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Title:

Trends in Bituminous Surfacings for Airfield Pavements

Authors:

Dr. Hans Christian Korsgaard, Department of Transportation, Carl Bro a/s, Denmark

J. Cook, Royal Airforce, Defence Estate Organisation (MOD), West Midlands, United Kingdom

ABSTRACT

Special requirements for airfields are driven by the need to design, construct and maintain airfield pavements that will satisfy the concerns of the international aviation community over potential safety issues. In comparison to roads, airfields for both military and civil air transport are subject to much greater loads, to much higher speeds, have more stringent standards of surface friction, have essentially different surface regularity requirements and higher standards for surface integrity, and are subject to more severe chemical treatment. These elements cannot be compromised in the process of harmonisation of standards.

Although the same materials are used in road construction as are used in airfield construction the performance requirements of airfield pavements are such that it is necessary to adopt a separate approach for the design and specification of airfield pavements to that used for roads and other trafficked areas. The four principal requirements that require special attention are:

a) Surface cleanliness, integrity and durability, b) Friction, c) Load classification, d) Roughness.

The maximum Aircraft Take Off Weights can be as high as 400 tonnes and the maximum single wheel load can be up to 30 tonnes in a triple tandem wheel configuration with tyre pressures up to 3 MN/m^2. Further, the speed varies from static load to velocities up to 300 km/h and the traffic frequency varies from almost no usage to much higher levels in channelized areas of runways and taxiways.

Runway evenness and the associated effects of longer wavelength variations in profile on airframe dynamic response is the subject of ongoing deliberations by ICAO.

Further, it is crucial that construction work on existing pavements provides long-term performance with minimal requirements for routine maintenance work.

Furthermore, the binder may have to be a fuel resistant binder and the binder may have to be resistant to de-icing agents.

The trends in airfield pavement technology are special requirements and use of special binders, special construction techniques and more advanced and intensive quality control.

1. Introduction

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2. National and International Obligations

Although the same materials are used in road construction as are used in airfield construction the performance requirements of airfield pavements are such that it is necessary to adopt a separate approach for the design and specification of airfield pavements to that used for roads and other trafficked areas. The four principal requirements that require special attention are:

- Surface cleanliness, integrity and durability
- Friction
- Load classification
- Evenness

In addition, the design, construction and operation of civil aerodromes (including airfield pavements) are covered by a set of International Standards and Recommended Practices issued by the International Civil Aviation Organization (ICAO). For military aerodromes the standards set by NATO or national military authorities will apply.

ICAO, whose headquarters are in Montreal, Canada, began it life in December 1944 with the signing of the Convention on International Civil Aviation by 52 states. From October 1947 ICAO became a specialized agency of the United Nations linked to the Economic and Social Council (ECOSOC). The above Convention set out the purpose of ICAO and stated, inter alia that "...the undersigned governments having agreed on certain principles and arrangements in order that international civil aviation may be developed in a safe and orderly manner and that international air transport services may be established on the basis of equality of opportunity and operated soundly and economically. "Each signatory country became responsible for setting and regulating standards of safety and operation within its own borders but to an agreed minimum standard. In the year 2000 there were 185 signatory States.

All European countries are contracting states to ICAO and as such are obliged to design and specify airfield pavements in accordance with these standards and practices. Furthermore, in some countries designers and specifiers must comply with higher standards laid down by their respective national regulatory authority for civil aviation.

3. Loads on Airfield Pavements

Airport pavements are complex structural systems and their performance depends on a broad spectrum of variables. The most important variables are those that relate to the imposed loadings. The load variables depend primarily on the size and number of aircraft that comprise the aircraft mix. The design of airfield pavement is complicated by the rapidly changing state of aircraft design technology. The introduction of larger and heavier aircrafts as well as changes in wheel loads, gear configurations, tire pressures and other load variables significantly affect the performance of airfield pavements.

The load variables that have a critical influence on airfield pavement performance are:

a) **Magnitude of Loadings:**

Maximum Aircraft Take Off Weights can be as high as 400 tonnes.

Maximum single wheel load can be up to 28 tonnes.

b) **Undercarriage Configuration**

1, 2, 4 or 6 wheels per gear.

c) **Tire Pressure**

Commercial aircraft: Tire pressures up to $2MN/m^2$
Military aircraft: Tire pressures up to $3MN/m^2$

d) **Types of Loadings:**

Static loads: Parking areas and holding points
Dynamic loads: All parts of the aerodrome where aircraft are moving.

These may be vertical loads or horizontal shear loads or a combination of the two.

The velocity of the aircraft varies from 0 when waiting on taxiways and before start on runways to velocities at 300 km/hr. ?????

4. Functional Requirements of Airfield Pavements

4.1 Surface Integrity and Durability

Two of the main functional requirements of airfield pavements are surface integrity and durability. In addition to supporting the imposed loads of aircrafts the pavement must also be resistant to jet blast, fuel, oils, hydraulic fluid and de-icing chemical/fluids.

De-icing chemicals used on airfields are generally different from those used on roads because of the stringent anti-corrosion requirements for airframes and aircraft components, together with normal environmental requirements. Some of these chemicals have been found to have deleterious effects on bituminous binders and mixed materials and so special tests are required as described below.

Durability and surface condition requirements are mainly driven by the following considerations:

a. Pavements that ravel, spall or crack are a potential source of debris. Debris or foreign matter on airfield pavement are a Foreign Object Damage (FOD) risk to aircrafts. This risk applies to all aircraft operation but is particularly critical for jet engined aircrafts because of the potential for debris being blasted an sucked into engine intakes especially where aircrafts are taxiing and taking off in proximity to each other, or taking off in formation on military runways. In addition, surfaces must not contain sharp edges, which might endanger aircrafts.
b. With the new generation of high performance turbofan engines, tests and experience have shown that loose material in joints/cracks can present a direct FOD risk. Also, the blast and heat from jet engine efflux, typically 400 ks aft air velocity at take off thrust for the Boing 777 and temperatures from military jets capable of melting asphalts, have a major degrading effect on bituminous surfaces.

4.2 Friction

The ICAO Aerodrome Design manual Part 3 states that a runway pavement should be designed and maintained so as to:

a. provide in all anticipated conditions of wetness, high friction levels and uniform friction characteristics and
b. minimize the potential risks of all forms of aquaplaning.

It has been established that the principal way to achieve the above requirements is to provide a runway surface with an open macro texture. If a runway has a good macro allowing the water to escape beneath the tire, then the friction value normally will be less affected by speed. Aircraft speed on runways can be as high as 270 km/hr.

Adequate macro texture of bituminous mixtures can be achieved by providing either porous friction course (porous asphalt), transverse grooving or anti-skid surfacing etc.

Reference shall be made to minimum friction requirements set out in the ICAO Aerodrome Design Manual Part 3 and where appropriate to the higher requirements laid down by the relevant national aerodrome licensing authority or military standards authority.

Such standards designate the friction characteristic test equipment, test speed, design objective for a new surface, maintenance planning level, minimum friction level and test water depth to be sued, and shall be strictly complied with.

5. Other Special Considerations

a) It is generally very difficult to gain access to airfield pavements in order to carry out maintenance work. Unlike roads it is not feasible to hand over sections of runways and taxiways for maintenance work. The withdrawal of runway and taxiways from service can have serious commercial, operational and planning implications at both civil and military airports. Hence, it is crucial that construction work on existing pavements provides long-term performance with minimal requirements for routine maintenance work.
b) Achieving adequate surface integrity and durability can conflict with the friction requirement. Achieving a suitable balance with ensures that requirements are fully met is a very special consideration in determining specifications for airfield surfacing materials.
c) In the Nordic countries there is a need for special binder properties to withstand low temperature cracking and subsequent Foreign Object Damage (FOD) to engines and consequently to aircraft should an engine fire result.

6. SPECIAL REQUIREMENTS

Detailed specifications for bituminous mixtures for airfields have evolved in the light of experience over many years and the achievable functional properties and surface characteristics have been linked to definable mixture constituents and finishing techniques. Similarly, a substantive correlation has been established between longevity in the field and certain laboratory tests such as the tests for aggregate soundness and compatibility between aggregate and bitumen, thus ensuring the required surface integrity and durability.

Due to the nature of aircraft refueling operations where either component failure or human error may lead to inadvertent spillage of kerosene (the hydrocarbon being the main component of aviation fuel) on the pavement, softening of a normal bituminous binder would occur, resulting in deformation of the surface under load and subsequent disintegration of the wearing course material. Spillage may also occur at other locations due to venting of aircraft fuel tanks during certain maneuvers. Although designated refueling areas are normally constructed in Portland cement concrete or proprietary fuel resistant material, this may not be possible in some locations for logistical or economic reasons. Hence the requirement for fuel resistant binders.

To maintain an airfield in a safe operations condition during freezing temperatures or when snow is present or to prevent the formation of ice or build up of snow on the surface when such conditions are forecast, an airport operator must apply chemical de-icing agents either in liquid or solid format to the appropriate surfaces of the aerodrome. Chemical agents must be proven not to be injurious to aircraft components and airframe and must also be compliant with EU-environmental requirements.

Certain generic types of the de-icing agent used on airfields for the reasons explained have been shown in certain circumstances to cause or at the very least to contribute towards, the rapid disintegration of some bituminous mixtures by dissolving or stripping the binder. The Civil Aviation Administration of Norway and Sweden have jointly developed through a programme of research, test methods to evaluate the potential effects of de-icing agents on both bituminous binder and bituminous mixtures.

Special requirements can be:

- Special requirements in relation to de-icing agents
- Special viscosity requirements
- Compatibility between aggregates and bitumen
- Special requirements in relation to resistance to fuel for asphalt mixtures
- Resistance of asphalt concrete for airfields to de-icing fluid
- Special requirements to water sensitivity
- Additional requirements for higher percentage of totally crushed aggregate on aggregates and grading
- Additional soundness requirements

6.1 Field of Application

When asphalt concrete is used as a surface course on airfield runways the pavement might have to be grooved in order to prevent aquaplaning. Specification of the grooves can be provided by CAA/MOD in each country.

6.2 Site Trials

The high risks involved in airfield pavement engineering and the consequent onerous functional requirements can make bituminous mix design super critical. It will therefore often be necessary to include an additional requirement for site trials as an integral part of the mix design process.

The relevant mixture Product Standard shall provide for a site trial of the designated mixture under conditions similar to those which would apply for full scale application in order to establish that the specified properties and functional requirements of surface integrity/FOD susceptibility, friction, surface texture and evenness can be achieved through the Contractor's proposed method of laying and compaction.

Such properties and requirements, together with the size of the trial area and the conditions under which it is to be laid, shall be stated in the Contract Specification.

Should the specified properties and functional requirements not be achieved at the site trial then either the method of laying, compaction and finishing shall be modified or the mixture composition modified within the limits specified until the requirements are met.

Surface friction, texture depth, surface evenness and surface integrity shall all meet the relevant ICAO and NATO specified requirements.

7. SUMMARY

In summary, critical safety considerations, onerous failure criteria and the need for long-term durability result in special requirements for the quality of airfield pavement materials.