Transport Canada Transports Canada

Advisory Circular

Subject: **Thin Bituminous Surface Runways**

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1.0 Introduction

(1) This Advisory Circular (AC) is provided for information and guidance purposes. It describes an example of an acceptable means, but not the only means, of demonstrating compliance with regulations and standards. This AC on its own does not change, create, amend or permit deviations from regulatory requirements, nor does it establish minimum standards.

1.1 Purpose

(1) The purpose of this document is to define what may constitute a thin bituminous surface runway. Further, this document outlines methodologies for the measurement and reporting of surface shear strength of thin bituminous surface. In addition, the document outlines recommended practices for pavement construction, condition inspection, maintenance, and repair of aerodrome thin bituminous surface pavements.

1.2 Applicability

(1) This document applies to aerodrome operators.

1.3 Description of changes

(1) Not applicable.

2.0 References and requirements

2.1 Reference documents

(1) It is intended that the following reference materials be used in conjunction with this document:

- (a) *Aeronautics Act* (R.S., 1985, c. A-2);
- (b) Part III, Subpart 01 of the *Canadian Aviation Regulations* (CARs) — Aerodromes;
- (c) Part III, Subpart 02 of the CARs — Airports;
- (d) Transport Canada Publication (TP) 312 5th Edition, Amendment 1 – Aerodrome Standards and Recommended Practices;
- (e) Advisory Circular (AC) 300-004 – Unpaved Runway Surfaces;
- (f) AC 302-011 – Airport Pavement Bearing Strength Reporting;
- (g) AC 302-017 – Runway Friction Measurement;
- (h) AC 302-023 – Measurement and Evaluation of Runway Roughness;
- (i) TP 14371 – Transport Canada Aeronautical Information Manual (TC AIM);
- (j) Federal Aviation Administration Advisory Circular (FAA AC) 150-5320-6G, 2021-06-07 – Airport Pavement Design and Evaluation;
- (k) International Civil Aviation Organization (ICAO) Annex 14 to the Convention on International Civil Aviation – International Standards and Recommended Practices: Aerodromes (Seventh Edition, July 2016);
- (l) ICAO Doc 9157-AN/901 – Aerodrome Design Manual, Part 3 Pavements (Second Edition, 1983);

(m) NAV CANADA – Canada Flight Supplement – Canada and North Atlantic Terminal and Enroute Data (updated and published every 56 days);

(n) Boeing Document No. D6-24555, 1984-04-05 – High Load Penetrometer Soil Strength Tester;

(o) American Society for Testing and Materials (ASTM) D2487, 2011 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System);

(p) ASTM D4429, 2009 – Standard Test Method for the CBR (California Bearing Ratio) of Soils in Place;

(q) Transportation Association of Canada – Pavement Asset Design and Management Guide (December 2013);

(r) Minnesota Department of Transportation – Minnesota Seal Coat Handbook (2006); and

(s) Guide to Sealed Granular Airport Pavements in Saskatchewan- Saskatchewan Ministry of Highways (2021)

2.2 Cancelled documents

(1) Not applicable.

(2) By default, it is understood that the publication of a new issue of a document automatically renders any earlier issues of the same document null and void.

2.3 Definitions and abbreviations

(1) The following **definitions** are used in this document:

(a) **Aircraft Classification Number (ACN)**: a number expressing the relative structural loading effect of an aircraft on a pavement for a specified standard subgrade category (ICAO pavement strength reporting format).

(b) **California Bearing Ratio (CBR)**: a measure of the load bearing capacity of a given sample of soil expressed as a ratio relative to the load bearing capacity of crushed limestone.

Note: The load bearing capacity of crushed limestone is expressed as a CBR of 100.

(c) **Pavement Classification Number (PCN)**: a number expressing the bearing strength of a pavement for unrestricted operations (ICAO pavement strength reporting format).

(d) **Unpaved Runway Surface**: a runway surface comprised of gravel, turf, clay or hard packed soil mixtures. Unpaved runway surface can be manually constructed pavements or naturally occurring unprepared surfaces.

(e) **Thin Bituminous Surface Runway**: A runway pavement structure meeting the criteria of a Class 3 Thin Bituminous Surface as defined by the Transportation Association of Canada. The structure is comprised of a double sealed granular surface layer, and one or more granular base layers. Thin Bituminous Surface Runways are distinct and separate from Surface Treated Runways, as defined in Advisory Circular 300-004 Unpaved Runway Surfaces.

(2) The following **abbreviations** are used in this document:

(a) **AC**: Advisory Circular;

(b) **ACN**: Aircraft Classification Number;

(c) **ASTM**: American Society for Testing and Materials;

(d) **CAR**: *Canadian Aviation Regulations;*

(e) **CBR**: California Bearing Ratio;

(f) **CRFI**: Canadian Runway Friction Index;

(g) **ICAO**: International Civil Aviation Organization;

(h) **PCN**: Pavement Classification Number;

(i) **TCCA**: Transport Canada Civil Aviation; and

(j) **TBS**: Thin Bituminous Surface.

3.0 Background

(1) Thin bituminous surfaces (TBS) are a broad class of surface treatments, which have a variety of performance characteristics. Several common terms for pavement types within this classification include: surface treatments, chip seals, slurry seals, sealed granular surface treatments, sealed granular pavements, etc. The Transportation Association of Canada groups these different treatments into three main structural categories: Class 1, Class 2, and Class 3 (Transportation Association of Canada, 2013).

(2) Class 3 TBS pavements may be considered to meet the definition of a thin bituminous surface runway as defined in this AC. Class 3 TBS are staged construction. Initially, full depths of base and subbase are placed with a TBS surface instead of Hot-Mix Asphalt (Transportation Association of Canada, 2013). While TBS generally do not add any structural performance to the pavement structure, they do impart several benefits compared to granular runways including: improved surface drainage, reduced surface water infiltration, improved friction, and reduced rolling resistance.

(3) Class 1 and Class 2 treatments will continue to be considered as surface treated runways (i.e., gravel runway). Refer to AC 300-004 – Unpaved Runway Surfaces for guidance respecting surface treated runways.

(4) Aerodrome operators should consult qualified pavement engineers prior to constructing or converting existing facilities, where this expertise is lacking in-house.

4.0 Acceptable thin bituminous surface pavement structures

(1) An acceptable thin bituminous surface pavement should consist of three main components:

(a) a double sealed granular pavement surface treatment;

(b) a granular base; and

(c) a granular subbase and/or a prepared subgrade underlying the structure.

(2) Newly built TBS runways require sufficient curing time to provide a competent and durable operational surface. Due to the time required for the bituminous emulsion to cure and potential for aggregate loss from the treated surface, newly built TBS runways should be considered as a gravel runway until such time as:

(a) the pavement has undergone at least one cycle of seasonal spring thaws and the moisture content of the underlying granular layers has stabilized;

(b) subsequently, at least one thorough sweeping of the full runway width has been completed; and

(c) the thin bituminous surface has been inspected and has cured.

4.1 Sealed granular surface treatment

(1) At a minimum, the sealed granular surface treatment should be comprised of two lifts, totaling a thickness of approximately 20 to 25 mm.

(2) Adequate curing time of each lift is necessary prior to the application of subsequent granular seal lifts.

(3) Well-graded aggregates have been successfully used for this application in Canada.

(4) Asphalt binder selection should be made in consideration of the aerodrome's region-specific needs.

4.2 Granular base

(1) As with gravel runways, thin bituminous surface runways derive their load bearing strength from the granular layers and the soil properties of the in-situ soil. The type, number, and thickness of granular layers is determined based on airport specific needs.

4.3 Granular subbase

(1) A granular subbase may also be incorporated into the structural capacity of the pavement.

4.4 Subgrade

(1) The naturally occurring soils upon which the pavement structure is built can have a significant impact on the type and depth of overlaying pavement layers.

(2) Thorough knowledge of existing soil characteristics is vital to the successful design and efficient operation of a pavement structure.

5.0 Soil properties and frost effects on pavements

5.1 In-situ soil classification and properties

(1) The standard method of classifying soils for engineering purposes is given in American Society for Testing and Materials (ASTM) D2487 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System). One of the purposes of soil classification is to predict the probable behavior of soils under the influence of frost and moisture.

(2) The Unified System classifies soils first on the basis of grain size (coarse grained and fine grained soils), then further subgroups soils based on the plasticity constants. Soils are expressed by soil group symbols (e.g., GW, which is described as "Well graded gravel and gravel sand mixtures, little or no fines").

(3) The California Bearing Ratio (CBR) provides a measure of the ability of a TBS pavement to resist shearing under aircraft loads. Appendix A of Federal Aviation Administration (FAA) AC 150-5320-6G – Airport Pavement Design and Evaluation gives an estimated range of field CBR values of 60-80 for well graded gravel soils and 20-40 for well graded sands. The potential for frost action for these soils is minimal, with low compressibility and expansive characteristics, while also possessing excellent drainage characteristics in general. The presence of clays and/or silts typically results in reduced strength characteristics and increased frost susceptibility.

(4) The use of a soil classification system such as the Unified Soil Classification System, may be useful as a check on the suitability of in-situ materials, or for knowledge of expected vulnerabilities within the pavement structure.

5.2 Frost effects

(1) Gravel surfaces have the advantage of being easily re-graded to eliminate roughness arising from frost effects. Consequently, subject to operational requirements, they may be the preferred type of surface in areas having severe frost effects. The severity and likelihood of frost effects should be carefully assessed prior to the conversion of existing gravel runways to a TBS runway.

(2) The detrimental effects of frost heave include surface roughness from non-uniform heave and loss of base and/or subgrade strength during frost melt. Other effects may include loss of compaction, restriction of drainage and deterioration of the surface. Conditions promoting detrimental frost heave are a frost susceptible soil, freezing temperatures penetrating the frost susceptible soil, and sufficient moisture to form expansionary ice lenses in the soil. The presence of salts (whether from clays or introduced from de-icing chemicals) can amplify the formation of ice lenses within the pavement structure.

(3) Generally, coarse grained soils such as gravels and sands have low frost susceptibility, silts have high frost susceptibility, and clays are moderately susceptible to frost. The depth of frost penetration is a function of the thermal properties of the pavement and soil mass, moisture content, and the severity of air/surface temperatures.

(4) For pavements constructed in areas exposed to seasonal frost and on frost susceptible subgrade soils, pavement roughness resulting from frost heaving is controlled by providing a sufficient thickness of non-frost susceptible material to limit the depth of frost penetration into the subgrade and to counteract the expansive forces. Adequate drainage can also limit the reduction to pavement bearing strength during the critical frost melting period, when pavements are most vulnerable.

(5) Permafrost occurs in arctic regions where soils may be frozen to considerable depth year-round. Seasonal thawing and re-freezing of the uppermost soil layer (the active layer) can lead to severe loss of bearing strength and differential heave and/or settlement. The design of pavements in permafrost regions should consider the depth of the active layer. Pavement construction usually increases the depth of the active layer, which often results in large and continuous post-construction settlements (particularly when the newly thawed subgrade soil had a high ice content).

6.0 Strength measurement and reporting

(1) Similar to gravel runway pavement structures, the amount of surface deflection under an applied load is dependent on subgrade bearing strength and overall thickness of the gravel base layer(s). Thus, the ability of a TBS runway to structurally support the aircraft load is primarily attributed to the base layer(s) and the subgrade. The overall loading capacity of a runway pavement structure is expressed as a Pavement Classification Number (PCN) in accordance with AC 302-011 – Airport Pavement Bearing Strength Reporting. Pavement type should be specified as Flexible, code F, and a note should be included specifying Thin Bituminous Surface.

(2) Publication of California Bearing Ratio (CBR) values may be provided in conjunction with the PCN value publication specified above. CBR values may be beneficial to air operators in the determination of tire pressure limitations for aircraft operation on the runway surface. Refer to AC 300-004 – Unpaved Runway Surfaces for guidance on CBR measurements.

(3) TBS pavements typically possess a relatively low shear strength when compared to traditional asphalt pavements or Portland cement concrete pavements. However, TBS shear strength is typically higher when compared against gravel or other unpaved runway surfaces. TBS shear strength may impact allowable aircraft loads imposed on the runway, particularly when wet conditions may be present at partial or full pavement structure depth. Operational restrictions may be necessary, such as the prohibition of locked-wheel turns on the runway.

(4) After prolonged extreme precipitation events and spring thaws, care should be taken in monitoring pavement strength until such time as moisture levels within the pavement structure stabilize. The pavement structure is typically at its weakest state under these circumstances. It may be necessary to implement weight restrictions and/or tire pressure limitations until such time as the pavement structure returns to more moderate moisture contents.

6.1 Determination of tire pressure restrictions

(1) Refer to AC 300-004 – Unpaved Runway Surfaces for guidance on the determination of tire pressure restrictions.

(2) The aerodrome operator should make use of local knowledge and climatic data to impose tire pressure restrictions at their discretion, as conditions may warrant.

7.0 Friction measurement

(1) While TBS pavements do not strictly meet the definition of paved surfaces in TP 312, the surface provided behaves similarly to these hard paved surfaces in some respects. With respect to friction measurement, TBS pavements are to be considered as paved surfaces in TP 312.

(2) Reference AC 302-017 – Runway Friction Measurement for guidance on methodologies for the measurement, evaluation, and maintenance of airport pavement surface friction. In addition, the document outlines performance specifications and correlation methods for Continuous Friction Measuring Equipment.

(3) Airport operators are subject to CAR 302.416, which specifies the requirement to measure and report the Canadian Runway Friction Index (CRFI). CAR 302.416(2) may no longer be applicable for runways which have been converted from gravel to TBS.

8.0 Markings

(1) With respect to markings, TBS pavements are to be considered as paved surfaces, and therefore are subject to markings requirements as specified in TP 312.

9.0 Slope gradients

(1) For adequate surface drainage and to prevent ponding, TBS runways and taxiways should have a centreline crown with a transverse slope of 2 to 2.5 %, in keeping with slopes typical of unpaved runways (see Section 3.1.2.6 of TP 312). Flatter grades are required on aircraft parking aprons and refueling areas.

(2) Where possible, a downward slope should be provided along the runway shoulders for a distance of 60 to 75 metres (about 200 to 250 feet) from each side of runway centreline.

10.0 Construction best practices

(1) This section provides an overview of best practices with respect to TBS construction.

(2) When converting existing gravel runways to a TBS pavement, it may be appropriate to improve the quality or increase the depth of existing granular layers and/or subgrade, prior to surface treatment.

10.1 Subgrade and construction of granular layers

(1) Preparation of subgrade and granular layers are typically performed like gravel runways.

(2) Where a period of weeks or longer will pass between preparation of the granular layers and sealed granular surface application, additional care must be taken to maintain integrity of the finished surface. An exposed granular surface may experience loss of moisture content. In combination with traffic wear, the surface may deteriorate from raveling and loss of granular material, ultimately requiring rework prior to sealed granular treatment. When sealed granular surface application will be delayed, the application of an asphalt emulsion prime coat should be applied to the granular surface as soon as possible to protect surface integrity of the granular layer.

(3) If the granular base course layer is to be stabilized with an asphalt emulsion, the mix design should be completed by a qualified testing laboratory. Asphalt emulsified stabilization of the base course may reduce or eliminate the need for a prime coat.

(4) Final grade is achieved with the granular base course layer, since sealed granular surface treatments will not appreciably correct variations in the granular base course surface.

10.2 Sealed granular surface treatment

(1) Prior to sealed granular surface application, the granular base course should be inspected and repaired, as necessary. Any surface failures should be repaired and primed prior to placement of the sealed granular surface treatment. The surface must be swept clean of dust, aggregate and excess moisture.

(2) Proof of calibration should be provided for the asphalt distributor and aggregate spreader prior to application of the sealed granular surface. Before application, and whenever changes in operation occur, the asphalt emulsion application rate and aggregate application rates should be verified.

(3) Sealed granular surface treatments rely on the mechanical energy from compaction to embed the aggregate into the asphalt emulsion. Pneumatic tire rollers or rubber coated steel drum rollers in static mode have been used successfully for this purpose. Pneumatic tire rollers are well suited for this type of application as they apply uniform pressure onto the aggregate without crushing the aggregate. When using steel drum rollers, the equipment weight should be selected carefully to prevent crushing of surface aggregate. In contrast to roadways, runways experience lower traffic volumes, but higher shear stress from aircraft loads. Maximizing the amount of rolling is critical to provide aggregate embedment and ensure surface longevity for aircraft operations.

(4) After rolling, while the surface may look set, it is not yet fully cured and aggregate adhesion is not fully developed. The surface remains susceptible to damage by traffic, particularly in the presence of rain, cold temperatures, or high humidity. While sweeping of loose aggregate is typically commenced soon after construction on roadways, the first sweep should be delayed as long as possible on runways to allow further curing and improve aggregate retention. Sweeping is performed prior to application of the second sealed granular surface treatment. After placement of the second treatment, the surface should be swept two to three times within a week.

(5) The runway should be operated as a gravel runway through the first winter season. After conclusion of winter operations, the runway should be swept again until a surface free of loose aggregate is achieved to allow operations as a TBS runway.

(6) While curing, sealed granular surface treatments are highly susceptible to damage from traffic and winter maintenance operations. Final sealed granular surface application should be completed as early as possible before the winter season to maximize the number of curing days with average daily temperatures above 10 degrees Celsius. Studies have shown sealed granular

surface treatments with less than 30 days curing above 10 degrees Celsius are particularly vulnerable to damage from winter maintenance operations.

11.0 Maintenance and repair of thin bituminous surfaces

11.1 Condition inspection of thin bituminous surfaces

(1) The maintenance work necessary to keep TBS runways in a safe operational condition is normally determined through periodic condition inspections. The technical features to consider during these inspections include slope gradients, drainage patterns, the identification of soft and wet spots, the presence of cracking, the presence of raveling, and areas of frost heave.

(2) During the winter season, the boundaries of frost heave should be observed and marked. These areas should be planned for replacement of unsuitable (frost susceptible) material down beyond the level of frost penetration. This work should be done when no frost is present.

11.2 Crack sealing

(1) Crack sealing should be performed as a component of routine maintenance on TBS runways. Crack sealing prevents infiltration of water from the runway surface into the base and subbase materials, which could otherwise lead to premature failure of the runway surface. Crack sealing is best conducted in the spring when cracks are at their widest and to limit the amount of time moisture can infiltrate the pavement structure. Crack routing and cleaning as with asphalt pavements is not feasible with TBS runways; products and techniques particular to sealed granular surfaces should be used.

11.3 Pothole patching

(1) Cold mix asphalt is an effective product for hand patching of minor surface defects on TBS runways. These types of surface defects are non-structural in nature and may include areas of localized shear failure or surface edges damaged from winter maintenance equipment. For best results, the area should be clean, dry, and an asphalt tack coat should be applied for improved bonding of the cold mix asphalt. After placement, the cold mix asphalt should be compacted. Completed patches should provide a uniform, flush surface with the surrounding runway surface and be swept clean of any loose debris.

11.4 Spot sealing

(1) Spot sealing is an effective treatment for larger areas of non-structural surface defects. Spot sealing is performed in the same manner and with the same materials used for initial sealed granular surface treatment.

11.5 Full and partial depth rehabilitation

(1) Structural rehabilitations, including full and partial depth rehabilitations, are required when larger areas of poor surface condition are present on the runway. These treatments typically include thorough mixing of the existing surface into the granular base layer followed by compaction. Additional placement of granular base materials may also be necessary. The surface is then prepared in the same manner as initial application.

11.6 Re-sealing

(1) Where the friction characteristics of an aged runway surface have deteriorated, but structural performance of the pavement remains suitable, a single sealed granular surface treatment can be applied to the full runway surface. Re-sealing serves to restore the frictional characteristics of the runway wearing surface and maintain the waterproofing of the runway surface. Treatment is applied similar to an initial sealed granular surface treatment application.

12.0 Conclusion

(1) Thin bituminous surface pavements offer improved operational performance to gravel pavements. TBS pavement bearing strength is reported as a PCN. CBR values may also be included with the strength publication.

(2) An acceptable thin bituminous surface pavement should consist of three main components:

- (a) a double sealed granular pavement surface treatment;
- (b) a granular base; and
- (c) a granular subbase and/or a prepared subgrade underlying the structure.

(3) Due to the time required for the bituminous emulsion to cure and potential for aggregate loss from the treated surface, newly built TBS runways should be considered as a gravel runway until such time as:

- (a) the pavement has undergone at least one cycle of seasonal spring thaws and the moisture content of the underlying granular layers has stabilized;
- (b) subsequently, at least one thorough sweeping of the full runway width has been completed; and
- (c) the bituminous surface has been inspected and has cured.

(4) Airport operators are subject to CAR 302.416, which specifies the requirement to measure and report the Canadian Runway Friction Index (CRFI). CAR 302.416(2) may no longer be applicable for runways which have been converted from gravel to TBS.

(5) TBS pavements should be considered as hard surfaced pavements with respect to markings and friction measurement as specified in TP 312.

13.0 Information management

(1) Not applicable.

14.0 Document history

(1) Not applicable.

15.0 Contact office

For more information, please contact:
http://www.tc.gc.ca/eng/regions.htm

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