Journée technique 2011

High Tire Pressure Test

Camille SAGUES   AIRBUS S.A.S
Sandrine FAUCHET   STAC

Présent pour l'avenir

Outline

- ♣Introduction
- ♣Background on tire pressures
- ♣HTPT
  - ¬ Pavement structure and simulator
  - ¬ Test results
  - ¬ Conclusions and recommandations
  - ¬ Ratification status

The HTPT program

The context

- The tire pressure of the modern aircrafts exceed 15 bars

- According to the ICAO regulations, some States impose operational limitations on aircrafts with a tire pressure higher than 15 bars.

The HTPT program

- **Why?**
  - To improve experimental and theorical knowledge related to the effects of aircraft internal tire pressure on damage to flexible pavement,
  - To propose a modification of the ICAO regulations.
- **Who?**
  - Patnership between Airbus, the DGAC-STAC, the LCPC, the LRPC Toulouse, Vancouver2 and Michelin.
- **How?**
  - An outdoor full-scall tests.
- **Where?**
  - Toulouse Blagnac Airport

Current regulations on tire pressure limitations

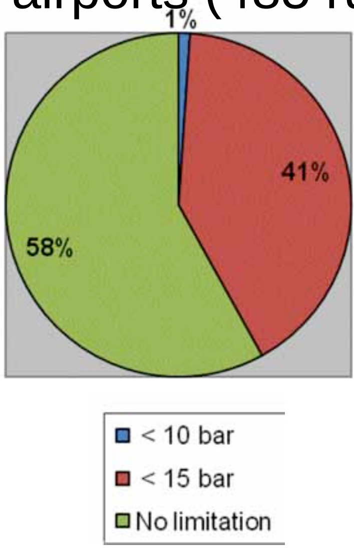
- The current ACN / PCN procedure specified in the ICAO Annex 14, “Aerodromes”, contains four maximum allowable tire pressure categories which are used in the reporting of pavement strength for an airport:
  - _W = No pressure limitation - High
  - **_X = 1.5 MPa (218 psi) limitation - Medium**
  - **_Y = 1.0 MPa (145 psi) limitation - Low**
  - _Z = 0.5 MPa (73 psi) limitation. – Very low

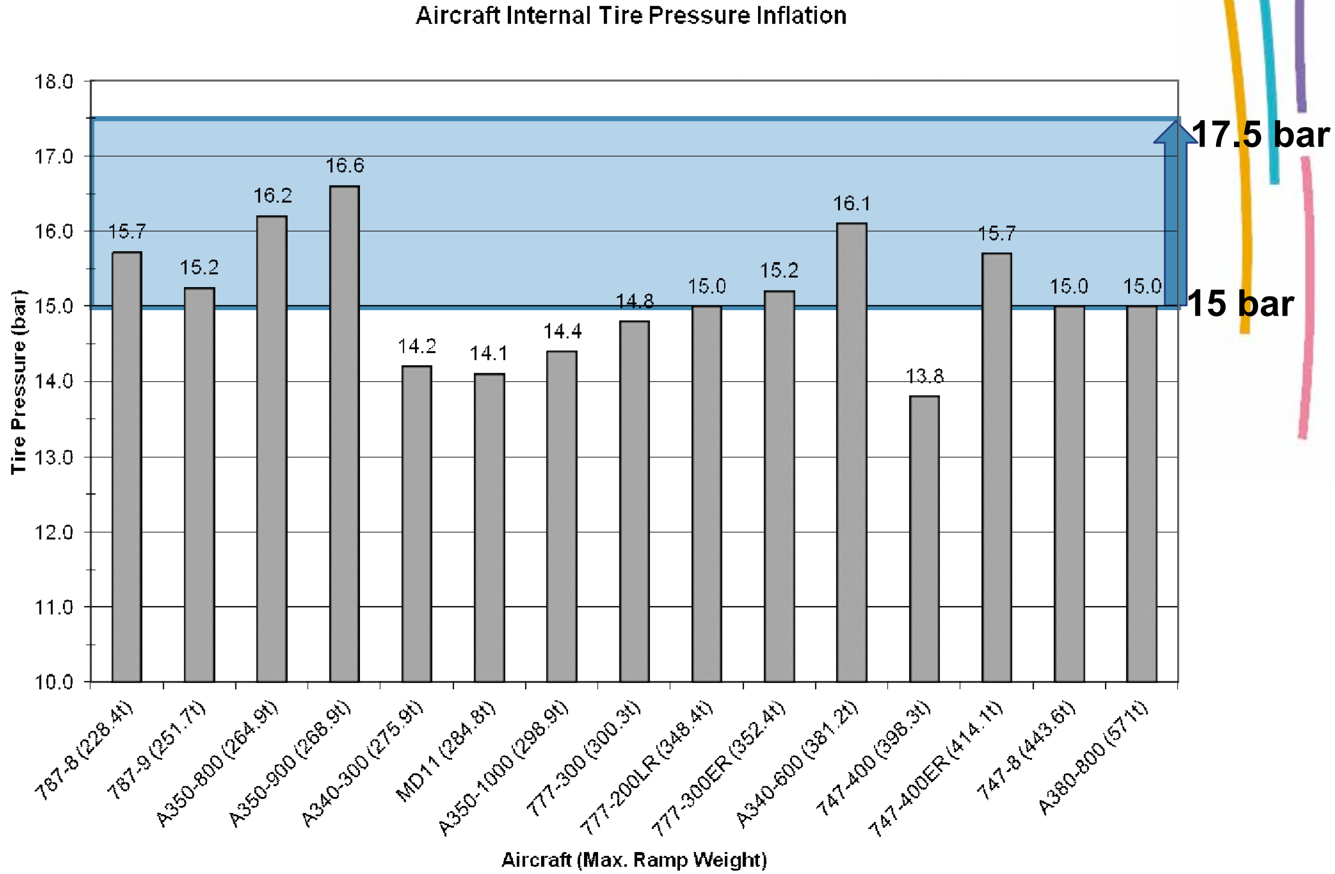
- Tire pressure categories were established in early 1980’s.
  - _Scientific rationale was not fully robust
  - _Origin of tire pressure limitations were not clearly established

- Airport PCN ratings should reflect current pavement capability and aircraft traffic

Aircraft tire pressure summary

- Tire pressure limitations repartition for LR airports (485 runways considered)





- **A340-500/-600, 747-400ER, 777-300ER and new 787, A350 and 747-8 all exceed category X upper limit**

Proposed change to ICAO tire pressure categories

Tire Pressure Category	Current ICAO Limits MPa (psi), loaded	Proposed New ICAO Limits MPa (psi), loaded
W	High	Unlimited
X	Medium: 1.50 (218)	High: 1.75 (254)
Y	Low: 1.0 (145)	Medium: 1.25 (181)
Z	Very Low: .50 (73)	Low: .50 (73)

Why do aircraft tire pressures tend to increase ?

✚ Payload

✚ Range

Fuel Burn reduction

Drag reduction

Noise reduction in approach

Less emissions

- MTOW Increase
- Fuselage length increase
- Wing-span increase (& shape) for drag reduction
- **Fewer wheels** for:
  - Weight saving, noise & drag reduction (approach)
  - Better maneuverability
- but, **larger wheels and tires** (higher load capabilities higher braking capabilities)

Higher wheel load

&

Tire pressure

How to address the tire pressure concern?

- Two-pronged approach:

  - **Airport survey**

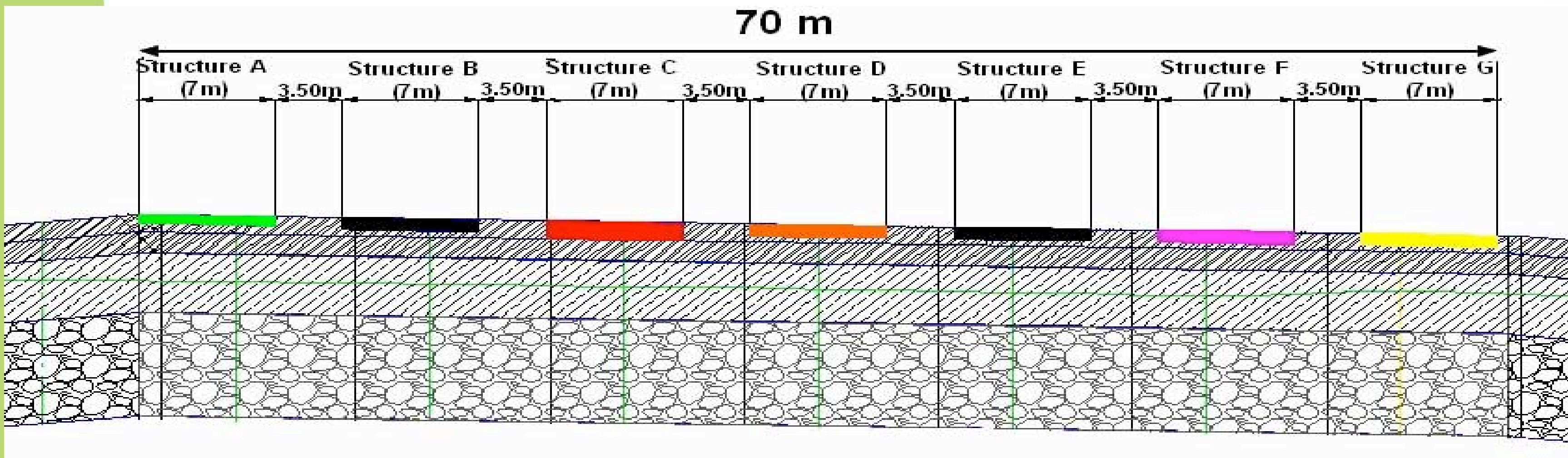
    _Airport Council International: Questionnaire sent to airports worldwide

  - Perform **full-scale tests** by considering main parameters which are expected to influence tire pressure effect on asphalt concrete base & surface course

    _AIRBUS / French DGAC HTPT, Blagnac – France
    _BOEING / FAA HTPT, NAPTF, Atlantic-City, NJ, USA

AIRBUS / DGAC-STAC Full scale HTPT tests

Experimental pavement structure

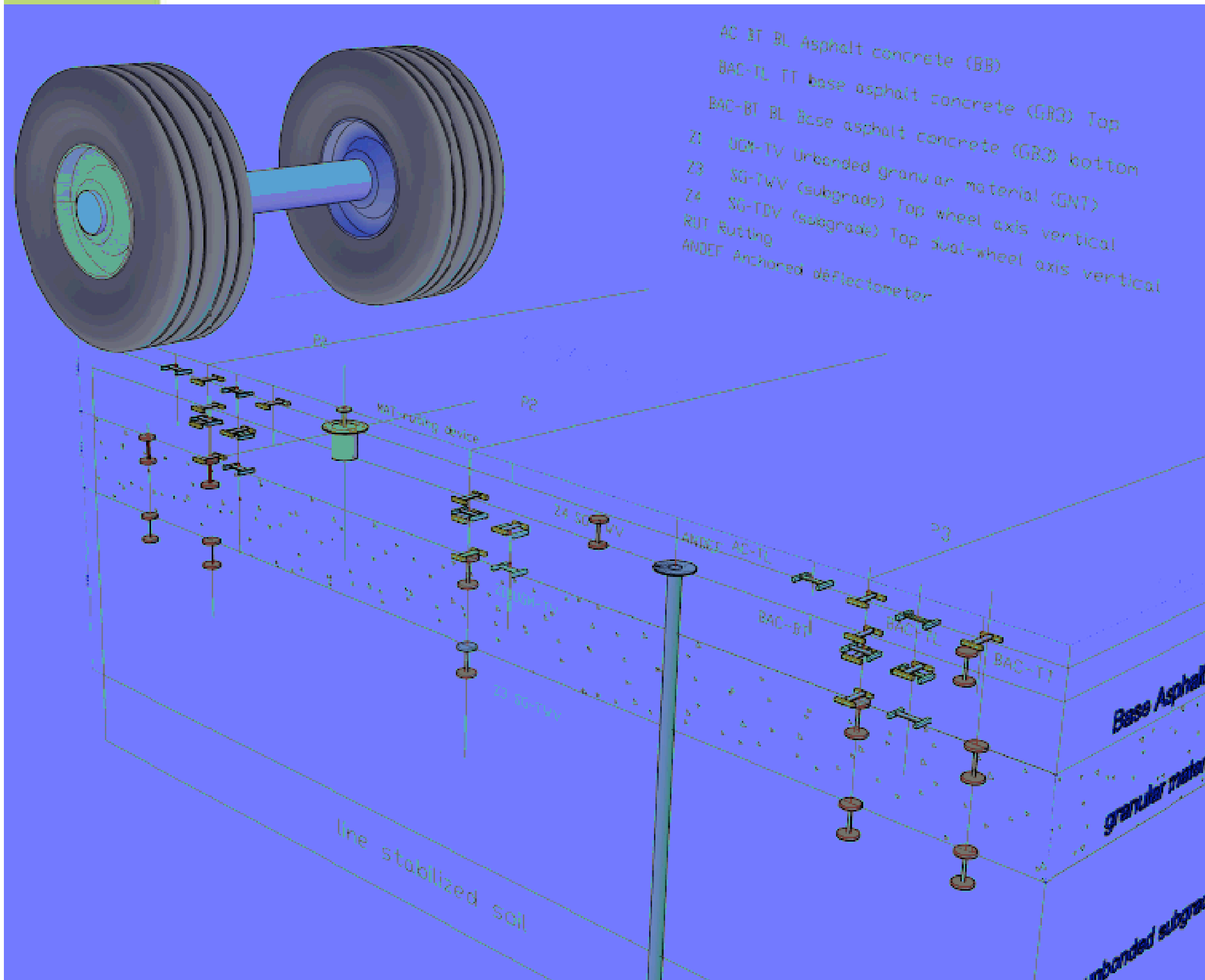


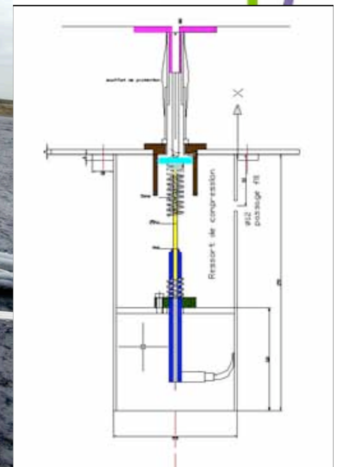
Structure A	Structure B	Structure C	Structure D	Structure E	Structure F	Structure G
0.06m SAC 1	0.08m SAC 1	0.12m SAC 1	0.08m SAC 2	0.08m SAC 1	0.08m SAC 1 gr.	0.08m SAC 3
0.20m BAC	0.18m BAC	0.14m BAC	0.18m BAC	0.18m BAC	0.18m BAC	0.18m BAC

HTPT Phase – 1/0.40m UGA/0.70m foundation

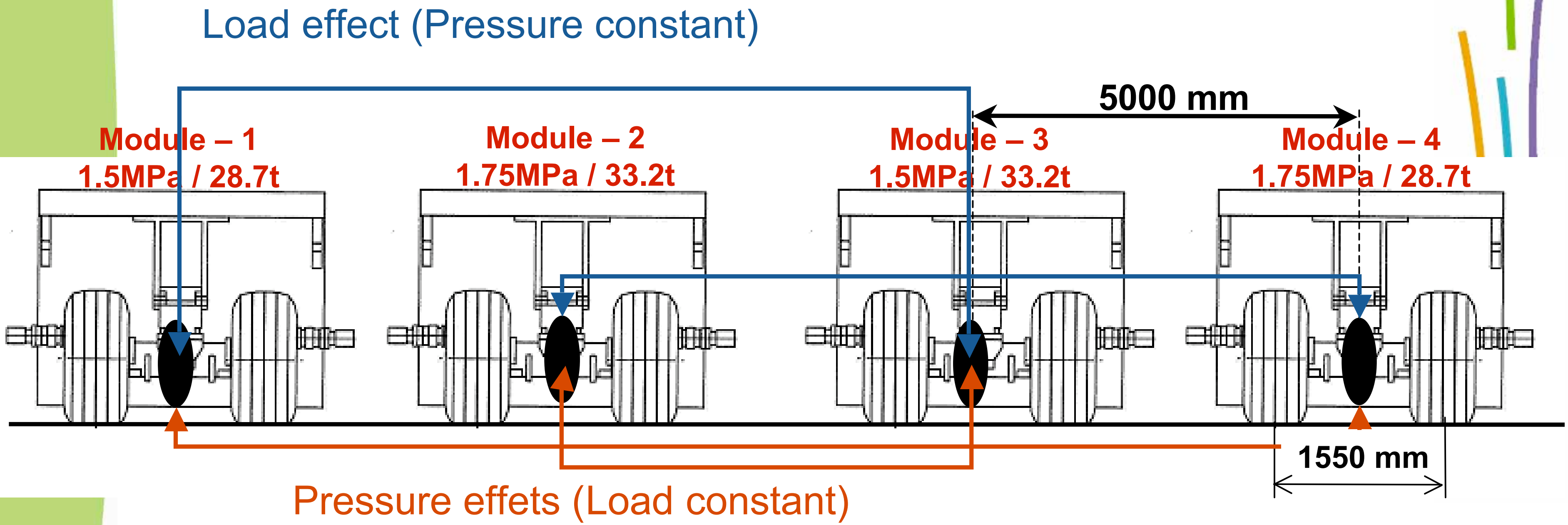
- **Representative range of pavement** characteristics regarding:
  - _ Rutting performance
  - _ Thickness
  - _ Surface treatment (grooving)

Instrumentation principle





The simulator



- 4 dual-wheel modules, each with a combination of loads and tire pressures
- Traffic speed ≈ 4 km/h (3.6 ft/s)
- Surface asphalt temperature up to 60°C
- 11,000 load applications from October 2009 to August 2010

HTPT test results after 11,000 loadings

Section	Module M1 (mm)	Module M2 (mm)	Module M3 (mm)	Module M4 (mm)	Pressure effect: M1 vs M4 @28.7t (Δ in mm)	Pressure effect: Load increase effect (Δ in mm)	Pressure effect: M3 vs M2 @33.2t (Δ in mm)	Wheel-load effect: M2 vs M4 @1.5MPa (Δ in mm)	Wheel-load effect: M3 vs M1 @1.75MPa (Δ in mm)
A	24.9	22.9	**27.9**	21.8	3.1	+1.9	5.0	1.1	3.0
B - E	22.9	22.4	27.5	20.7	2.2	+2.9	**5.1**	1.7	**4.6**
C	24.2	22.6	25.4	21.8	2.4	+0.4	2.8	0.8	1.2
D	20.9	20.2	21.9	17.5	**3.5**	-1.8	1.7	2.7	1.0
F	19.7	21.1	22.6	17.8	1.9	-0.4	1.5	3.3	2.9
G at 10,000 passes	23.2	22.0	26.9	20.9	2.3	+2.6	4.9	1.1	3.7

- Section A had the thinnest asphalt layer (6cm), C the thickest surface asphalt layer (12cm) and Sections B, D, E, F and G had the reference AC surface thickness (8cm)

HTPT test results

- Total rut depth greater than 20-25 mm (0.79-0.98 in)
- **No pavement structural failures**

- Rut depth differences between 1.5 MPa (218 psi) and 1.75 MPa (254 psi), at constant wheel-load, range:
  - from 1.9 mm (0.07 in) to 3.5 mm (0.14 in) for 28.7t wheel-load
  - from 1.5 mm (0.06 in) to 5.1 mm (0.20 in) for 33.2t wheel-load
  - **The contribution of tire pressure to rutting is very low**

- Rut depth differences for two different wheel-loads
  - the wheel-load effect ~ from 0.4 mm (0.02 in) to 2.9 mm (0.11 in).
  - **The contribution of wheel-load to rutting is very low**

- **Pavement temperature** is the most important parameter regarding rutting initiation
- **Thickness** was revealed to be an insignificant factor.
- **Modified AC** (high performance toward rutting) and **grooved sections** perform better than other sections.

Conclusions of DGAC-Airbus tests

♣ Test results indicate that **rutting can be significantly reduced by using improved asphalt binders**.

♣ Rut depth variation increases simultaneously with temperature **independent of tire pressure**.

♣ **Wheel-load effect** is insignificant on surface and base asphalt concrete, but more confined to the unbound material, therefore, more related to the structural behavior of airfield pavement, which is already considered in the ACN and the pavement thickness design method.

♣ **HTPT tests results (as well as Boeing/FAA tests) clearly indicates that the tire pressure effect resulting from an increase from 1.5 MPa (218 psi) to 1.75 MPa (254 psi) will not affect adversely the surface or base asphalt concrete layers, nor the structural capacity and life duration of typical airfield pavement structures**.

Conclusions and Recommandations

- Both the ACI airport survey and the full-scale tests demonstrate that the proposed change of tire pressure limitations can be ratified **without putting aircraft or airfield pavement at risk**.

- They allow the ICAO tire pressure limit codes to be formally and permanently changed to be **more consistent with both the performance of real world pavement and new generation aircraft**.

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ICAO Status

- **ICAO-Pavement Sub-Group** assembled material related to tire pressure for the **ICAO AOSWG** mid-July 2010

- The AOSWG submitted the proposal for the **ICAO-AP** mid-October 2010: The AP accepted the change

- Proposed revision to the high tire pressure category has been, to date, positively endorsed by the informal groups of the **ANC**

- Final approval expected during the formal ANC meeting scheduled for May/June 2011,

- Then it goes to States for consultation in accordance with established procedures dgac

STAC

Merci de votre attention

SANDRINE FAUCHET
STAC/IA
sandrine.fauchet@aviation-civile.gouv.fr
01 49 56 82 27

CAMILLE SAGUES
AIRBUS S.A.S
Camille.sagues@airbus.com
05 61 93 57 19