UNH T² Center Technical Note

Unpaved Roads

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Over 50 percent of roads in the United States are gravel. This meant 1.6 million miles of road in 2000. The design of gravel roads is similar to paved roads. Create a good crown, shoulders, and roadside ditching for gravel roads. These will improve road drainage and life expectancy.

An unpaved surface allows easier seepage of water into the road, dusting, and increased wear from traffic. Gravel roads require more frequent maintenance and rehabilitation than paved roads. Paving a gravel road is very beneficial, but the decision to pave a gravel road is not always simple.

Design

Design is a necessary process in the creation of a road to minimize:

- failure in the subgrade,
- surface damage, and
- costs associated with maintenance and rehabilitation.

Most maintenance personnel can answer this question, "What are the three most important factors in designing a good road?" The answer is "Drainage, drainage, drainage!" Improving a road's drainage significantly decreases the amount of road maintenance. While proper drainage can be expensive, it will save money over time by eliminating costly maintenance and rehabilitation projects.

Key drainage features are:

- crown,
- ditches,
- shoulders, and
- culverts where necessary.

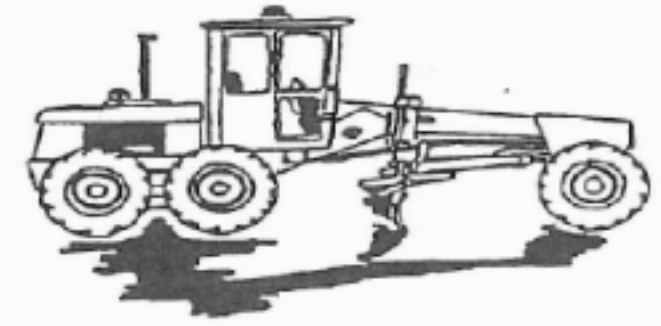
These features will keep surface water away from the roadway and subgrade.

Another key design element is the aggregate subgrade. The minimum design thickness is four inches, which is twice the maximum particle size, or the structural thickness plus the aggregate loss (operational loss); whichever is greater. However, a depth of six inches is typical. What material you use is the

most important thing to consider when designing the subgrade. Choose the best gravel that fits into the budget.

Maintenance Practices

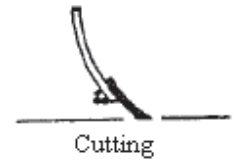
The purpose of road maintenance is to preserve the shape and structure of the road and to maintain a smooth travel surface. Perform maintenance on gravel roads with a motor grader. Gravel road maintenance is best done in wet weather to reduce loss of fines, such as dust.



Reshape the roadway, shoulders, and ditches regularly. Maintain about a 4% (or ½ inch per foot) crown on the roadway with as little deviation as possible. Use a grader to create a crown that follows a straight line from the centerline of the road to the shoulder.

Patching and filling in dips is also a good practice. Fill in the hole or dip with excess material and blade it to match the shape of the roadway. Compact both the roadway and patches to prevent water from entering the subgrade, minimize damage from traffic, and provide a smooth riding surface.

Shape the shoulder to be at least as steep as the roadway to allow water to flow off the roadway. Often, when a shoulder is shaped too high, a secondary ditch is formed. Water accumulates in the secondary ditch rather than running off into the ideal ditch. The water then seeps into the subgrade and softens the roadway.



Softened areas present severe problems in periods of heavy rainfall because they lead to significant erosion or "washouts." Reshape in spring when roadside vegetative growth is minimal.

Ditches are always necessary even where space is limited. Make ditches wide and deep enough to carry runoff from the roadway. Shape the ditch steep enough to keep water moving away from the road. Do not allow water to become stagnant because it creates a breeding ground for mosquitoes.

Consult the *Motor Grader Operator's Manual* by the UNH Technology Transfer Center for more information on reshaping gravel roads.

Mowing

Mowing is a beneficial maintenance practice. It facilitates shouldering and other maintenance work, allows recovery of gravel that has drifted off the roadway, and increases driver safety by improving sight distance. Roadside vegetation catches drifting snow and keeps it on the roadway. Mowing allows drifting snow to pass over the roadway. This reduces snow removal costs and damage from freeze-thaw cycles.

Dust Stabilization

One nuisance created on gravel roads is dusting. Dusting occurs when weather or traffic causes fine aggregates to release into the air. As much as one ton of aggregate is lost per mile of gravel road each year for every vehicle using the road daily (*Gravel Roads Maintenance and Design Manual, FHWA and SD LTAP, 2000*).

Reasons to use dust stabilization include:

- to respond to resident complaints,
- reduce material loss,
- save on expensive maintenance, and
- minimize impact on the nearby environment.

However, if the traffic volume on the road is low and no residents have complained, then taking stabilization measures may not be worth the cost.

Table 1 (on tech. note p.4) lists several dust stabilizers. Select which stabilizer to use based on budget, desired functionality and environmental characteristics.

When to Pave a Gravel Road

Cost is the major issue affecting municipalities when considering whether to pave a road. However, the long-term maintenance cost should be considered as well as the immediate construction cost. Several questions must be considered, including:

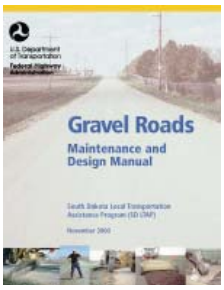
- Is there enough traffic to justify paving the road?
- Should the drainage and subbase be repaired instead of paving?
- Do standards require the road to be paved?
- What does the public think?
- Which will be the most cost effective over time?

Additional Factors

Many other factors influence the decision of whether to pave a gravel road, including:

- Paved roads increase safety by improving skid resistance and visibility from reduced dust. However, people tend to speed more on paved roads than on gravel roads.
- Gravel roads look more natural than paved roads, which is a factor when considering road aesthetics.
- There is usually increased runoff (water and salt) from a paved road since pavement prevents water penetration; whereas gravel surfaces allow some penetration. Increased runoff creates a larger impact on the surrounding environment.
- There may be inevitable reasons for repair, such as installing underground utilities or use of the road by heavy vehicles. Consider keeping a road unpaved if major repairs cannot be avoided. It is less expensive to repair a gravel road than a paved road.

The *Gravel Road Maintenance and Design Manual* by the South Dakota LTAP and FHWA, provides a good rationalization on whether or not to pave a gravel road.



Sources
Gravel Roads Maintenance and Design Manual, FHWA and SD LTAP, November 2000
Maintenance of Aggregate and Earth Roads, Washington State DOT, June 1987
Earth and Aggregate Surfacing Design Guide for Low Volume Roads, USDA, September 1996
Dust Palliative Selection and Application Guide, USDA, November 1999

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Table 1. Types of Stabilizers

Stabilizer	Attributes	Benefits	Limitations	Typical Dosage
Calcium Chloride (CaCl2)	Hygroscopic-draws moisture from air to keep road surface constantly damp	• Increases surface tension of water--holds water to surface and tightens soil particles • Allows regrading and recompacting of road without losing moisture and density • Works well for most dust stabilization purposes	• Tends to leach out during severe rain-may impact local water quality • May cause slippery surface if the road has a lot of fine aggregates	• One per season
Clay Additives	Agglomerates with fine dust particles	• Increases dry strength of road surface • Natural--minimal environmental impact • Infrequent dosage	• Difficult to haul • Difficult to mix with gravel • Not suitable for heavy traffic loads	• Once every five years
Lignin	Binds surface particles	• Suitable for heavy traffic loads • Works well in dry weather • Natural--minimal environmental impact • Strongly increases dry strength of road • Waterproofs road	• Not effective in wet weather • Causes slippery surface when wet • Causes brittle surface when dry	• One to two per season
Magnesium Chloride (MgCl2)	Hygroscopic-draws moisture from air to keep road surface constantly damp	• Strongly increases surface tension--forms a hard road when dry • Allows regrading and recompacting of road without losing moisture and density • Works well for most dust stabilization purposes	• Same as Calcium Chloride (top)	• One per season
Petroleum Products	Binds surface particles	• Waterproofs road • Functions in wet weather • Works well for most dust stabilization purposes	• Significant environmental impact • Banned in some areas • Expensive	• One per season
Sodium Chloride (NaCl)	Hygroscopic-draws moisture from air to keep road surface constantly damp	• Relatively inexpensive • Abundant--often part of municipalities' winter maintenance budget	• Requires frequent reapplication • Corrosive to steel • Not very effective	• Two per season