

IMAG

Skid resistance friction trailer

Technical information



Description of the IMAG

IMAG is an automatic skid resistance measurement device for runways designed by the Civil Aviation Technical Centre (STAC) of the French Civil Aviation Administration (DGAC), developed in collaboration with Aeroports de Paris (ADP). Patented in 1991, IMAG is currently used in operational conditions on several French airports such as Roissy-Charles de Gaulle, Orly, Strasbourg, Metz-Nancy-Lorraine and Europort Vatry.

On these airports, the IMAG is used during the winter period to measure runway surface friction and to inform pilots about runway conditions.

Outside of the winter period, the IMAG helps managing the national aeronautical assets, by measuring the friction characteristics of dry runway. These measures are performed as routine measurement for planning of maintenance operations.

Between 1993 and 2002, the IMAG participated to several international test campaigns to harmonise results from different friction measuring equipments for maintenance purposes. These test campaigns helped establishing correlation between different equipment used worldwide.

Between 1996 and 2003, a work program dedicated to friction measurement in winter conditions aimed to determine an International Runway Friction Index (IRFI) correlated to aircraft performances. The IMAG participated at this program as the International Reference Vehicle for friction harmonisation.

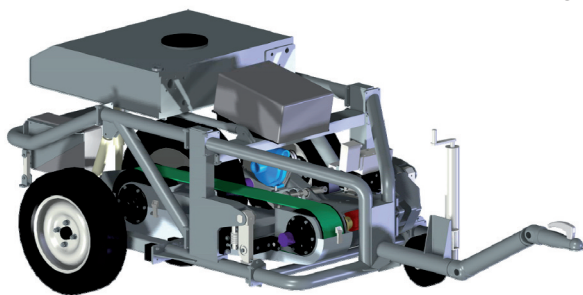


Illustration of IMAG (© VECTRA)

Operating Mode

The principle of IMAG's method of measurement is quite simple (for details, please refer to « Technical characteristics »). A measuring wheel, ballasted, is towed at a constant speed and braked at a constant slip ratio of 15 %.

The machine is fitted with gauges to measure the following forces :

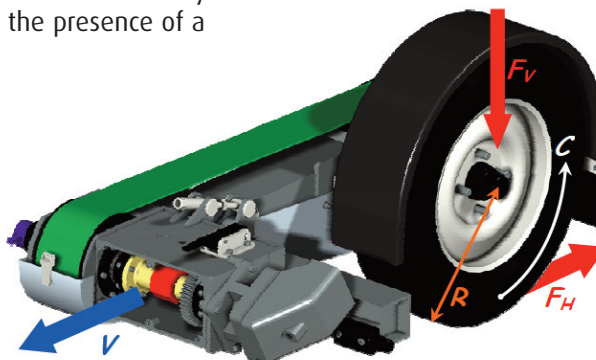
- ★ F_h : longitudinal pulling force due to skid resistance of the surface and rolling resistance of the tyre ;
- ★ C : braking torque due to the tire friction force ;
- ★ F_v : vertical weight applied on the measuring wheel.

Two parameters can be determined :

- ★ $M \text{ force} = F_h / F_v$ (longitudinal drag coefficient)
- ★ $M \text{ torque} = (C/R) / F_v$ (friction coefficient), with R the radius of the measuring wheel.

The measures of parameters F_v and C are significant, since :

- ★ the measurement of F_v allows the roughness of the inspected pavement surface to be taken into account (due to the roughness, F_v is not constant) ;
- ★ the measurement of both F_h and C help distinguishing the part of rolling resistance due to the friction between the tyre and the pavement from the part due to the presence of a contaminant.



F_v : vertical load
 C : braking torque
 F_h : horizontal force
 R : wheel radius
 $\mu \text{ torque} = (C/R) / F_v$

Diagram (© VECTRA)

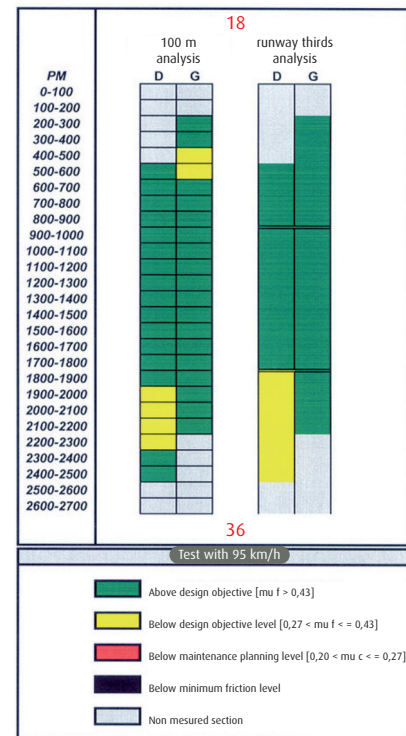
Practical examples

Results can be exploited in two different ways:

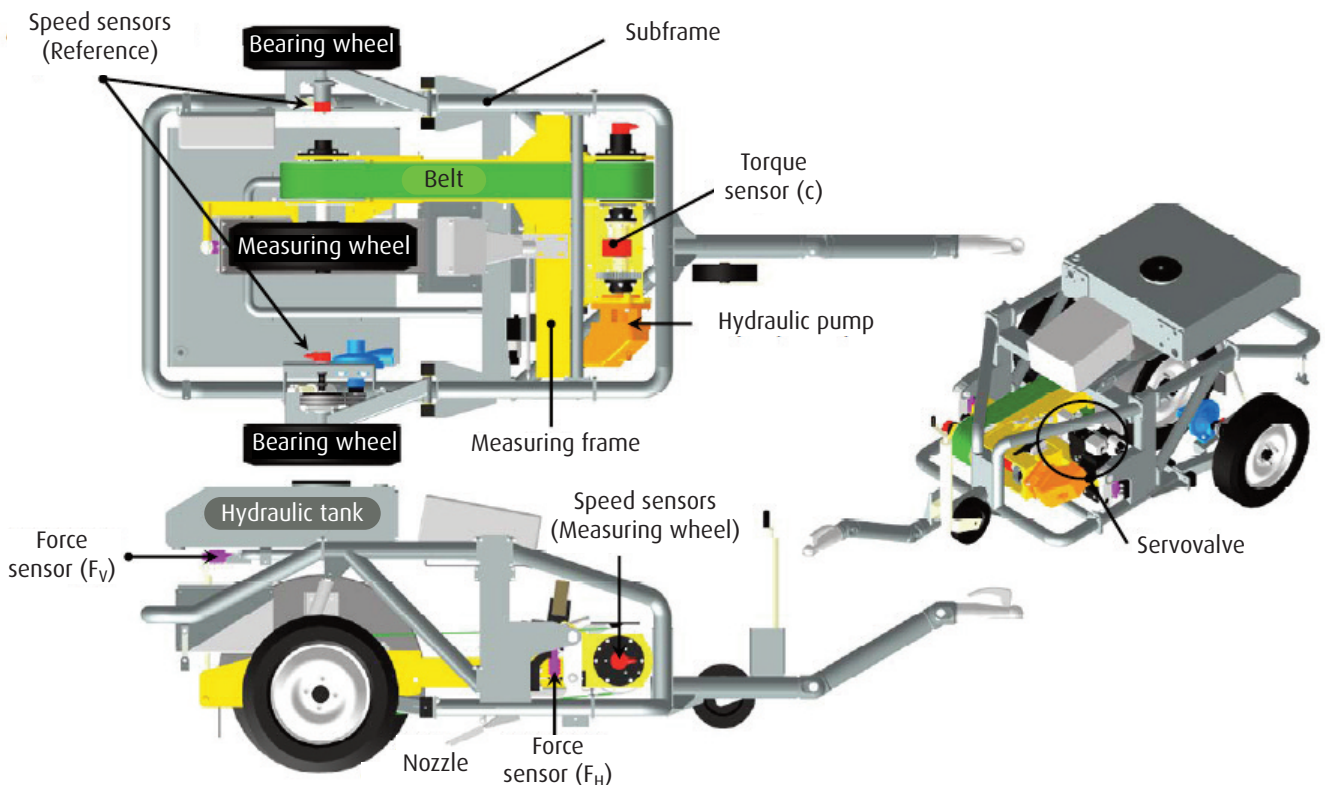
- ✳ for operational measurements (winter period), the results are immediately available after tests as a friction value for each third of runway as recommended by ICAO.
- ✳ for functional measurements (outside of the winter period), or experimental measurements, the computer software can give more accurate and detailed results (value for each 100 m or each third of the runway).

Removal of rubber

The following graph illustrates the friction results obtained on a runway. Note the variation of friction coefficient and localized low values due to partial coverage with rubber in the touchdown area. This example illustrates the need to undertake rubber removal on specific areas of the runway.



Example of runway friction results (© STAC)



View of IMAG (© VECTRA)

Technical characteristics



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Type

- ✱ A three wheeled trailer towed by a vehicle.
- ✱ A framework with two supporting wheels fitted with speed and distance gauges.
- ✱ A mobile measurement frame fitted with a PIARC smooth tyre:
 - ✓ Size: 165R15
 - ✓ Tyre inflation: 150 kPa
 - ✓ Load on measuring wheel: 180 kg



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Friction coefficient measurement system

- ✱ Brake on measuring wheel while moving, at a constant slip rate of 15 %.
- ✱ Continuous measurement of the longitudinal pulling force, the braking torque and the dynamic wheel weight.
- ✱ Data processing of results and conversion into two types of information: a pure friction coefficient (due to surface friction alone) and a drag coefficient (due to both surface friction and presence of contaminant).
- ✱ Measurement speed up to 130 km/h.
- ✱ Usual measurement speed: 40, 65 and 95 km/h.



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Analysis

- ✱ A towing vehicle powerful enough to reach rapidly test speed at the beginning of test runs.
- ✱ On board electronic system to check the functional parts of the equipment (braking system).
- ✱ Computerised system from data processing and analysis through to media:
 - ✱ paper strip or screen.



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Additional equipment

- ✱ Transmission of measurements by WiFi or RJ45.
- ✱ Independent wetting system to evaluate runway surface friction characteristics as part of maintenance program.
- ✱ The device, fitted in the van, provides a constant flow of water on to the runway, the film thickness being related to the speed of van by an electrically controlled valve.
- ✱ Rugolaser to evaluate simultaneously the surface texture.



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