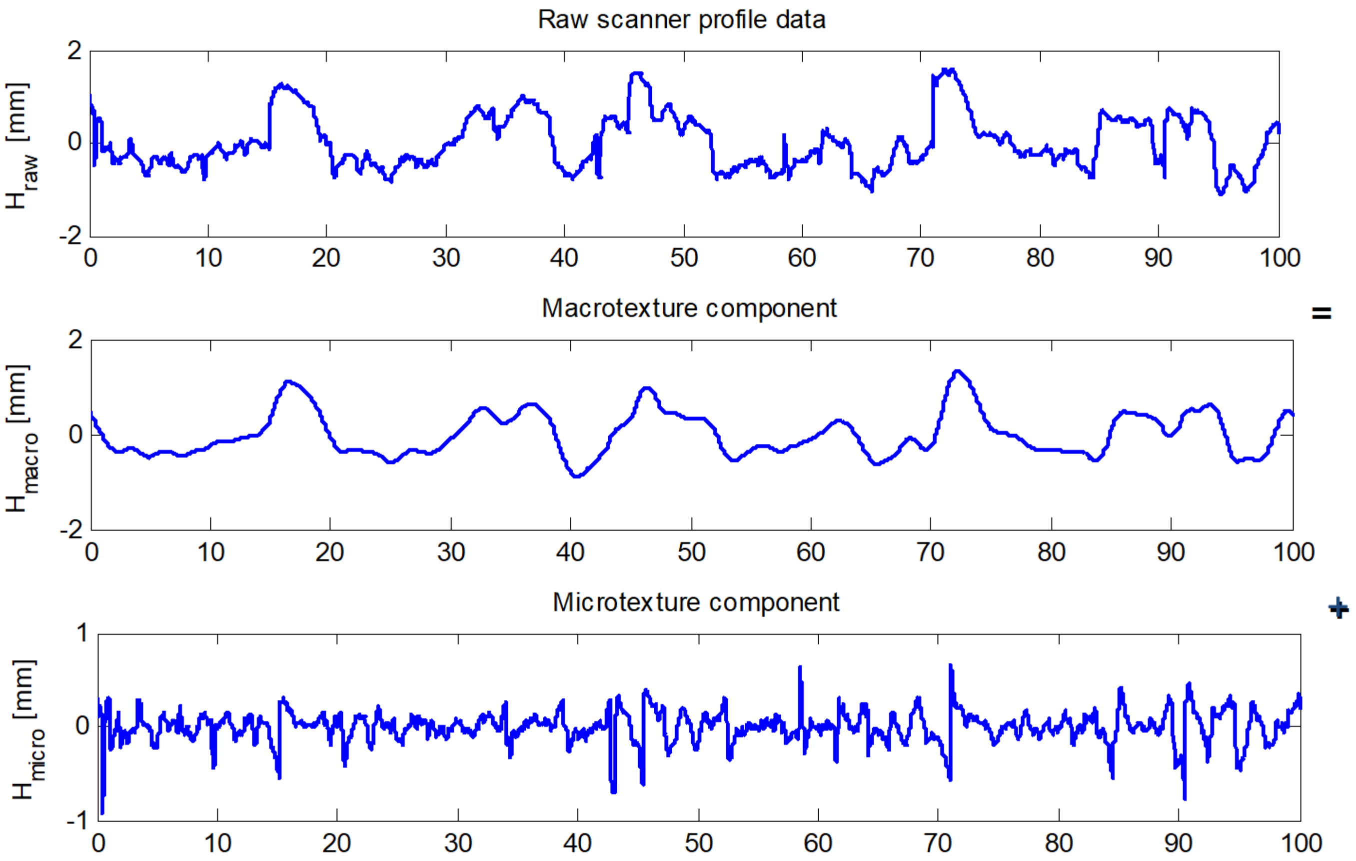
Sources: ESDU Data Item 10015 & 23002 and TM 201.

Deducing micro texture parameter from laser scans

→ Different parameters can be derived from surface scans that characterise micro texture;

→ Identify parameter that gives best correlation with F_1 deduced from flight tests and BPT.

High Resolution surface laser scan line



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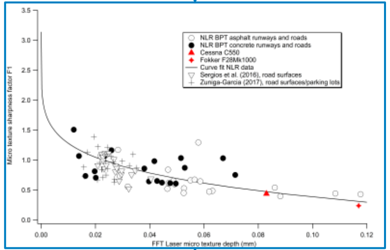
Correlation analysis

Test aircraft & BPT

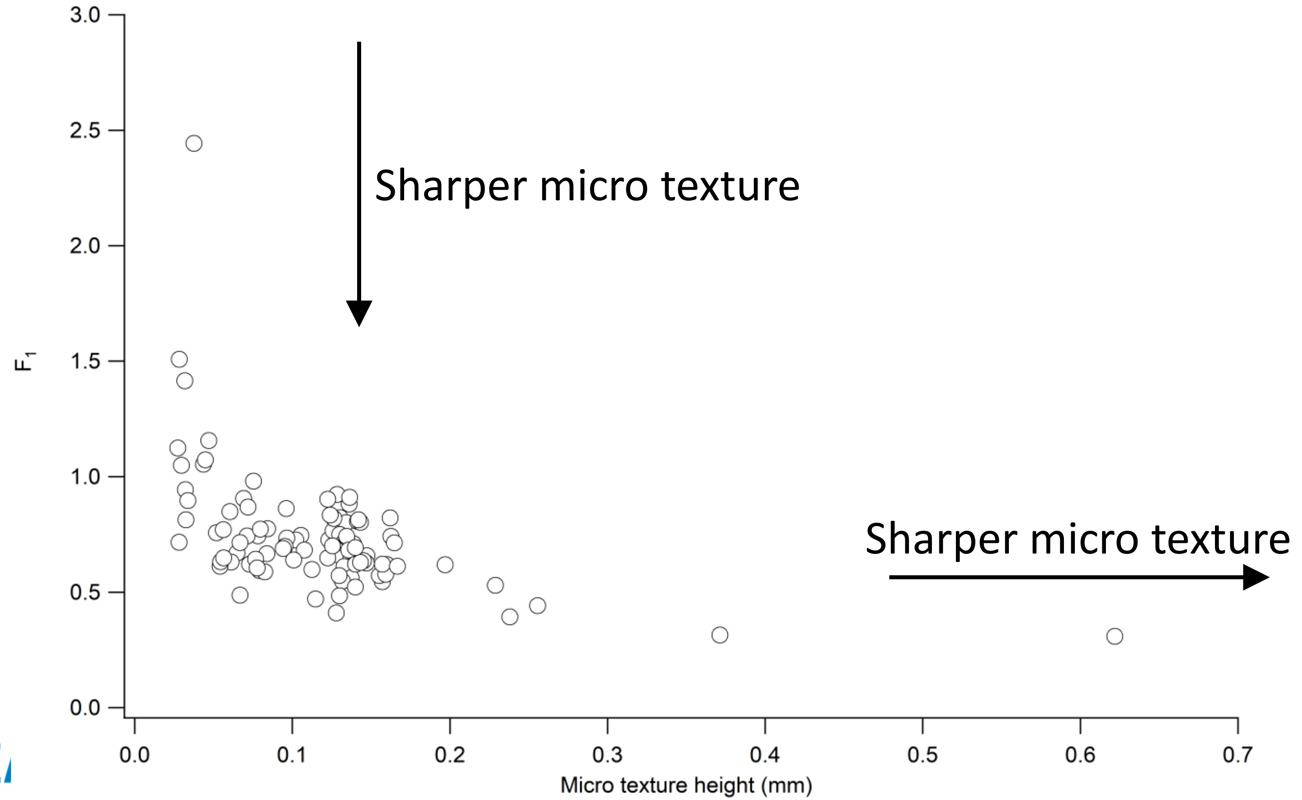
micro texture sharpness parameter F_1



Surface laser scanner

micro texture characteristic

Example of relation F_1 and selected micro texture parameter



Threshold for slippery wet runways

Threshold for slippery wet runways

- ‘*Slippery wet*’ runway is defined by ICAO study group (1991):
  - a wet runway on which ***twice*** dry braked stopping distance is approximately needed to stop an aeroplane;
  - Should correspond to MFL;
  - Based on FAA/NASA/USAF Runway Research program.
- US study proposed stopping distance ratio of **2.0-2.5** as threshold;
- Currently for performance calculations constant μ_{eff} of 0.16 is used for ‘slippery wet’ (RWYCC=3):
  - FCOMs MEDIUM versus DRY give avg. SDR of **2.3**

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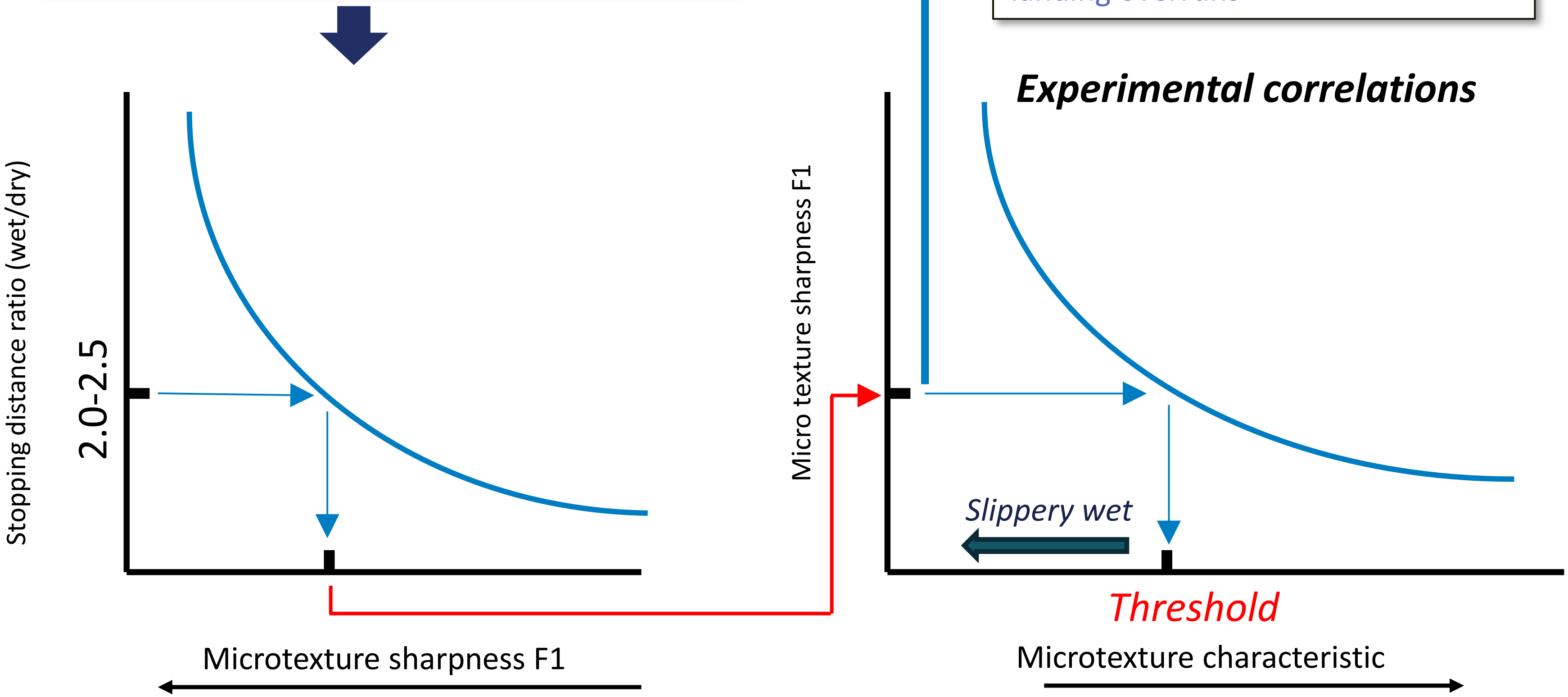
Threshold for slippery wet runways

Simulated landing stopping performance

Validate with F_1 estimated from landing overruns



Threshold F_1

- Proposed F_1 threshold based on combination of:
  - Simulations of landing stopping performance by varying F_1, macro texture and water depth (*μ-speed relations based on ESDU models*);
  - F_1 deduced from wet runway overrun accidents by matching ESDU model results.
- Further validation is recommended by analysis of 'slippery wet' runways as identified by for instance onboard measurements (*like RunwaySense on Airbus aircraft*).

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Findings and next steps

Findings

- New method for objective assessment of runway micro texture is developed;
- Method can assist in assessing braking friction characteristics of runways in a more consistent manner which is much less subjective;
- Method can help in determining slippery wet runways.

Next steps

- → Choices need to be made which micro texture parameter derived from surface scans should be used;
- → Proposed threshold should be evaluated in order to establish a common accepted criterium for slippery wet surface related to micro texture or macro texture (in case the macro texture is very smooth);
- → Consider other devices to assess micro texture (e.g. optical);
- → Approach needs further validation before full operational use by aerodrome operators and AIBs.

Open Issues

- Operational water depth measurements remains challenging;
- Consideration of surface temperature in wet runway friction;
- Macro texture depth effects (need for minimum values);
- Integrate overall review, link runway, operation, airworthiness & airlines → safety;
- Review & revise runway condition code underlying assumptions?

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Planned follow-up activities

This project is funded by the European Union's Horizon 2020 Programme

What next

- → Initiate rulemaking to revise Regulation (EU) No 139/2014 in order to establish micro-texture values, below which a runway would be considered as slippery wet and maintenance actions are required
- → Develop a guidance on the method that will be used to measure the micro-texture
- → Establish clear criteria for the development of a trend monitoring programme of runway surface, and
- → Review the certification specifications regarding runway surface construction
- → Present the outcome to ICAO with a view of including the method in ICAO documentation

Questions and answers

Question and Answers

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Concluding Remarks

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Thank you for joining this webinar!

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