Evaluation and Rating of Gravel Roads

DONALD M. WALKER

Roadway maintenance management systems and pavement management systems are growing in popularity with road maintenance agencies. These systems require an objective evaluation of roadway pavement conditions, including a numerical rating scale to be used in analysis and priority selection procedures. An evaluation and rating system for gravel roads has been developed. The evaluation and rating give primary consideration to drainage, crown, and adequacy of the gravel thickness. Other measures of distress, such as washboarding, dust, ruts, and potholes, are also considered; however, they are considered as secondary indicators of roadway conditions. The procedure highlights an understanding of typical distress along with the causes and remedies for the individual types of distress. The rating procedure is closely linked to the appropriate maintenance or rehabilitation treatment.

Roadway maintenance management and pavement management systems are growing in popularity with road maintenance agencies. These systems require an objective evaluation of roadway pavement conditions. Normally, they require a numerical rating scale to be used in the analysis and priority selection of projects. Although considerable research and development effort has been devoted toward evaluation and rating of asphalt and concrete pavements, only a limited amount of work has been completed on rating systems for gravel surface roadways. The U.S. Army Corps of Engineers has developed one system (*1*).

The Transportation Information Center at the University of Wisconsin in Madison has developed a visual rating evaluation system for asphalt, concrete, and gravel roads, called the Gravel-PASER system (*2*). The system is in use by city, county, and town governments in Wisconsin and is being incorporated into various pavement management systems. It is being used on road systems with urban arterials, county highways, and low-volume town and county roads. Actual use and training of field personnel is best done with the Gravel-PASER Manual, which incorporates many photographs to illustrate the rating procedure. Individual maintenance agencies may want to develop their own version of a rating and evaluation procedure that incorporates local conditions.

PAVEMENT MANAGEMENT SYSTEMS

The development and use of a pavement management system has provided many benefits to agencies with road maintenance responsibility. Such a system is an organized approach to make the most effective use of limited budgets. By documenting the actual conditions of roads, realistic budgets can be developed and timely repairs can be scheduled. The development of an overall plan for the roadway systems helps agencies develop a meaningful budget and plan for future needs. The detailed information provided by a pavement management system is also effective in gaining public support for an adequate budget.

Key steps in developing a roadway management system should be taken. As a minimum, the roadway system must be broken into individual roadway segments of a similar pavement thickness and traffic volume. Inventory information on the segment, such as geometrics, traffic volume, and functional classification, is normally included. Also, some assessment of the roadway condition must be provided. Generally, through detailing the type of distress, its extent, and its severity, an overall indicator of condition is developed.

The management system can then develop cost and recommended maintenance rehabilitation strategies on the basis of condition information. A system can further order projects by priority in analysis to maximize cost benefits. Many systems have completely automated the process. Others simply include an inventory and condition survey and require the user to develop priorities and cost estimates.

Agencies with many miles of low-volume roads may not feel a sophisticated pavement management system is justified. However, a basic inventory and condition rating can be developed using local personnel with limited training. Because most agencies routinely review road conditions in the development of their budgets, little additional work is required to document these conditions. An agency can begin with a simple system that can evolve into a more sophisticated pavement management system as the benefits are demonstrated.

ROAD CONDITION EVALUATION AND RATING

All pavement management systems require the evaluation of pavement conditions. Even without a formal pavement management system, a basic record of pavement conditions is useful to maintenance supervisory staff. However, the rating and evaluation system must reflect the needs of the agency. With computerized systems, users are tempted to collect large amounts of data. For obvious cost reasons, only data that will be used should be collected. A simple approach that produces results is more likely to continue in use than a large, complicated system with limited benefits.

The pavement rating scale used in the PASER manuals is a visual rating. The scale is based on the type and severity of common defects. The overall rating scale is directly related to the type of maintenance or rehabilitation most appropriate for that roadway segment.

The PASER pavement rating scale requires the use of judgment by the person doing the rating. In a simple system, the best time to make those evaluations and judgments is when

Engineering Professional Development, University of Wisconsin, 432 N. Lake Street, Madison, Wis. 53706.

the rating team in the field, looking at the roadway. This rating system has the benefit of requiring the rating team to look for critical defects and answer the difficult questions on location. Having supervisory personnel inspect for critical information in the field, make a judgment on the overall road condition, and recommend maintenance or rehabilitation has its benefits. If that decision cannot be reached by a visual inspection, the staff is motivated to recommend additional testing, sampling, or other evaluation. The decision is not delayed and does not become an arbitrary analysis of numerical values.

Inspection and rating can be done by technical staff, managers, or elected officials. This system is designed to be simple and effective. Experience indicates that elected officials with a limited technical background can easily be trained to do the rating. The system works best when rating is done by both management and staff. This approach improves communication and significantly improves implementation of maintenance or reconstruction recommendations.

RATING GRAVEL ROADS

Rating and evaluating gravel-surfaced roads differs from rating paved surfaces. Gravel road surface conditions change quickly. Heavy rains, heavy local traffic, or recent maintenance activities can significantly change many of the gravel road surface characteristics. Therefore, gravel road rating should be based primarily on three major factors.

Because the purpose of the rating and evaluation is to determine a need for future maintenance and rehabilitation, the rating system should reflect the major factors that affect the performance of the roadway. These factors are roadway crown, drainage, and adequacy of the gravel layer. Performance of a gravel road under traffic depends heavily on these factors.

The road crown and drainage system, primary factors in the evaluation, can be readily observed. Determining the adequacy of the gravel layer may be more difficult. Whether the thickness is sufficient and the aggregate quality is acceptable to carry the traffic using the road should be determined. Actual sampling of material thickness and quality would be helpful. However, performance of the roadway under existing traffic can provide a good indication of the adequacy of the gravel layer. Load-related distress, such as rutting, and failure, such as potholes, are obvious indicators of inadequate load-carrying abilities.

Other surface distresses will be of secondary interest. Washboarding, loose rock, and dust are primarily indications of traffic distress and the adequacy of recent maintenance activities. Although these factors are important in planning routine maintenance, they are less critical for planning major rehabilitation or reconstruction.

ROAD CONDITIONS AND DEFECTS

A gravel road is best given an overall rating through observation of individual defects. These defects can be combined to provide the information necessary to make an overall assessment of road conditions. This system will consider three primary conditions: crown, drainage, and gravel layer, along with the secondary effects of surface deformation and defects.

Crown

A gravel-surfaced road must be built so that water drains quickly off the roadway. Thus, a crown is built into the road. Normally, a gravel road should have between ½ and ¾ in. per ft of width of fall (crown) from the center of the edge of the roadway. No ponding or depressions that will collect water should be in the road. The shoulder or edge of the roadway must transition smoothly into the ditch. High shoulders or secondary ditches trap water and soften the roadway. A carpenter's level mounted on a straight 2 × 4 may be useful in determining the exact amount of crown. However, an adequate crown and the absence of features such as ruts and secondary ditches can easily be observed.

Drainage

The drainage system adjacent to the roadway must be adequate to handle surface water flow. The system includes primarily ditches and culverts. The ditch must be wide and deep enough to accommodate all surface water and have an adequate slope so that water does not pond or cause erosion. Generally, a V-shaped or rounded ditch is provided. Having the bottom of the ditch a minimum of 1 ft below subgrade to provide adequate drainage is desirable. Evidence of serious ponding, flooding, and erosion can be seen at almost any time of the year. A review of slope and ditch adequacy may be more easily made during wet weather conditions. Detailed surveys or wet weather inspection would be useful on individual projects planned for grading or reconstruction.

Roadway culverts and bridges are also important elements to be reviewed. Collapsed culverts or silt- and debris-filled culverts or bridges are indications of poor drainage. Adequate headwalls and culvert apron endwalls help minimize erosion.

Rating drainage on a roadway segment requires an assessment of the overall condition and identification of spot problems. Localized conditions are commonly found to need cleaning or repair. Making an overall assessment, such as the percentage of roadway that needs ditch cleaning versus major ditch and culvert construction, is important. Those assessments will help determine the extent of budgeted maintenance or rehabilitation required.

Adequate Gravel Layer

The third major factor to consider is the adequacy of the gravel layer. The gravel pavement thickness must obviously be designed to accommodate the traffic loads and soil conditions. Therefore, no simple and uniform guidelines exist. In evaluating and rating this characteristic, signs of distress related to inadequate pavement strength should be sought. Failures from heavy loads take the form of rutting and potholes. Minor surface rutting (less than 1 in.) can occur from traffic dislodgement of gravel. Deeper rutting (over 1 in.) is a better indicator of actual strength limitations related to the gravel layer. Isolated potholes may indicate isolated conditions. More extensive potholes and breakdown of the surface are indications that an adequate layer does not exist.

Understanding the maintenance record of a road also improves the ability to rate and evaluate conditions. If frequent regrading is necessary to prevent rutting and repair potholes, an adequate gravel layer may not exist. Obviously, roadway strength is related to drainage and subgrade support, as well as gravel thickness. A gravel layer that would normally be adequate may not perform well if the roadway is frequently flooded or in an area of a very high water table.

If surface distress, such as rutting and potholing, is not sufficient to evaluate the adequacy of a gravel layer with confidence, more field investigation is recommended. Several test holes can provide information on the thickness of the gravel layer. A visual inspection of the aggregate may indicate poor gradation. Laboratory testing of aggregate properties is even more useful.

SURFACE DISTRESS

The following defects are important to consider when developing an overall surface rating. Records on the extent and severity of these types of defects, when monitored from year to year, can show how well roadways are performing. The rate of change and development of surface defects can be helpful in selecting between routine maintenance and major rehabilitation.

Washboarding

Washboarding (corrugations) of an aggregate surface is a common distress under traffic loading. Washboarding provides an uncomfortable ride and can be a safety hazard. Slight to moderate (1–3 in.) washboarding can normally be corrected by routine grading. Heavy washboarding may be an indication of the need for additional gravel.

Potholes

Potholes may develop as an isolated defect. These require spot-patching or maintenance from a safety standpoint. Extensive (over 25 percent of the area) and deep (over 4 in.) potholes are an indication of lack of strength and the need for more major rehabilitation and the addition of gravel. Potholes trap water and can speed surface deterioration if routine maintenance is not provided.

Rutting

Rutting is another important defect to consider. Minor (less than 1 in.) rutting in the wheel path may be simply an indication of a heavy traffic volume. Routine regrading and maintaining good surface drainage can remedy this defect. Deeper rutting (over 3 in.) may indicate lack of gravel thickness or subgrade support. This defect is very serious and usually indicates that major reconstruction is required.

Dust

Dust from traffic is also a common occurrence on a gravel road. The gradation of the gravel, weather conditions, and traffic volumes will determine the extent and severity of dust. Since heavy dust conditions remove necessary fines from the roadway, this defect can be an indicator of future maintenance problems. Thick dust that obscures traffic can create obvious safety problems. A dust palliative is useful, especially near populated areas.

Loose Aggregate

Dusty conditions and the resulting loss of fine aggregate can produce an excess amount of loose large aggregate on the gravel surface. Under traffic, this loose aggregate can tend to collect between wheel paths and along the side of the road, creating a driving hazard and affecting drainage. Minor amounts of loose aggregate can often be remixed by routine grading. Large accumulations (over 4 in.) of loose aggregate can impede drainage and indicate a loss of the strength of the remaining gravel layer.

GRAVEL RATING SCALE

A simplified 5-point rating scale has been developed. Each category is intended to indicate conditions directly related to the need for maintenance or rehabilitation. The ratings may be thought of as follows:

5 (Excellent): A newly constructed road. Excellent crown, drainage, and gravel layer.

4 (Good): Recently regraded with good crown and drainage and adequate gravel layer.

3 (Fair): Needs routine regrading or minor ditch maintenance.

2 (Poor): Needs additional aggregate or major drainage maintenance.

1 (Failed): Complete rebuilding required.

The rating scale is discrete, and other ratings (2.5, for example) are not encouraged.

Table 1 contains a description of the individual ratings with the typical distress and recommended maintenance or rehabilitation procedures. Roadways will not have all types of distress at any particular time. They may only have one or two of the individual distresses.

IMPLEMENTATION

Establishing the limits of individual roadway segments requires initial planning. Elements of a segment should all have similar pavement thickness, traffic volume, and function. A segment should be limited by what would be reasonable for individual maintenance or reconstruction projects. Smaller segments can be created to isolate different conditions. Typical gravel road segments in Wisconsin seem to average 1 mi or slightly more.

TABLE 1 RATING SYSTEM

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 maintenance may be needed.
3 Fair	Good crown (3" - 6"). Ditches present on more than 50% of roadway. Gravel layer is mostly adequate, but additional aggregate may be needed at a few locations to help correct washboarding or isolated potholes and ruts. Some culvert cleaning needed. Moderate washboarding (1" - 2"), 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. *Note: Individual roadways may not have all of the types of distress listed for any particular rating. They may have one or two types.
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.

TABLE 1 (*continued on next page*)

TABLE 1 (*continued*)

Surface rating	Visible Distress*	General condition/ Treatment measures
1 Failed	No roadway crown or road is bowl shaped with extensive ponding.	Travel is difficult and road may be closed at times.
	Little if any ditching.	Needs complete rebuilding and/or new culverts.
	Filled or damaged culverts.	
	Severe rutting (over 3" deep), over 25% of area.	
	Severe potholes (over 4" deep), over 25% of area.	*Note: Individual roadways may not have all of the types of distress listed for any particular rating. They may have one or two types.
	Many areas (over 25%) with little or no aggregate.	

Inventory Date_____
By_____

SEGMENT & LOCATION
Road/Name_____ Segment No._____
From_____ To_____
Length_____

USE & CLASSIFICATION
Road Function_____ Avg. Daily Traffic_____
Land Use_____

ROADWAY CONDITION DATA
Crown_____ Gravel Depth/Quality_____
Ditch and Culvert Adequacy_____
Roadway Condition Rating_____
Special or Spot Problems_____
Comments_____

GEOMETRICS
Width of Traveled Way_____
Horizontal Alignment Rating_____
Vertical Alignment Rating_____
R/W Width_____
Comments_____

OTHER
Comments_____

IMPROVEMENT HISTORY

Year	Work Completed	Estimated Cost

FIGURE 1 Sample inventory form.

Rating	Action Required	Miles
5	None	9.3
4	Minor Grading	20.7
3	Minor Ditching/Reshaping	58.5
2	Added Gravel/Drainage Rehab	39.8
1	Reconstruction	19.2
	Total Miles of Gravel Roads	147.5

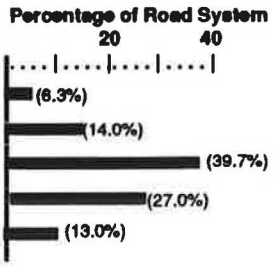

FIGURE 2 Surface condition ratings.

Experience indicates that the field rating process can easily cover 20 to 40 mi per day. Small agency networks have been completed in one day, but larger agencies may require more. The survey should be done annually, at the same time of year. Fall and Spring seem to be convenient and useful for budget development.

Rating an individual roadway segment usually involves evaluating conditions over a considerable length (1 mi or more). Because no roadway segment will be entirely consistent, averaging of conditions is necessary. Small or isolated conditions should not influence the overall rating, but should be noted for maintenance. The overall purpose of the condition rating is to provide a relative comparison between pavement segments. The rating system should be used to keep the conditions in relative order. That is, those rated 3 should all be better than those rated 2 and not as good as those rated 4. Within a specific rating, of course, not all roadways will be identical.

A sample inventory form is shown in Figure 1. Collecting past maintenance and construction information on the inventory form is useful. This information can be used in selecting future maintenance. Information on localized problems (which only occur once) is also useful for maintenance scheduling but not critical for decisions on major roadway reconstruction. Individual agencies are strongly urged to develop their own inventory form to fit their needs and the complexity of their system.

APPLICATIONS

This simple procedure allows decision makers to compare the conditions of road segments. Documenting poor road conditions helps to assign funds to the roads most in need of work. Listing roadway improvements by category has also been found helpful. That categorization is a simple listing of all roads that need routine minor regrading and ditch maintenance (rated 3), a separate listing of those that need additional gravel and major ditch cleaning (rated 2), and a listing of those needing complete reconstruction (rated 1). A review of these lists is helpful in selecting projects that may not appear on a priority listing of the worst roads. Because a priority listing is usually oriented toward worse conditions, ditch cleaning and routine maintenance projects may not surface until the road segment is completely deteriorated. Therefore, a review of individual listings by category helps balance decision making for cost-effective budgets.

One of the most important benefits of rating pavements is that decision makers are given an understanding of the overall road conditions. Figure 2 shows graphically the condition of a roadway system. If a road system is only in fair or poor condition, this type of data display can be very effective in convincing decision makers that additional improvements are necessary. The display can also indicate the benefits received from previous budget allocations. Watching this representation of road conditions from year to year is helpful in assessing the effectiveness of budgeted road funds. Once the rating has been completed, this information is easy to assemble and can be a significant benefit.

SUMMARY

A simplified gravel road rating procedure has been developed to assist agencies in implementing pavement management systems. Local agencies with low-volume roads can use the procedure as part of a comprehensive pavement management system or as a simple maintenance planning and budgeting tool.

The rating system, which uses a visual inspection approach and is linked directly to required maintenance and rehabilitation, uses information normally collected and understood by local maintenance supervisors and elected officials. Experience has shown that this rating procedure helps local officials develop budgets based on need. Better decision making and adequate budget preparation are the benefits of gravel road evaluation and rating.

ACKNOWLEDGMENTS

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REFERENCES

1. *Rating Unsurfaced Roads*. Special Report 87-15. U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, N.H., 1987.
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