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New airplanes for old airfields

An airport airside construction and rehabilitation illustrated story

100 Years of Airport Evolution

Lisbon Airport - Amadora 1920

Lisbon Airport - Humberto Delgado (Portela) 2019

100 Years of transport Aircraft Evolution

Vimy Commercial - 5 Metric Tonnes, 11 passengers, in service 1918

Airbus 380 - 575 Metric Tonnes, 853 passengers (maximum), in service 2007

New airplanes for old airfields

In recent years a panoply of products, materials and technologies have been used to effectively improve the quality and structural capacity of pavements, such as:

- **High modulus bituminous mixes**, using either low penetration bitumen (10 to 25 pen bitumen – e.g. France & Portugal) or modified asphalts, or conventional bitumen, say 35/45 pen, modified by incorporating organic and plastic additives (e.g. Maghreb countries)
- **Fiber geogrid** to prevent/retard crack propagation in the cracked areas – Glass (GFG) and carbon geogrids (CFG), the latter with an enhanced structural role to be used in elevations restriction situations
- **New bituminous mixes** for wearing course with bimproved surface characteristics (skidding resistance, texture, riding quality, draining properties and noise) and durability (fatigue life and less maintenance works), such as the **SMA** (Stone Mastic Asphalt)

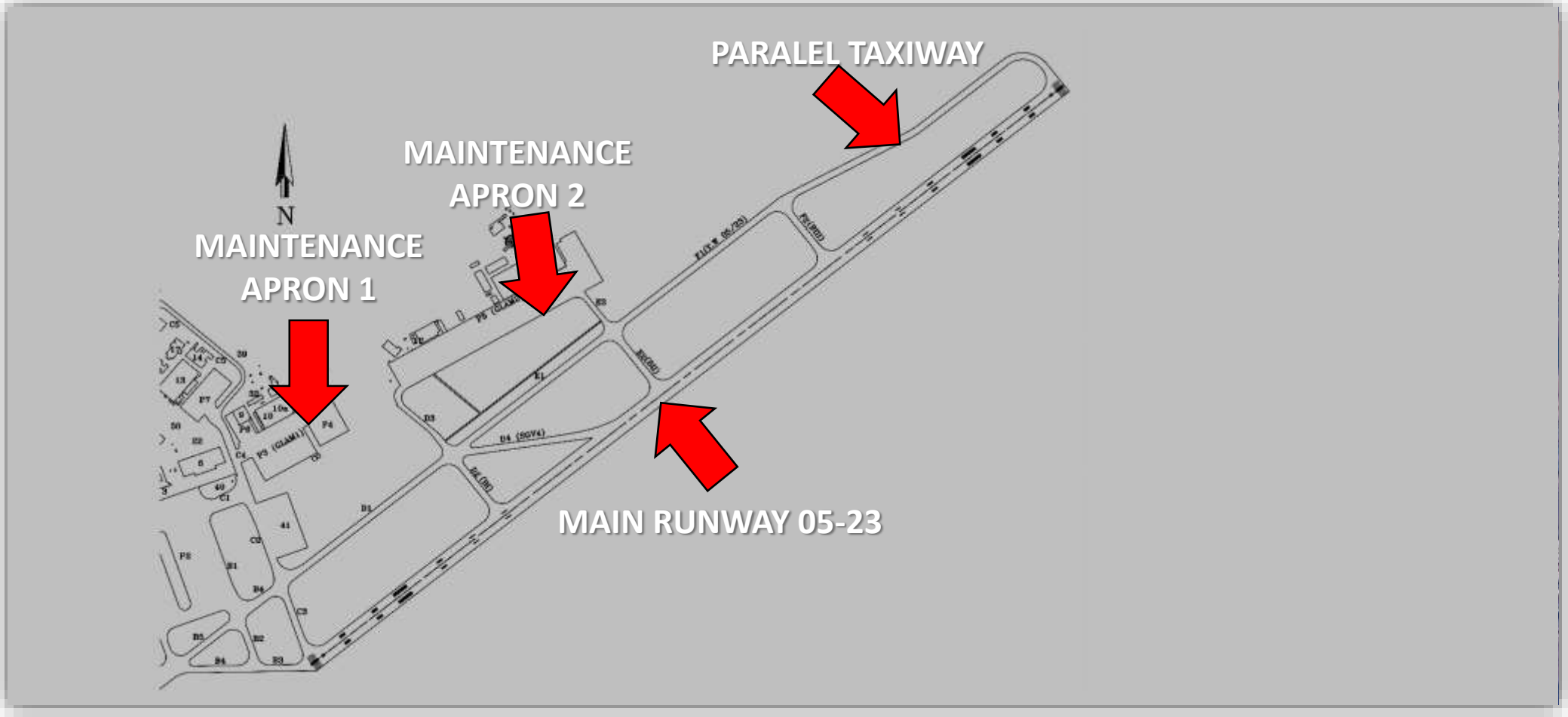
Houari Boumedienne International Airport - Algiers

- Rehabilitation and reinforcement of:

- Runway 3500 x 60 m
- Parallel taxiway 3650 x 25m
- Four 150 x 25 m taxilanes
- Parking platforms 36300 m^2 and 86000 m^2
- Infrastructures for installation of airfield lighting

- Analysis for use by the Airbus 380 aircraft.

Houari Boumedienne International Airport - Algiers



Houari Boumedienne International Airport - Algiers

MAIN RUNWAY 05-23 REHABILITATION

- 0-2500m built in 1960 prestressed concrete slab
- 2500-3500m extension plain concrete slabs 37cm thick
- Reinforcement in the 80's bituminous mix base and bituminous concrete wearing surface

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MAIN RUNWAY 05-23 REHABILITATION

Testing

- Scan with geo-radar
- Soil samples lab tested
- Complete runway profile
- Heavy weight deflectometer tests
- Core samples (bituminous and concrete layers)

Houari Boumedienne International Airport - Algiers

THE MAIN RUNWAY REHABILITATION

DESIGN

Elastic multilayer model using the Alizé software

Failure criteria

- limitation of fatigue cracking due to horizontal tensile strain at the bottom of the bituminous layers
- limitation of tensile stress in concrete cement layers
- limitation of vertical compressive strain on the top of the foundation soil

Traffic determined using the Federal Aviation Administration methodology, based on the last years of registered traffic and considering the annual growth defined by the Algerian airport authority. The departures of the various aircraft types were converted to Airbus 380 departures

Houari Boumedienne International Airport - Algiers

MAIN RUNWAY REHABILITATION

0 - 1 200 m

- milling of the existing asphalt layers exposing the prestressed concrete slab;
- high modulus bituminous dense mix reinforcement (average thickness of 20 cm);
- reinforcing glass fiber grid (40 x 40mm);
- high modulus bituminous concrete wearing course, 8 cm thick.

Houari Boumedienne International Airport - Algiers

MAIN RUNWAY REHABILITATION
1200 to 3500 m

- milling of the existing asphalt layers to a depth of 8cm
- high modulus bituminous dense mix reinforcement (average thickness of 15 cm);
- reinforcing glass fiber grid (40 x 40mm);
- high modulus bituminous concrete wearing course, 8 cm thick.

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MAIN RUNWAY REHABILITATION

SITE SITUATION

- milling of the existing asphalt layers - COMPLETED
- high modulus bituminous dense mix reinforcement – IN PROGRESS
- reinforcing glass fiber grid (40 x 40mm) – IN PROGRESS
- high modulus bituminous concrete wearing course – TO BEGIN AFTER INSTALATION OF RUNWAY LIGHTING CABLES

Houari Boumedienne International Airport - Algiers

Original prestressed slabs

- Overall good quality of anchor heads
- Only one failed in 2500 m
- Excellent quality of the concrete

Houari Boumedienne International Airport - Algiers

Problems with the high modulus bituminous mix (here at the maintenance apron).

- Adverse additive reaction with the bitumen.
  - A change of material solved the problem;
  - In 4 weeks the bituminous layer gained the specified modulus as the solvents evaporated.

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PARALEL TAXIWAY AND ACCES TAXIWAYS REHABILITATION

- Milling of the existing asphalt layers to a depth of 8 cm;
- high modulus asphalt concrete reinforcement with an average thickness of 10 cm.

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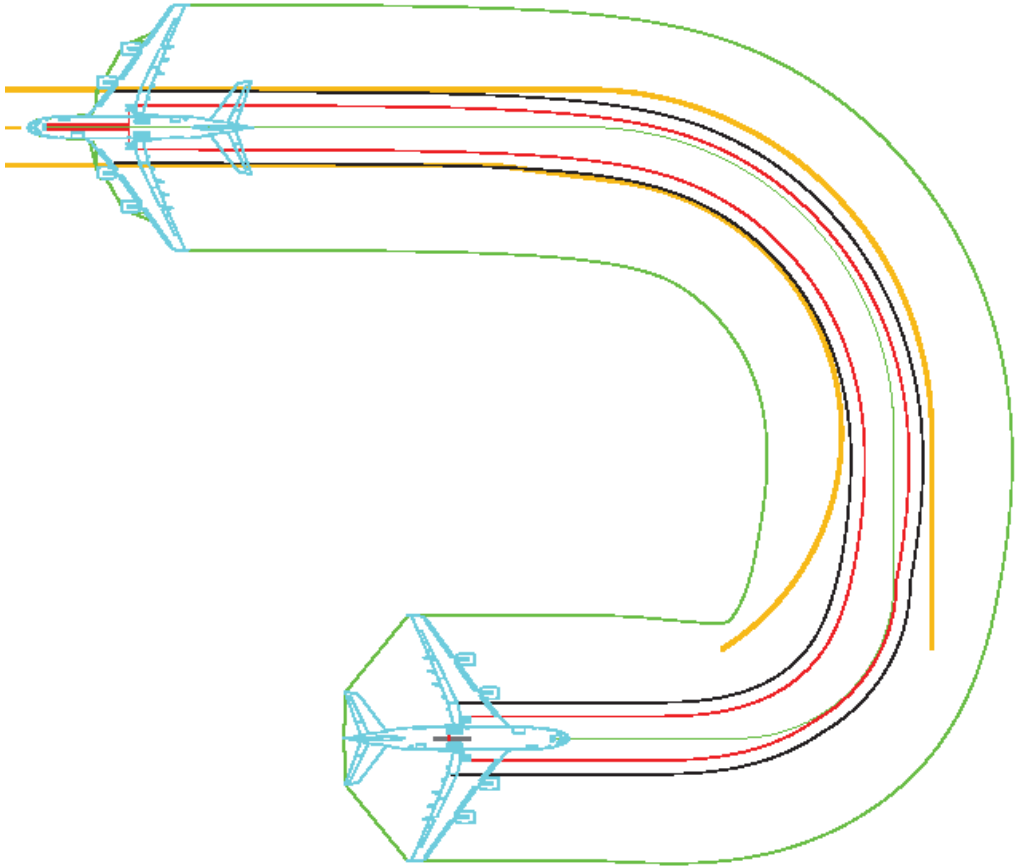
Widening of the taxiway pavement at intersections and shoulders to accommodate Airbus 380 (simulation using Civil 3D)



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MAINTENANCE APRONS REHABILITATION

Apron GLAMM 1

Total reconstruction of the pavement in progress

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MAINTENANCE APRONS REHABILITATION

Apron GLAMM 2

- Milling of the bituminous layer
- Sealing of concrete slabs joints
- Reinforcement with glass fiber grid
- High modulus bituminous concrete reinforcement (10 cm average thickness)

Houari Boumedienne International Airport - Algiers

APRON GLAMM 2

- Half of the platform in service
- Works continue for the second phase (milling of the bituminous layer finished)

Faro Airport - Portugal

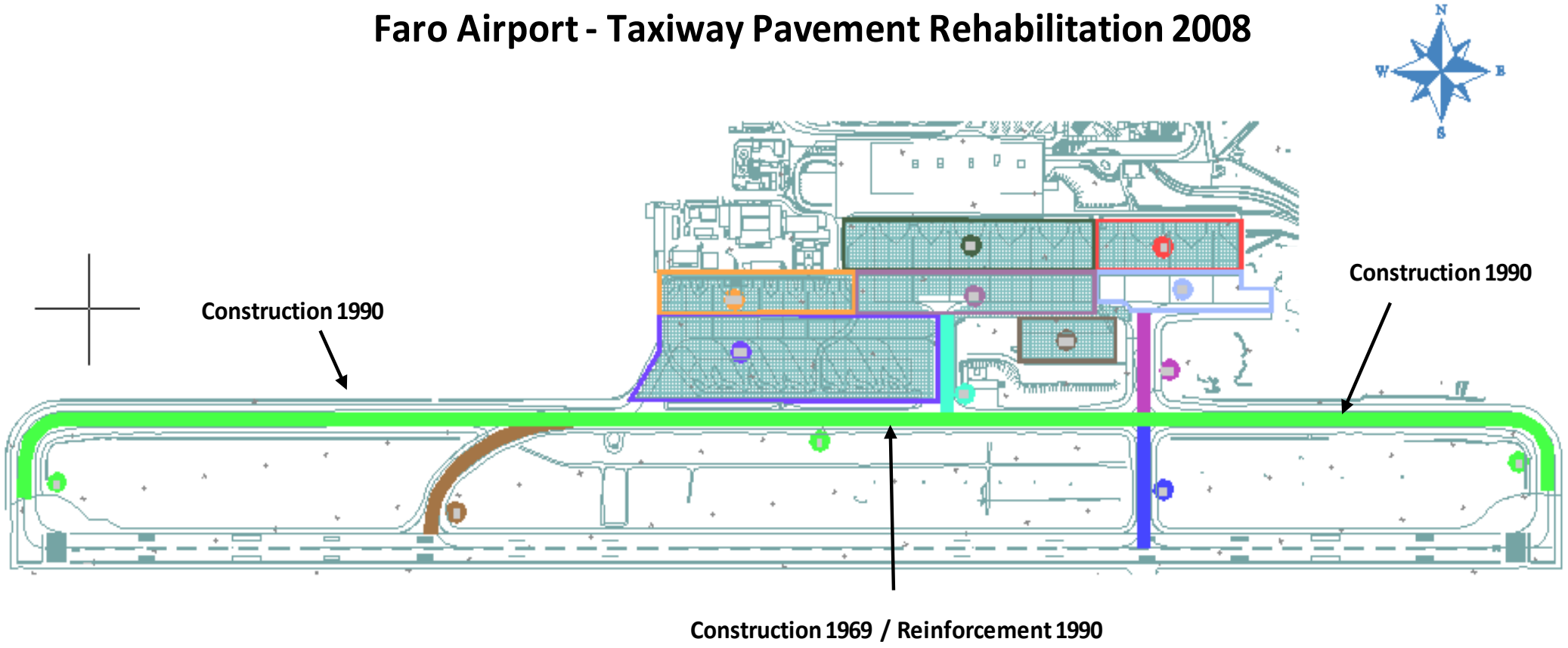
“P” TAXIWAY REHABILITATION

Original construction in 1969

- Reinforced in the central portion in 1990
- Extended to have the same length of the runway in 1990
- Pavement rehabilitation in 2008

Faro Airport - Portugal

Faro Airport - Taxiway Pavement Rehabilitation 2008



Faro Airport - Portugal

“P” TAXIWAY REHABILITATION

- Pavement in very poor condition
  - 40% of surface showing alligator cracking
  - 34% with raveling
- PCN (pavement classification number) ranging from 21 to 31

Faro Airport - Portugal

"P" TAXIWAY REHABILITATION

In the year 2008 the parallel taxiway of Faro Airport was rehabilitated to a required PCN value of 70 and expected traffic for at least 10 years. The design airplane was the Airbus 330. Rehabilitation works were:

- Milling of asphalt layers
- Placing a glass fiber grid to prevent/retard crack propagation in the cracked areas
- High modulus bituminous mix layer (with 10/20 pen bitumen)
- Wearing course in polymer modified AC (asphalt concrete) with 35/50 pen bitumen

Faro Airport - Portugal

MILLING EXISTING BITUMINOUS LAYER

PLACING HMBM LAYER

João Paulo II Airport - Portugal

NOVEMBER PLATFORM REHABILITATION

Flexible pavement:

- 7 cm of bituminous layers;
- 5 cm of bituminous semi-penetration layer;
- 15 cm of tout venant layer.

João Paulo II Airport - Portugal

NOVEMBER PLATFORM REHABILITATION

PAVEMENT CONDITION

- Alligator cracking;
- Longitudinal and transverse cracking (fatigue cracks);
- Raveling(with loss of material);

João Paulo II Airport - Portugal

NOVEMBER PLATFORM REHABILITATION

PAVEMENT CONDITION

- Longitudinal and transverse cracking (along the rigid pavement and shoulders);
- Patching (with open fissures along the edges).

João Paulo II Airport - Portugal

NOVEMBER PLATFORM REHABILITATION

Pavement rehabilitation designed:

- For a 15 years service life for the anticipated traffic, after converting the aircraft movements to the critical aircraft (C130 or Dash Q400);
- Or to ensure a PCN value equal to the ACN of the heaviest aircraft (C130).

João Paulo II Airport - Portugal

NOVEMBER PLATFORM REHABILITATION

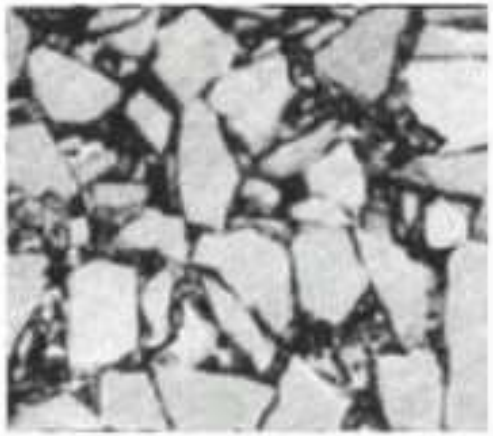
- ✓ Demolition of the existing layer of bituminous concrete to a thickness of about 7 cm;
- ✓ Demolition of the bituminous semi-penetration layer and top of the existing granular layer to a total thickness of about 8 cm;
- ✓ Scarification and compaction of the remaining granular layer to a thickness of 12 cm;
- ✓ Execution of the high modulus mixture base layer 10 cm thick;
- ✓ Execution of wearing course in bituminous concrete 5cm thick

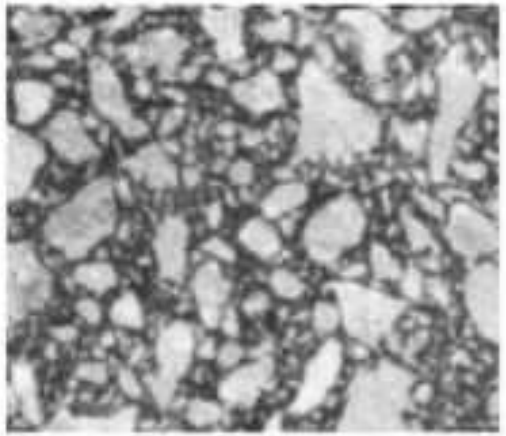
The specification for the high modulus bituminous mix considers the use of either a modified bitumen (incorporating resins) or and additive to reduce the penetration of the standard 35/60 bitumen.

SMA – Stone Matrix Asphalt

Definition

Stone Matrix Asphalt is a bituminous mix with an aggregate content that interlocks to resist deformation. The stone skeleton is filled with bituminous asphalt and fibbers are added to guarantee the uniform distribution of the bitumen in the mix.





A bituminous mix that is more resistant to long term deformation and durable than a conventional mix is obtained, due to the high bitumen content and to the use of fibbers.

Used initially for road construction this material has been used as a wearing course for airfield pavements.

Airport use in Portugal includes the rehabilitation of the runway of Faro Airport 2017-201,8 rehabilitation of taxiways at the Lisbon Airport and also works at Porto Airport

New airplanes for old airfields

The use of modern materials in rehabilitation of old airfield pavements, as shown in the examples above, allows for:

- Pavement structures of reduced thickness, compatible with the demands of new heavier aircraft, reducing the altimetric constrains of reinforcement works;
- More durable pavements with better riding quality .