Pavement Surface Evaluation and Rating

PASER Manual

Gravel Roads

Transportation Information Center
University of Wisconsin–Madison

Contents

This manual is intended to assist local officials in understanding and rating the surface condition of gravel roads. It describes types and causes of distress and provides a simple system to visually rate the road segment's condition. The rating procedure can be used as condition data for the Wisconsin DOT local road inventory and as part of a computerized pavement management system like PASERWARE.

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Gravel Roads

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There are many miles of unsurfaced roads in this country. Wisconsin alone has over 22,000 miles of gravel roads under the jurisdiction of local governments. Maintaining and improving these roads is a major responsibility for local governments.

Gravel roads may service very remote areas and very few vehicles. On the other hand it is common to have gravel roads providing service to agricultural, logging, and recreational areas with fairly high traffic volumes. Many urban areas also have some gravel roads. Heavy trucks and residential traffic can combine to make very heavy demands on these unsurfaced roads.

This manual is intended to help you plan the maintenance and overall management of gravel roads. It discusses common problems and typical repairs. A simple system for evaluating conditions and rating roads is included.

The Wisconsin Transportation Information Center also has PASER manuals for other pavement types (see inside back cover). The rating systems are similar and compatible so that local road agencies can work with a comprehensive condition rating method. The rating procedure can be used as condition data for the Wisconsin DOT local road inventory (WISLR) and as part of a computerized pavement management system like PASERWARE.

Taking an organized approach to roadway management has many benefits. By documenting the actual conditions of roads you can set realistic budgets, make timely repairs, and set up cost effective maintenance procedures. Developing an overall plan for the roadway system lets local agencies develop budgets and plan for future needs. When detailed information is available, local officials can respond more effectively to questions from the public. A planned approach is easier to explain and receives greater public support.

Several key steps are necessary to develop a meaningful roadway management plan. First, you must inventory the existing condition. This is normally done by dividing the roadway into segments with similar conditions. During the inventory you collect information on construction history, roadway width, etc. Then you need some method for assessing the condition of the existing roadway. This Gravel PASER Manual uses a visual approach. Other information from material sampling, testing, and traffic counts can be useful for a more detailed system plan.

Another necessary step is setting priorities for roadway improvements. You can use roadway condition and the local importance of these roads to assign priorities. Then budgets can be developed based on cost estimates for the projected improvements. Since not all improvements can be made in one year, you can set up a multi-year budget plan. You can make a capital improvement plan for three to five years. Normally this is updated annually.

Gravel road evaluation

Evaluating and rating gravel roads requires a different perspective than similar evaluations of asphalt or concrete pavements. This is due to the nature of gravel roads and their variability. Surface conditions on gravel roads can change literally overnight. Heavy rains and local heavy traffic can dramatically change the surface characteristics of gravel roads from one day to the next. In addition, routine maintenance activities, such as one pass of a motor grader, could improve the surface conditions of a gravel road significantly.

Since the evaluation or rating of a road could vary depending on recent weather conditions or recent maintenance activities, it should be based on major factors. Detailed surface conditions should be secondary.

The most important factors in evaluating a gravel road are the road cross section, drainage, and adequacy of the gravel layer. The gravel road cross section must contain adequate crown and good lateral drainage systems. The crown should be approximately 6", the adjacent ditches should be deep enough to contain surface water, and the culvert systems should be clean and sized to prevent any serious impoundment of water against the roadway.

The depth of the gravel layer will obviously depend on the existing soils and the amount of heavy traffic. For most conditions, a minimum gravel thickness of 6" is required. Heavier layers are necessary for very poor soils and/or very heavy traffic loads. Using geotextiles in very poor subgrade soil conditions can also significantly improve the performance of a gravel road.

Surface distress, such as ruts and potholes, indicates a lack of strength. This could be caused by improper drainage, by lack of adequate gravel cover, or possibly both. Therefore, surface distress becomes an important indicator of the primary concern for drainage and adequate gravel. The level of service that a gravel road provides to the driver also depends on smooth ride and dust control. Therefore distress such as washboarding, loose rock, and dust are important in the overall service of the road. However, these conditions are secondary since they can change quickly due to weather and maintenance activities. They should not influence the primary evaluation of the roadway.

It may be difficult to distinguish between a poorly maintained gravel road and an unimproved (dirt) road. The local road agency must first decide if they plan to maintain the road with a gravel surface or as an unimproved road. A minimum of 1½"–2" of gravel surfacing is generally necessary to be considered a gravel road. More gravel is needed to provide a good level of service.

Surface conditions and defects

The *Gravel PASER Manual* presents a method for visually assessing and rating the conditions of existing roadways. It is based on understanding the conditions and defects common on gravel roads. To set a rating you assess both the extent of problems on the road and the appropriate repairs or reconstruction needed.

It is helpful to separate the various conditions common to gravel roads. Five road conditions can be used to evaluate and rate gravel roads.

Crown
The height and condition of crown, and an unrestricted slope of roadway from the center across the shoulders to the ditches.

Drainage
The ability of roadside ditches and under-road culverts to carry water away from the road.

Gravel layer
Adequate thickness and quality of gravel to carry the traffic loads.

Surface deformation
Washboarding, potholes and ruts.

Surface defects
Dust and loose aggregate.

Each of these is described in some detail in this manual. Assessing the condition of an actual roadway usually involves looking for different combinations of conditions.

In reviewing different conditions and defects, it is important to consider their severity and extent. Generally problems begin slowly and progressively become more serious. Slight defects will grow into moderate and then severe conditions. At first, defects may be found in only a few isolated places. As the condition worsens, more defects will show up on the surface. Examples in this manual will help you identify conditions and determine both how bad they are and how extensive they are.

CROWN

An unsurfaced road must be built so water drains quickly off the roadway. If it is not, water stays in ponds or puddles, soaks into the roadbed, and softens it. Building a crown into the road—making the center of the road higher than the shoulder—enhances drainage. Normally, a gravel road will have 4"–6" of crown, or fall, from its center to the edge.

A roadway that has no crown will pond water. A windrow of soil or a high shoulder may also trap water on the roadway and impede drainage. In severe cases the crown is reversed—lower than the edges—so that the road is in a bowl shape. Naturally, this traps water and rapidly deteriorates the roadway, especially under traffic.

Inadequate crown can be restored by regrading with a motor patrol grader. Light blading will restore minor irregularities. Restoring crown to a flat roadway may require complete reworking. This involves scarifying, or cutting loose, 3"–4" of gravel and reshaping the crown. It is helpful to apply water and use compaction to establish the crown.

If the surface gravel on the roadway is inadequate you may need to add gravel to construct a road with proper crown. Use good quality aggregate. Hard and sound aggregate will prevent the breakdown of large aggregate into small particles under traffic. A proper mixture of aggregate sizes (gradation) is also important. You need an adequate amount of fines to bind the gravel together on the road. See Wisconsin Transportation Bulletins No. 4, ***Road Drainage*** and No. 5, ***Gravel Roads*** for more information.

When you do routine maintenance grading, take care to grade the roads to allow free drainage from the center of the road to the shoulder and into the ditch. Improper grading can create a secondary ditch.

► **Excellent crown. No restriction to water flow from centerline to ditch.**

Flat crown with poor grading has created secondary ditch preventing free drainage into roadside ditch. ▼

▲ **Poorly graded crown traps water causing it to run down center of road.**

DRAINAGE

Roadside ditches and culverts must be able to handle surface water flow. Without adequate ditches, water will pond on the roadway and soften the road base. The ditch must be wide and deep enough to accommodate all the surface water. It must slope so water drains and doesn't form local ponds. A ditch bottom which is several feet below the top of the road is best. This will provide thorough drainage of the roadbed and prevent flooding. Deeper and wider ditches may be necessary to accommodate very heavy surface water flow. Ditches must be maintained to prevent erosion or the buildup of debris.

Drainage across roadways is handled with culverts or bridges. These drainage structures must be maintained to prevent ponding and water backup. Culvert headwalls and riprap are very helpful in directing water flow and preventing erosion of the roadbed.

Ditch cleaning is a routine maintenance procedure necessary to keep water flowing properly. Spoil material from a ditch may be used along the roadway if there is room. Major ditch cleaning may require loading and hauling excess material. Take care to maintain uniform ditch slopes. Seed the soil or install additional erosion control after major ditching repairs.

Roadway culverts tend to fill with debris and silt. They must be cleaned routinely to maintain their water carrying capacity. Replacing headwalls and riprap is also necessary to prevent erosion. Collapsed or damaged culverts must be replaced.

◄ **Excellent drainage with wide deep ditches.**

Partial drainage. Ditch and new culvert being added on left. Little or no drainage on right. ▼

▲ **Good ditches.**

DRAINAGE

Continued

►
Poor drainage due to little or no ditch, no driveway culverts.

Shallow, narrow ditch cannot carry surface water causing ditch erosion and temporary roadway flooding.
▼

◄
Shallow ditch and partially filled culvert. Ditch needs cleaning and culvert should be lowered to allow a minimum of 12″ of aggregate cover.

►
No ditch. Road is actually trenched into roadside forcing water onto surface.

► **Excellent gravel layer.**

GRAVEL LAYER

Traffic loads require an adequate layer of gravel to carry and distribute the loads to the subsoils. The thickness needed will vary with the amount of heavy traffic and the stability of the subsoils. A minimum layer of 6" is normally required. Heavier layers, up to 10" or more, are sometimes used for heavy loads or poor soil conditions.

The gravel must be of good quality to provide long term service. The gradation and durability of the gravel (measured by hardness and soundness testing) are important. A proper gradation contains a mixture of larger aggregate (1"), sand-sized aggregate, and fines. More fines (8%–15%) are recommended for surfacing gravel than are normally used in base gravel. See Transportation Information Bulletin No. 5, ***Gravel Roads,*** for more information.

◄ **Adequate gravel layer. No ruts or potholes.**

◄ **Little or no gravel layer.**

SURFACE DEFORMATION

Washboard

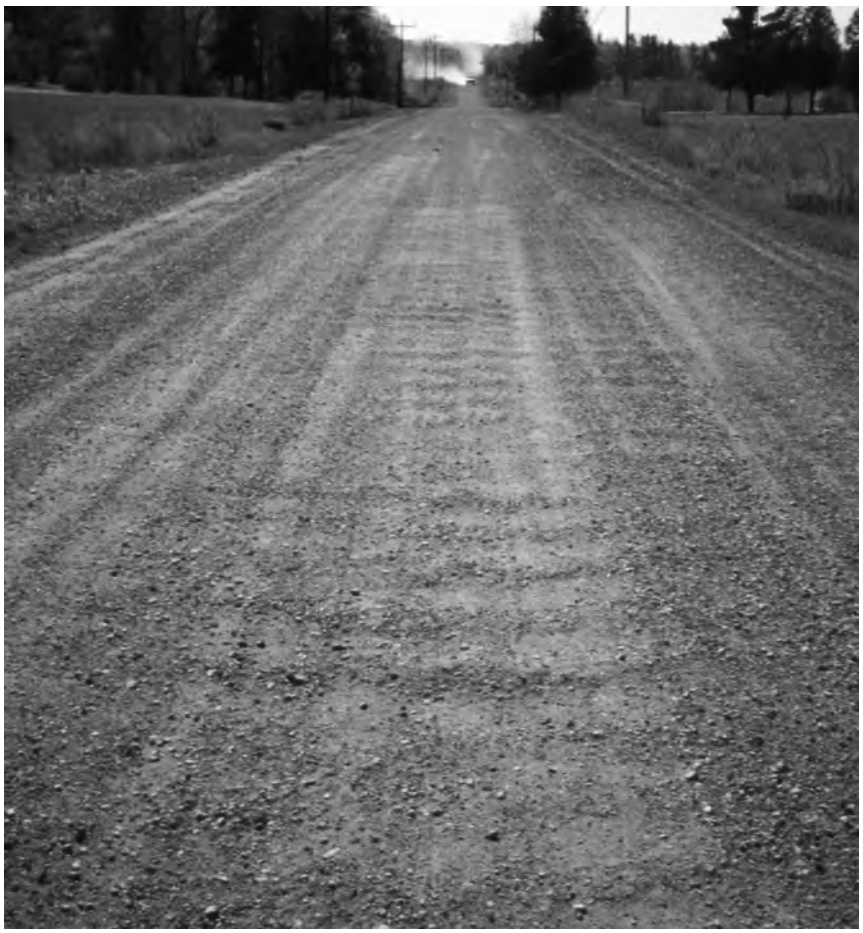
Traffic action can dislodge aggregate and create a washboard effect on the surface. This washboarding or corrugation develops across the road, perpendicular to the direction of traffic. It is more prevalent under heavy traffic and under loose aggregate conditions. It may also tend to develop on hills or curves, near intersections, or in areas where traffic is accelerating or decelerating. Soft roadbeds and improper grader operation can also cause washboards.

Light washboarding can be removed with routine grading. Washboarding that is moderate or severe often requires scarification, cutting down 3"-4", and regrading. If there is insufficient material, new gravel will be required. Select an aggregate with sufficient fines to resist future washboarding.

Since washboarding may be concentrated at specific locations, spot regrading is often required. Take care to blend the regraded sections into the adjoining roadway. Since moisture is needed for compaction, correcting washboarding after a rain is more effective. Maintain the crown, and super-elevation, and match bridges and intersections when repairing spot corrugations.

Operating a motor patrol grader at a high rate of speed can actually create corrugations during routine maintenance. Speeds below 10 mph are recommended. Proper blade angle and pitch, and proper tire inflation, are also essential.

▼ **Moderate washboarding in center of road.**



► **Severe washboarding traps water.**

Potholes

Potholes and depressions can develop in the gravel or surface. They're caused when surface material is worn away or soft spots develop in underlying soils. They may fill with water and are accelerated in roads without adequate crown. Isolated potholes may be repaired by hand. This can involve putting granular material into the holes and compacting it.

◄ **Small, isolated potholes. Routine regrading should eliminate them.**

► **Series of moderate potholes require scarification and regrading.**

▲ **Potholes at bridge may require scarification and hand patching. Gravel and debris should be cleaned off bridge deck.**

◄ **Severe potholes covering most of road need additional gravel and regrading.**

Extensive potholes require reworking and major regrading. It is usually necessary to add granular material to repair them. Scarify the area prior to repair to insure a good blend. You may need to reshape the road to restore a crown and make drainage improvements to restore surface stability and prevent future potholes.

Ruts

Traffic can create a surface depression or rut over a portion of a gravel road. The ruts may be caused by dislodging some of the surface gravel. Loose unstable gravel may be displaced by traffic causing minor surface ruts. Severe rutting (over 3") may be caused by weak underlying soils. Poor crown and drainage conditions weaken the base and accelerate rutting.

Slight rutting can be removed by blading and restoring the crown. Severe rutting caused by unstable subsurface soils will require improvements in drainage and addition of aggregate.

▲ **Rut in wheel path needs regrading to eliminate ponding and prevent further road deterioration.**

▼ **Numerous ruts and very poor drainage create soft roadbed conditions and need major regrading and new aggregate.**

SURFACE DEFECTS

Dust

Traffic on dry gravel roads can generate dust. Good quality gravel used in the construction of gravel roads has a combination of large aggregate, sand, and fine material or binder. These fines can be picked up under the action of traffic and become airborne.

Dust on gravel roads creates several problems. Visibility can be severely restricted under heavy dust conditions, creating traffic safety hazards. Dust is a form of air pollution and can be very objectionable to nearby property owners. The loss of the fine material from a well-graded gravel surface can eventually lead to a loss of stability. Without the fine binder material, the larger particles become unstable and are dislodged by traffic.

Rolling and compacting a new gravel surface will help maintain a tight and impervious surface or crust. Under traffic and during extended dry periods this crust may be disturbed and heavy dust conditions result. Controlling dust with liquid calcium chloride or other surface treatment agents can be very helpful.

It is essential to replace the fines in the gravel mix to maintain the road and keep it stable under traffic. Fines can often be reclaimed from the shoulder edge and regraded and mixed with existing gravel. This should be done as routine maintenance while restoring and maintaining the crown.

◄ **Heavy dust obscures vision and causes loss of roadway fine material. A dust control chemical may be advisable in areas of heavy traffic.**

Loose aggregate

Loose aggregate or unstable surface gravel conditions can develop from loss of fines through heavy dust action or from erosion due to an improper gradation mix of the original aggregate. Vehicles can move loose or unstable aggregate forming ridges or windrows in the direction of traffic. Generally gravel will be moved from the wheel path and form ridges at the center of lanes and at roadway edges. Loose aggregate can also accumulate at places where vehicles frequently turn or stop.

Loose aggregate may be temporarily bladed to the shoulder although you have to be careful not to restrict drainage. By remixing loose aggregate with fines from the road edge it may be possible to produce a well graded mix. However, a severe accumulation of loose aggregate usually requires mixing with additional well graded surface gravel.

▲ **Loose aggregate over most of road. Light grading and compaction during wet weather would improve stability and develop a surface crust.**

► **Heavy accumulation of loose aggregate on outside of roadway. Regrading and possibly new aggregate are needed.**

Rating road surface condition

A simplified rating system has been developed to help manage gravel roads. It uses a scale of 1 to 5—**5** is **excellent** condition and **1** is **failed**. In a normal progression the road will start out in excellent condition and gradually deteriorate under the effects of traffic and weather. Routine grading and minor patching may be sufficient to restore the road to excellent condition. As conditions worsen, more extensive maintenance may be required; complete rebuilding may eventually be necessary.

To select a rating first assess the crown, drainage, and gravel layer. Then review the individual defects and select the type of maintenance or rehabilitation necessary. The rating should reflect the condition and type of maintenance or repairs required. Look at the photographs in this section to become more familiar with the ratings and conditions.

Ratings are related to needed maintenance or repair

Rating 5 Newly constructed road. Excellent crown and drainage. No maintenance required.

Rating 4 Good crown and drainage. Routine maintenance.

Rating 3 Roadway shows traffic effects. Needs regrading, minor ditch maintenance, and spot gravel application.

Rating 2 Road needs additional aggregate layer, major drainage improvements.

Rating 1 Travel is difficult. Complete rebuilding required.

Surface rating	*Visible distress**	*General condition/ treatment measures*
5 Excellent	No distress. Dust controlled. Excellent surface condition and ride.	New construction—or total reconstruction. Excellent drainage. Little or no maintenance needed.
4 Good	Dust under dry conditions. Moderate loose aggregate. Slight washboarding.	Recently regraded. Good crown and drainage throughout. Adequate gravel for traffic. Routine grading and dust control may be needed.
3 Fair	Good crown (3"-6"). Adequate ditches on more than 50% of roadway. Gravel layer mostly adequate but additional aggregate may be needed in some locations to correct washboarding or isolated potholes and ruts. Some culvert cleaning needed. Moderate washboarding (1"-2" deep) over 10%-25% of the area. Moderate dust, partial obstruction of vision. None or slight rutting (less than 1" deep). An occasional small pothole (less than 2" deep). Some loose aggregate (2" deep).	Shows traffic effects. Regrading (reworking) necessary to maintain. Needs some ditch improvement and culvert maintenance. Some areas may need additional gravel.
2 Poor	Little or no roadway crown (less than 3"). Adequate ditches on less than 50% of roadway. Portions of the ditches may be filled, overgrown and/or show erosion. Some areas (25%) with little or no aggregate. Culverts partially full of debris. Moderate to severe washboarding (over 3" deep) over 25% of area. Moderate rutting (1"-3"), over 10%-25% of area. Moderate potholes (2"-4") over 10%-25% of area. Severe loose aggregate (over 4").	Travel at slow speeds (less than 25 mph) is required. Needs additional new aggregate. Major ditch construction and culvert maintenance also required.
1 Failed	No roadway crown or road is bowl shaped with extensive ponding. Little if any ditching. Filled or damaged culverts. Severe rutting (over 3" deep), over 25% of the area. Severe potholes (over 4" deep), over 25% of area. Many areas (over 25%) with little or no aggregate.	Travel is difficult and road may be closed at times. Needs complete rebuilding and/or new culverts.

** Individual road sections will not have all of the types of distress listed for any particular rating. They may have only one or two types.*

RATING 5

EXCELLENT — Little or no maintenance required

New construction with excellent crown, drainage and gravel layer. Little or no distress.

► **Newly constructed road with excellent crown, drainage and gravel layer.**

► **Road has excellent crown. Gravel has been stabilized for dust control. Very good drainage.**

RATING 4

GOOD — Routine maintenance may be required

Good crown, drainage and gravel layer. Distress limited to traffic effects such as dust, loose aggregate, and slight washboarding.

◄
Good crown, ditches, and gravel layer. Slight traffic effects, washboarding, and loose gravel.

◄
Good crown and gravel, ditch appears good throughout. Occasional routine grading for traffic effects.

◄
Plenty of crown and excellent ditch. Needs routine grading to eliminate slight secondary ditch and loose gravel.

RATING 3

FAIR — Regrading and drainage improvement, spot gravel application needed

Adequate drainage and crown on more than 50% of roadway. Gravel layer is adequate with only need for spot replacement. Regrading needed to improve crown and repair wash-boarding and slight ruts or potholes.

► **Good gravel and crown but ditch partially blocked. Needs cleaning or additional culvert.**

► **Heavy accumulation of loose gravel requires regrading. Ditch cleaning needed on right side.**

► **Fair crown and good gravel layer. Shallow ditch needs improvement.**

RATING 3

FAIR — *(continued)*
Regrading and drainage improvement, spot gravel application needed

◄
Fair crown and gravel layer. Needs ditching on right and more crown.

◄
Adequate drainage and fair crown. A few small potholes indicate need for regrading and additional gravel.

RATING 2

POOR — More gravel and major drainage improvements required

Travel at slow speeds (25 mph) may be necessary. Additional gravel layer needed to carry traffic. Little or no crown. Ditching is inadequate on more than 50% of roadway.

► **Some gravel and crown but almost no ditch. Driveway culvert required.**

▲ **Little gravel and almost no ditches or crown.**

No crown, poor drainage, and needs gravel. ▼

▲ **Lack of ditch on right causes ruts. Needs gravel.**

Numerous potholes indicate additional gravel most likely required to restore crown. Needs extensive reworking. ►

RATING 1

Failed — Reconstruction required

Needs complete rebuilding. Travel is difficult; road may be closed at times.

◄
Ruts. No ditch or aggregate.

▲ **Deep ruts and potholes. No drainage. Travel is difficult.**

▲ **Complete failure. Restricted travel.**

Practical advice on rating roads

Inventory and field inspection

Most agencies routinely observe roadway conditions as a part of their normal work and travel. However, an actual inspection means looking at the entire roadway system and preparing a written summary of conditions. This inspection has many benefits over casual observations. Useful comparisons between segments can be made and more dependable decisions are likely because the entire roadway system is considered.

An inspection also encourages a review of specific conditions important in roadway maintenance—drainage and adequate strength, for example.

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 also improves your credibility with the public.

Finally, a written inventory is very useful in documenting the changing roadway conditions. Without records extending over several years, it is impossible to know if your road conditions are improving, holding their own, or declining.

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

The Wisconsin DOT local road inventory (WISLR) is a valuable resource for managing your local roads. Adding PASER surface condition ratings is an important improvement.

Averaging and comparing sections

For evaluation, divide the local road system into individual segments which are similar in construction and condition. Rural segments may vary from ½ mile to a mile long, while some sections in urban areas will likely be 1-4 blocks long or more. If you are starting with the WISLR inventory, the segments have already been established. You may want to review them for consistent road conditions. Obviously no roadway segment has entirely consistent conditions. Some "averaging" will be necessary. Also, individual road segments will not have all of the types of distress listed for any particular rating; they may have only one or two. The objective is to rate the condition that represents the majority of the roadway. 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 project design. For example, some spot repairs may be required.

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

The overall purpose of condition rating is to provide a relative comparison of the condition of all your pavement segments. Therefore, comparing any two pavement segments would show the better pavement having a higher rating. Within a given rating, say 3, not all pavements will be exactly the same. However, they should all be considered to be in better condition than those with lower ratings, say 2. Sometimes it is helpful in rating a difficult segment to compare it to other previously rated segments. For example, if it is better than one you rated 2, and worse than a typical 4, then a rating of 3 is appropriate. Having all road segments rated in the proper relative order is most important and useful.

Separating road function from conditions

Gravel roads often are found in very low volume applications. This sometimes is confusing. People rating roads are more willing to accept poor condition on a road if it is little used. In higher traffic situations, they expect a road in better condition.

Therefore, there may be a tendency in evaluating the condition of a road to evaluate the condition more harshly in higher traffic volume situations and to be more lenient in evaluating little-used roads. This tendency should be avoided. The evaluation of the actual roadway condition must be objective.

You will also consider the road's function or importance but this must be done separately. Roads can be categorized by their use or their function. In selecting project improvements, you will likely consider both the road condition and the road's importance to select the most needed projects.

Planning maintenance and repair

We have found that relating a normal maintenance or rehabilitation procedure to the surface rating scheme helps local officials use the rating system. However, an individual surface rating should not automatically dictate the final maintenance or rehabilitation technique. You should consider safety, future traffic projections, original construction, and roadway strength since these may dictate a more comprehensive rehabilitation than the rating suggests.

Summary

Using local road funds most efficiently requires good planning and accurate identification of appropriate rehabilitation projects. Assessing roadway conditions is an essential first step in this process. The PASER evaluation procedure has proven effective in improving decision making and using highway funds more efficiently. It can be used directly by local officials and staff. It may be combined with additional testing and data collection in a more comprehensive pavement management system. For additional training and information, contact the Wisconsin Transportation Information Center.

Transportation Information Center Publications

Pavement Surface Evaluation and Rating (PASER) Manuals

Asphalt PASER Manual, 28 pp.

Brick and Block PASER Manual, 8 pp.

Concrete PASER Manual, 28 pp.

Gravel PASER Manual, 20 pp.

Sealcoat PASER Manual, 16 pp.

Unimproved Roads PASER Manual, 12 pp.

Drainage Manual
Local Road Assessment and Improvement, 6 pp.

SAFER Manual
Safety Evaluation for Roadways, 40 pp.

Flagger's Handbook (pocket-sized guide), 22 pp.

Work Zone Safety, Guidelines for Construction, Maintenance, and Utility Operations, (pocket-sized guide), 58 pp.

Wisconsin Transportation Bulletins

#1 Understanding and Using Asphalt
#2 How Vehicle Loads Affect Pavement Performance
#3 LCC—Life Cycle Cost Analysis
#4 Road Drainage
#5 Gravel Roads
#6 Using Salt and Sand for Winter Road Maintenance
#7 Signing for Local Roads
#8 Using Weight Limits to Protect Local Roads
#9 Pavement Markings
#10 Seal Coating and Other Asphalt Surface Treatments
#11 Compaction Improves Pavement Performance
#12 Roadway Safety and Guardrail
#13 Dust Control on Unpaved Roads
#14 Mailbox Safety
#15 Culverts-Proper Use and Installation
#16 Geotextiles in Road Construction/Maintenance and Erosion Control
#17 Managing Utility Cuts
#18 Roadway Management and Tort Liability in Wisconsin
#19 The Basics of a Good Road
#20 Using Recovered Materials in Highway Construction
#21 Setting Speed Limits on Local Roads
#22 Pre-wetting and Anti-icing
#23 Meeting Minimum Sign Retroreflectivity Standards

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