

Pavement Surface Evaluation and Rating

PASER

Asphalt Airfield Pavements

Manual



RATING
5



RATING
3



RATING
1



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This manual is intended to assist airfield managers in understanding and rating the surface condition of asphalt pavement. It describes types and causes of defects and provides a simple system to visually rate pavement condition.

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Pavement Surface Evaluation and Rating

PASER Asphalt Airfield Pavements Manual

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PASER — Pavement Surface Evaluation and Rating

Asphalt Airfield Pavements

An airport manager's goal is to use available funds to provide a safe and economical pavement surface—no simple task. It requires balancing priorities and making difficult decisions in order to manage pavements. General aviation airfield pavements are often managed informally, based on the staff's judgment and experience. While this process is both important and functional, using a slightly more formalized technique can make it easier to manage pavements effectively.

Experience has shown that there are three especially useful steps in managing pavements:

- 1) Inventory all pavements.
- 2) Periodically evaluate the condition of all pavements.
- 3) Use the condition evaluations to set priorities for projects and evaluate alternative treatments.

A comprehensive pavement management system involves collecting data and assessing several pavement characteristics: roughness, surface distress (condition), surface skid characteristics, drainage, and structure (pavement strength and deflection). Planners can combine this condition data with economic analysis, to develop short-range and long-range plans for a variety of budget levels. However, general aviation agencies may lack the resources for such a full-scale system.

Since surface condition is the most vital element in any pavement management system, managers may use the simplified rating system presented in this manual on asphalt airfield pavements to evaluate their asphalt pavements. A PASER manual for concrete airfield pavements is also available (see references, page 24).

Evaluating pavement condition

PASER uses visual inspection to evaluate pavement surface conditions. The key to a useful evaluation is identifying different types of pavement distress and linking them to a cause. Understanding the cause for current conditions is important in selecting an appropriate maintenance or rehabilitation technique.

There are four major categories of common asphalt pavement surface distress:

Surface defects

Raveling, flushing, polishing.

Surface deformation

Rutting, distortion — rippling and shoving, settling, frost heave.

Cracks

Thermal, reflection, slippage, joint/edge, block, and alligator cracks.

Patches and potholes

Deterioration has two general causes: environmental due to weathering and aging, and structural caused by repeated traffic loadings.

Obviously, most pavement deterioration results from both environmental and structural causes. However, it is important to try to distinguish between the two in order to select the most effective rehabilitation techniques.

The rate at which pavement deteriorates depends on its environment, traffic loading conditions, original construction quality, and interim maintenance procedures. Poor quality materials or poor construction procedures can significantly reduce the life of a pavement. As a result, two pavements constructed at the same time may have significantly different lives, or certain portions of a pavement may deteriorate more rapidly than others. On the other hand, timely and effective maintenance can extend a pavement's life. Crack sealing and surface treatments (such as slurry seal) can reduce the effect of moisture in aging of asphalt pavement.

With all of these variables, it is easy to see why pavements deteriorate at various rates and why we find them in various stages of disrepair. Recognizing defects and understanding their causes helps us rate pavement condition and select cost-effective repairs. The pavement defects shown on the following pages provide a background for this process.

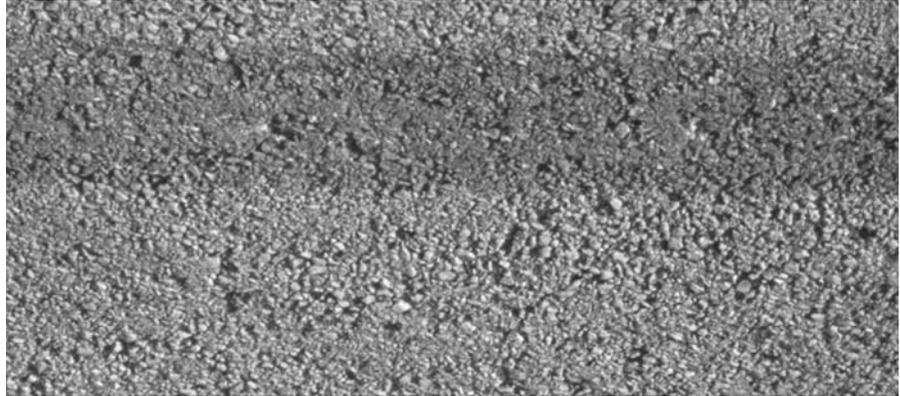
Periodic inspection is necessary to provide current and useful evaluation data. It is recommended that PASER ratings be updated every year.

4 EVALUATION — Surface Defects

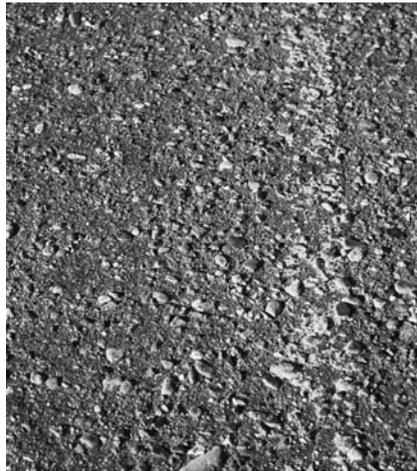
SURFACE DEFECTS

Raveling

Raveling is progressive loss of pavement material from the surface downward, caused by: stripping of the bituminous film from the aggregate, asphalt hardening due to aging, poor compaction especially in cold weather construction, or insufficient asphalt content. Slight to moderate raveling has loss of fines. Severe raveling has loss of coarse aggregate. Debris from raveling may damage aircraft. Protect pavement surfaces from the environment with a surface treatment or an overlay if additional strength is required.



▲ Slight raveling. Small aggregate particles have worn away exposing tops of large aggregate.



◀ Moderate to severe raveling. Erosion further exposes large aggregate.

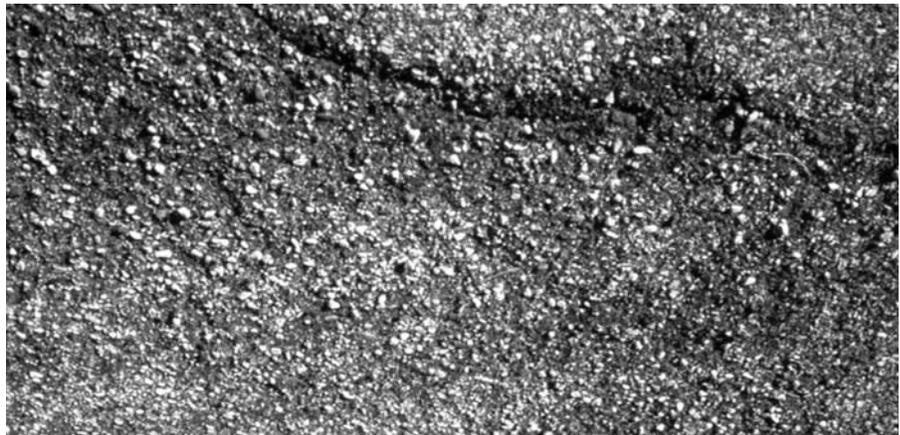
▼ Severe raveling and loss of surface material.

Polishing

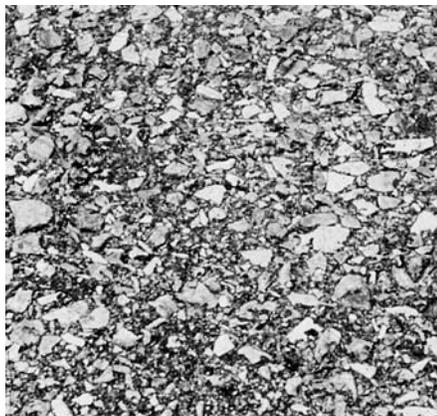
Polishing is a smooth slippery surface caused by traffic wearing off sharp edges of aggregates. Pavement grooves may also be worn away. Repair with surface treatment or thin bituminous overlay using skid-resistant aggregate.

Flushing

Flushing is excess asphalt on the surface caused by a poor initial asphalt mix design or by paving or sealcoating over a flushed surface. Repair by overlaying with properly designed asphalt mix or sealcoat.



Polished, worn aggregate needs repair.



◀ Flushing. Dark patches show where asphalt has worked to surface.

SURFACE DEFORMATION

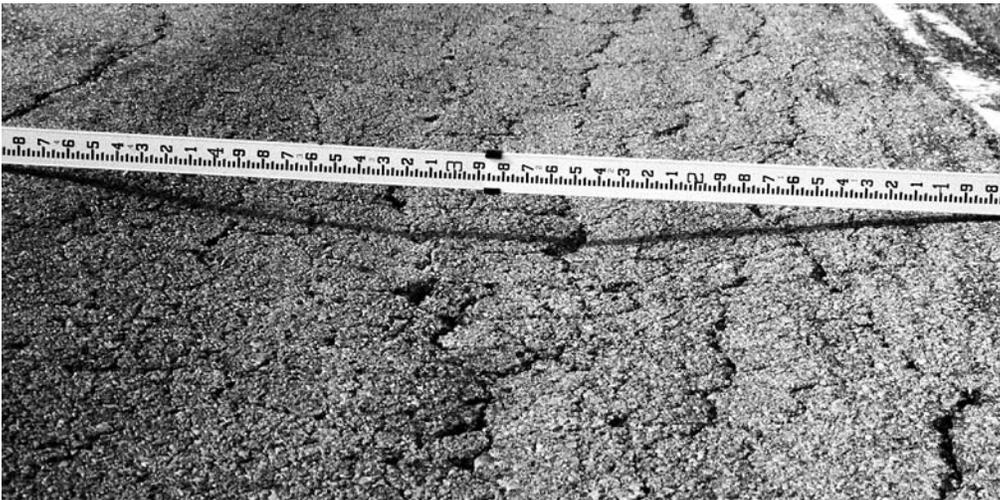
Rutting

Rutting is displacement of material, creating channels in wheelpaths. It is caused by traffic compaction or displacement of unstable material. Severe rutting (over 2") may be caused by base or subgrade consolidation. Repair minor rutting with microsurfacing or overlays. Severe rutting requires milling the old surface or reconstructing the pavement before resurfacing. Base or subgrade improvement may be necessary if rutting is related to poor base or subgrade conditions.



▲ Even slight rutting is evident after a rain.

◀ Severe rutting over 2" caused by poor mix design.



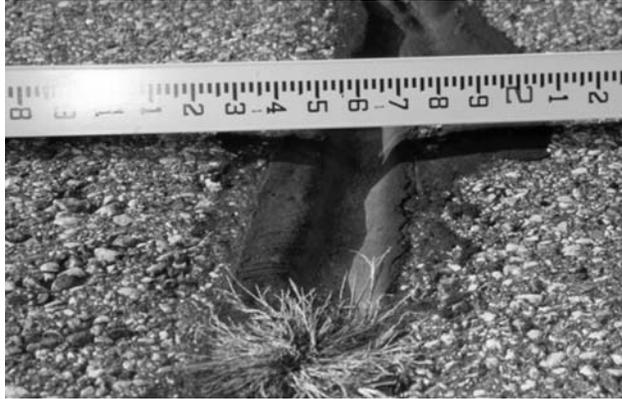
◀ Severe rutting caused by poor base or subgrade.

6 EVALUATION — Surface Deformation

Distortion

Shoving or rippling is the displacement of surfacing material. It can develop when the asphalt mixture is unstable because of poor quality aggregate or improper mix design. Repair by milling smooth and overlaying with stable asphalt mix.

Other pavement distortions may be caused by settling, frost heave, etc. Patching may provide temporary repair. Permanent correction involves removal of unsuitable subgrade material and reconstruction.



◀ Minor settlement over sealed crack.

Heavy traffic has shoved pavement into washboard ripples and bumps.



Significant settlement (over 2") and cracking adjacent to sealed crack.



▲ Frost heave damage from spring break-up.



▲ Severe settling from utility trench.



◀ Severe settlement of patch.

CRACKS

Thermal cracks

Thermal cracks are often regularly spaced. The cause is movement due to temperature changes and hardening of the asphalt with aging.

Thermal cracks will initially be widely spaced (several hundred feet apart). Additional cracking will occur with aging until they are closely spaced (within several feet). These usually begin as hairline or very narrow cracks; with aging they widen. If not properly sealed and maintained, secondary or multiple cracks develop parallel to the initial crack. The crack edges can further deteriorate by raveling and eroding the adjacent pavement.

Help prevent water intrusion and damage by sealing cracks as soon as they appear. Routing and cleaning the crack will improve the performance of crack sealant.

Differential thermal stress can also cause cracking. Pavement marking paint and sealcoats using materials with significantly different thermal



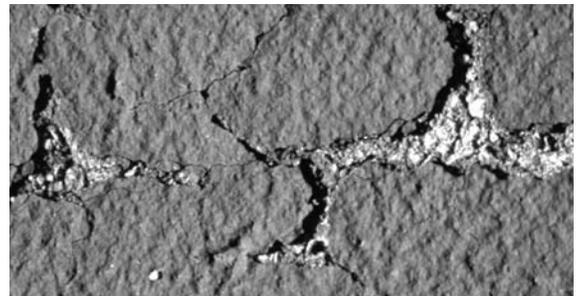
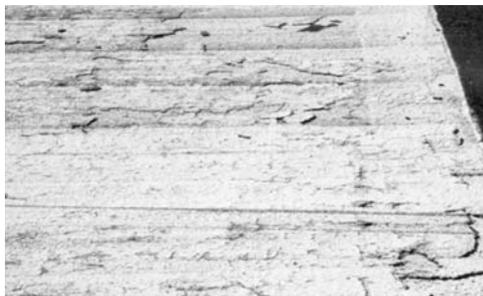
▲ Widely spaced, well-sealed cracks.

▲ Sealed cracks, some closely spaced.

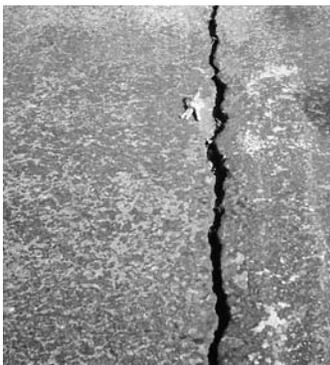
◀ Failed sealant.

Pavement marking may cause thermal stress and lead to surface cracking.

Severe thermal cracking in coal tar sealant.



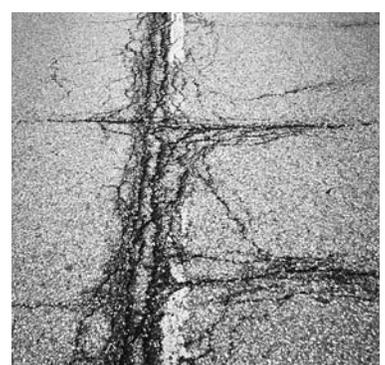
▲ Tight cracks less than 1/4" in width.



▲ Open crack – 1/2" or more in width.



▲ Water enters unsealed cracks softening pavement and causing secondary cracks.



▲ Pavement ravel and erodes along open cracks causing deterioration.

8 EVALUATION — Cracks

properties can create surface cracking.

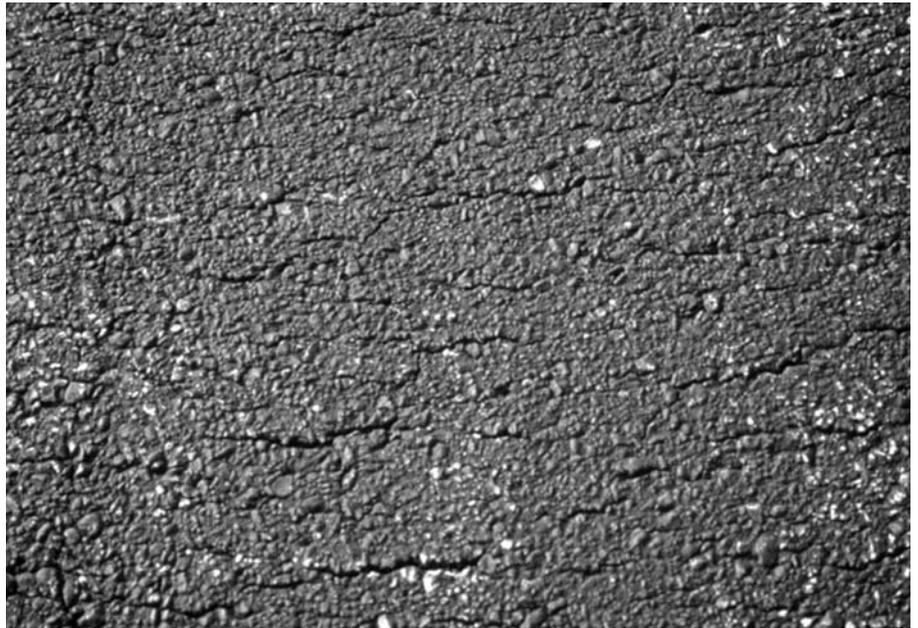
Reflection cracks

Cracks in overlays reflect the crack pattern in the pavement underneath. They are caused by movement in the underlying pavement due to temperature change. This movement creates very large stress in the overlay. Therefore, they are difficult to prevent and correct.

►
Cracks
reflected
through
bituminous
overlay.



►
Hairline cracks
reflected through
sealcoat.

***Slippage cracks***

Crescent or rounded cracks caused by slippage between an overlay and an underlying pavement. Slippage is most likely to occur at locations where traffic is stopping and starting. Repair by removing the top surface and resurfacing using a tack coat.



▲ Loss of bond between pavement layers allows traffic to break loose pieces of surface.



Paving joint and edge cracks

Paving joint cracks are caused by inadequate bonding and poor compaction of the joint during construction. They may also be caused by reflection of poor joints in the underlying pavement. Cracks within one foot of the edge are caused by insufficient shoulder support, poor drainage, or frost action. Cracks usually start as hairline or very narrow, widening and eroding with age. Without crack filling, they can ravel, develop multiple cracks, and become wide enough to require patching.

Sealing cracks will help reduce moisture penetration and prevent further subgrade weakening.



▲ Paving joints. Slight crack on joint near center. Open joint on right side.

◀ Partially open 1/4" paving joint.



◀ First stage of wheelpath cracking caused by heavy traffic loads.

▶ Severe cracking and edge distress.



◀ Edge cracking in asphalt along concrete slab.



10 EVALUATION — Cracks

Block cracks

Block cracking is interconnected cracks forming large blocks. Cracks usually intersect at nearly right angles. Blocks may range from one foot to approximately 10' or more across. The closer spacing indicates more advanced aging caused by shrinking and hardening of the asphalt over time. Apply surface treatments during early stages to reduce weathering of the asphalt caused by exposure to the sun, moisture and freezing. Overlay or reconstruction is required in the advanced stages.



▶ **Right angle cracking forms blocks.**



▶ **Large blocks with open cracks filled with grass.**



▶ **Small blocks with open cracks.**



Alligator cracks

Interconnected cracks forming small pieces ranging in size from about 1" to 6". This is caused by failure of the entire pavement due to traffic loading (fatigue) and usually due to inadequate base or subgrade support. Repair by excavating and replacing failed subgrade base and surface. Large areas require reconstruction. Improvements in drainage may often be required.



Alligator crack pattern. Tight cracks and one patch.



Alligator cracking near pavement edge.



Alligator cracking and pothole.

12 EVALUATION — Patches and Potholes

PATCHES AND POTHoles

Patches

Original surface repaired with new asphalt patch material. Indicates a pavement defect or utility excavation which has been repaired. Patches with cracking, settlement or distortions indicate underlying causes remain. Repair or reconstruction are required when extensive patching shows distress.



▲
Typical repair of utility excavation. Patch in good condition.

▶
Patched area in poor condition.

▼
Overlay repair with edge raveling and cracks.



Potholes

Holes and loss of pavement material are caused by traffic loading, fatigue and inadequate strength. Often combined with poor drainage, this can create dangerous pavement debris. Repair by excavating or rebuilding localized potholes. Reconstruction required for extensive defects.



▲
Shallow
pothole.

◀
Large pothole
and dangerous
loose debris.

Complete
pavement
failure.
▼



Rating pavement surface condition

With an understanding of surface distress, you can evaluate and rate asphalt pavement surfaces. The rating scale ranges from **5–excellent** condition to **1–failed**. Most pavements will deteriorate through the phases listed in the rating scale. The time it takes to go from excellent condition (5) to complete failure (1) depends largely on the quality of original construction, age, and the amount of heavy traffic loading.

Once significant deterioration begins, it is common to see pavement decline rapidly. This is usually due to a combination of loading and the effects of additional moisture. As a pavement ages and additional cracking develops, more moisture can enter the pavement and accelerate the rate of deterioration.

Look at the photographs which follow and become familiar with the descriptions of the individual rating categories. To evaluate an individual pavement segment, first determine its general condition. Is it relatively new, toward the top end of the scale? In very poor condition and at the bottom of the scale? Or somewhere in between? Next, think generally about the appropriate maintenance method. Use the outlined rating categories.

Finally, review the individual pavement distress and select the appropriate surface rating. A given pavement will likely **not** have all of the types of distress listed for any particular rating. It may have only one or two types.

In addition to indicating the surface condition of a pavement, a given rating also includes a recommendation for needed maintenance or repair. This feature of the rating system facilitates its use and enhances its value as a tool in ongoing airfield pavement maintenance.

Rating 5 – Excellent

No maintenance required

Rating 4 – Good

Minor routine maintenance, crack sealing

Rating 3 – Fair

Preservative treatments, crack sealing and surface treatment

Rating 2 – Poor

Structural improvement and leveling (patching then overlay)

Rating 1 – Failed

Reconstruction

Rating system		
Surface rating	Visible distress*	General condition/treatment measures
5 Excellent	None, or initial thermal cracks, all narrow (less than 1/8")	New pavement less than 5 years old. No maintenance or isolated crack sealing required.
4 Good	Additional thermal cracking. Cracks generally spaced more than 50' apart. Less than 10% of cracks and joints need sealing. Minimal or slight raveling. No distortion. Patches in good condition.	Recent sealcoat or pavement over 5 years old. Seal open cracks or joints and replace sealant where needed.
3 Fair	Moderate raveling. Thermal cracks and joints generally spaced less than 50' apart. Crack sealing or repair of sealant needed on 10%-25% of cracks or joints. Edge cracks along 10% or less of pavement edges. Block crack pattern with cracks 6'-10' apart. Isolated alligator cracking and poor patches. Minor distortion or crack settlement less than 1".	Seal open cracks and joints. Replace failed sealant. Apply new surface treatment or thin overlay. Minor patching and joint repair.
2 Poor	Frequent thermal cracks. Wide cracks and joints with raveling in cracks. Deterioration along more than 25% of cracks. Edge cracks on up to 25% of pavement edges. Block cracks spaced 5' apart or less. Alligator cracking or poor patches cover up to 20% of surface area. Distortion or settlement 1"-2".	Needs significant crack sealing plus patching and repair on up to 25% of pavement surface. Overlay entire area with structural overlay.
1 Failed	Widespread, severe cracking with raveling and deterioration. Alligator cracking and potholes over 20% of the area. Distortion over 2".	Condition may be limiting service. Needs reconstruction.

* A given pavement segment may only have one or two types of distress rather than all of the types listed for a particular rating.



RATING 5

**EXCELLENT —
No maintenance
required or isolated
crack sealing.**

New pavement less than 5 years old. No visible distress or initial thermal cracks, all less than 1/8".

◀
**New
pavement.**

**Recent overlay.
Sealed joint.**
▼



16 Rating pavement surface condition

RATING 4

**GOOD —
Seal open cracks or joints.**

Recent sealcoat or pavement over 5 years old. Additional thermal cracking. Cracks spaced 10'-20' apart. Open cracks and joints need sealing on less than 10% of cracks. No distortion and patches in good condition.

►
Recent sealcoat.

Cracks sealed.
No distortion.
Slight raveling.
▼



►
Pavement more than 5 years old. No patches or distortion. Schedule routing and sealing for isolated open joints.





◀ Cracks widely spaced and sealed.

▼ Joints would benefit from sealing.



▲ Old sealant is leaking. Needs replacement at isolated locations.



18 Rating pavement surface condition

RATING 3

FAIR —

Seal open cracks and joints. Apply new surface treatment or thin overlay. Minor patching and joint repair.

Moderate raveling. Thermal cracks and joints, generally spaced less than 50' apart. Crack sealing or repair of sealant needed on 10%-25% of cracks or joints. Edge cracks along 10% or less of pavement edges. Block crack pattern with block cracks 6'-10' apart. Isolated alligator cracking and poor patches. Minor distortion or crack settlement less than 1".



▲ Thermal cracks less than 10' apart. Slight raveling.



▶ Several patches in good condition.

▼ Worn sealcoat needs new surface treatment.

▼ Open cracks need sealing.





◀ Moderate raveling.
Joint needs sealing.



◀ Moderate raveling.
Needs surface treatment soon.



◀ Pavement settlement at crack less than 1" deep.



◀ Joint sealant needs replacement at several locations. Follow with new surface treatment on apron.



◀ Edge cracking at several locations.

20 Rating pavement surface condition

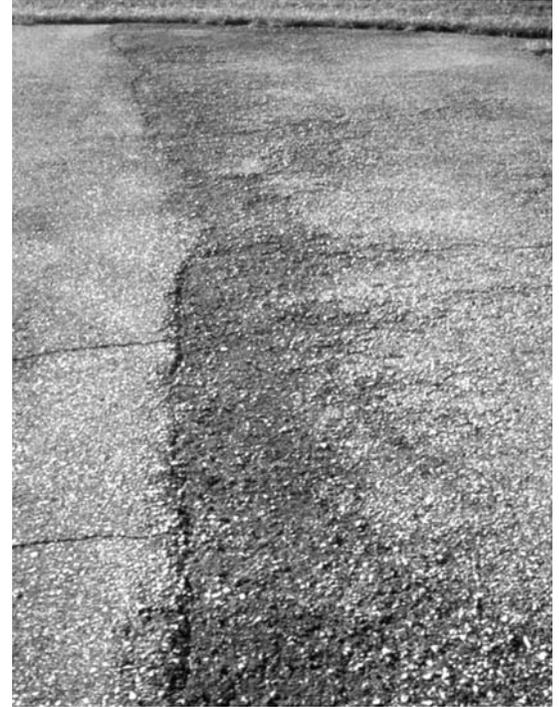
RATING 2

POOR —
Needs significant crack sealing plus patching and repair on up to 25% of pavement surface. Use structural overlay over entire area.

Frequent thermal cracks. Wide cracks and joints with raveling in cracks. Deterioration along more than 25% of cracks. Edge cracks on up to 25% of pavement edges. Block cracks spaced 5' apart or less. Alligator cracking or poor patches cover up to 20% of surface area. Distortion or settlement 1"-2".



▲ Wide cracks with no sealant.



▶ Severe raveling.

▶ Multiple cracks open and deteriorated
▶ Numerous cracks with settlement over 1".
▶▶



▲ Block cracking with cracks less than 5' apart.

▶ Patch in poor condition.





◀ Needs overlay.



◀ Edge cracking on up to 25% of the pavement.



◀ More than 25% of crack sealant needs replacement. Minor settlement over cracking.

▼ Sealant repair needed on more than 25% of cracks.

▼ Repair broken pavement and apply overlay.



22 Rating pavement surface condition

RATING 1

FAILED —
Condition may be limiting service. Needs reconstruction.

Widespread, severe cracking with raveling and deterioration. Alligator cracking and potholes over 20% of the area. Distortion over 2"

Over 25% alligator cracking.



▲ Extensive alligator cracking. Poor patches.

▲ Severe cracking and deterioration.



▲ Failed patch. Settlement over 2".

▶ Extensive failed pavement and debris.



Practical advice on rating airfield pavements

Inventory and field inspection

Most airport owners routinely observe pavement conditions as a part of their normal work. However, an actual inspection means looking at the entire system as a whole and preparing a written summary of conditions. This inspection has many benefits over casual observations. It can be helpful to compare pavement features as a whole system so ratings and maintenance decisions can be more consistent.

An inspection also encourages a review of specific conditions important in pavement maintenance, such as drainage, adequate strength, and safety.

A simple written inventory is useful in making decisions where other people are involved. You do not have to trust your memory, and you can usually answer questions in more detail. Having a written record and objective information also improves your credibility with the funding agencies.

Finally, a written inventory is very useful in documenting changing pavement conditions. Without records over several years, it is difficult to know if conditions are improving, holding their own, or declining.

A sample inventory form is shown on the inside back cover. It is very helpful to collect background information on each feature. Pavement thickness, age, and major maintenance are examples of helpful information.

Annual budgets and long range planning are best done when based on actual needs as documented with a written inventory.

Pavement features

Inventory and pavement condition data are normally organized by dividing the pavements into segments or features.

A plan or aerial photo of the entire airfield is most helpful in identifying these individual features. Runways, taxiways and aprons should be considered as separate categories. Within each category, the pavement should be separated into features with similar construction. For example, pavements with different thickness, age, or type of construction should be rated separately.

A runway may be all one feature if conditions are similar. However, if parts of the runway have significantly different construction details or condition, then separate features will make the rating more logical and useful.

Each taxiway, can be considered a separate feature. You may combine several sections of taxiway if conditions are similar.

Apron areas can be separated into features according to the areas they serve. For example, aprons serving a terminal, hangers, tie-down area, or fueling area would be separate features. Areas in different conditions may also be separated into features.

Averaging and comparing sections

No pavement feature is entirely consistent. Also surfaces in one section may not have all of the types of distress listed for any particular rating. They may have only one or two types.

The objective is to rate the condition that represents the majority of the pavement feature. Small or isolated conditions should not influence the rating. It is useful to note these special conditions on the inventory form so this information can be used in planning specific improvement projects. For example, some spot repairs may be required.

Occasionally surface conditions vary

significantly within a feature. For example, short sections of good condition may be followed by sections of poor surface conditions. In these cases, it is best to rate the feature according to the worst conditions and note the variation on the form.

The overall purpose of condition rating is to be able to compare each feature relative to all the other features in your airport pavement system. On completion you should be able to look at any two pavement features and find that the better surface has a higher rating.

Assessing drainage conditions

Moisture and poor pavement drainage are significant factors in pavement deterioration. Some assessment of drainage conditions during pavement rating is highly recommended. While you should review drainage in detail at the project level, at this stage simply include an overview drainage evaluation at the same time as you evaluate surface condition.

Consider both pavement surface drainage and lateral drainage (ditches or storm sewers). Pavement should be able to quickly shed water off the surface. Ditches should be large and deep enough to drain the pavement and remove the surface water efficiently into adjacent waterways.

Look at the crown and check for low surface areas that permit ponding. Runways and taxiways should have approximately a 1.5% cross slope or crown across the pavement. Apron areas require positive drainage and often include storm drainage systems. Maintenance of the entire drainage system is critical. Ditches, subsurface drains and outlets should be inspected and cleaned regularly.

A pavement's ability to carry heavy traffic loads depends on both the pavement materials (asphalt surfacing and granular base) and the strength of the underlying soils. Most soils lose strength when they are very wet. Therefore, it is important to provide drainage to the top layer of the subgrade supporting the pavement structure.

Planning annual maintenance and repair budgets

We have found that relating a normal maintenance or rehabilitation procedure to the surface rating scheme helps managers use the rating system. However, an individual surface rating should not automatically dictate the final maintenance or rehabilitation

technique.

Consider future traffic projections, original construction, and pavement strength since these may dictate a more comprehensive rehabilitation than the rating suggests.

Summary

Using funds most efficiently requires good planning and accurate identification of appropriate rehabilitation projects. Assessing pavement conditions is an essential first step in this process. This asphalt pavement surface condition rating procedure has

proven effective in improving decision making and using funds more efficiently. It can be used directly by airport staff and consultants. It may be combined with additional testing and data collection in a more comprehensive pavement management system.

References

Concrete Aviation Airfields PASER Manual, 2003, Engineering Professional Development, College of Engineering, University of Wisconsin-Madison.

Guidelines and Procedures for Maintenance of Airport Pavements, 7/14/03, Federal Aviation Administration, Advisory Circular AC:150/5380-6A.

AIRFIELD PAVEMENT INVENTORY

Airfield _____ Condition survey date _____

Done by _____

Facility (runway, taxiway, apron) _____

Feature description _____

Feature location _____

Feature area _____

Construction date _____

Pavement type: Asphalt Concrete Layer thicknesses: _____

Maintenance history _____

PASER Rating (5 = Excellent, 4 = Good, 3 = Fair, 2 = Poor, 1 = Failed)

Comments on pavement and drainage conditions _____

Recommended maintenance _____

Recommended rehabilitation _____

PASER

Asphalt Airfield Pavements