

Improving Farm Roads and Drives with Drainage

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As farms grow, so do the machinery and transport vehicles using their roads and driveways. Heavy equipment (for example milk trucks, grain/feed trucks, and manure tankers) can damage roads and drives, causing ruts, and can become stuck during wet conditions. This is a sign that drives need upgrading to avoid further deterioration and the frustration of stuck equipment during wet periods.

Good drainage of the sub-grade (natural soil under the road, Figure 1) is essential when developing an all-weather road. Most soils lose their bearing strength as moisture content increases. Therefore, measures must be taken to limit the amount of water that can reach the sub-grade soil. There are several ways to limit water from reaching the sub-grade, depending on the site.

If the water table moves into the sub-grade in part of a road, drainage tile with an unrestricted outlet will be needed to keep the sub-grade as dry as possible. Runoff water from fields should not flow onto the road surface. Precipitation percolating through the road surface should have a short path to drain away from the sub-grade. Surface water can be kept away from the sub-grade can be accomplished by constructing road ditches on either side of the road. The bottom of the road ditch should be at least 1.5 feet below the surface of the sub-grade. The cross section of the road ditch should be large enough to handle the expected flow of water without causing erosion of the ditch bottom. The slope of the ditch and the ditch lining material should be designed to avoid erosion as well. Banks of the road ditch should be no steeper than 4:1 (4 inches horizontal:1 inch vertical) to avoid equipment rollovers.

Where flowing water must cross the road or a driveway, culverts often carry water under the road sub-base. Culverts must be sized to transport the expected flow without causing ponding in the ditch or stream system, or overtopping of the road surface. Culverts allow the road to be used without driving through flowing water. An alternative to culverts is specially designed “stream crossings” which allow water to flow across the road surface. Since stream crossings are frequently wet, the base and surfacing material of this part of the road must be designed differently than where the road is well drained. A thicker road sub-base, and frequently a concrete surface, are used in a stream crossing. Culverts require periodic maintenance to remove sediment and debris that might clog them.

Precipitation falling on a road can reach the sub-grade and reduce its strength. Several measures can limit how much water reaches the sub-grade. Crowning the gravel road

surface in the center of the road with a surface slope of 1/2in./ft (4%) encourages good surface drainage. The road surface should be smooth for surface drainage to occur. Ruts, potholes, and gravel ridges or windrows at roadsides trap water and encourage infiltration to the sub-grade soil. Regular maintenance is needed to remove ruts, potholes, and gravel ridges at the edge of the road. The road surfacing material must contain some fine soil particles (binder) to encourage runoff. Wisconsin Transportation Bulletin No. 5 states that a good road surfacing gravel has the following characteristics (percentages based on weight):

- 40-80% hard stone, uniformly graded from 1/4 to 3 in. diameter
- 20-60% sand smaller than 1/4 in.
- 8-15% fines

The road sub-base is designed to spread the wheel load over a larger area of sub-grade surface and to allow water to move to the road ditch before percolating into the sub-grade. To accomplish both of these tasks, the sub-base must be sufficiently porous and must remain on top of the sub-grade. Sub-base porosity is achieved by using larger aggregate particle sizes. Sub-base materials can be well-graded gravel to breaker run (3/4 to 3 in.) with 0-10% fines. The thicker the sub-base layer, the lower the pressure exerted on the sub-grade for a given wheel load. Therefore, thicker sub-base layers are needed for larger and more frequent loads. Sub-grade soils containing a higher percentage of fines (silt and clay) can experience pumping of soil/water mixtures into the sub-base over time. This mixing of soil with the sub-base reduces the strength of the sub-base and further limits its ability to internally drain water to the road ditch. Geotextile materials are often used as a barrier between the sub-grade and sub-base to preclude the pumping of sub-grade soils into the sub-base.

Crowning of the sub-grade surface encourages water to flow toward the road ditch. Crown the sub-base surface at the same 4% slope as the road surface to maintain a uniform road base thickness.

Good gravel roads are needed for efficient transportation on the farm. Good roads require strong foundations, and water management is critical for maintaining the strength of the foundation.

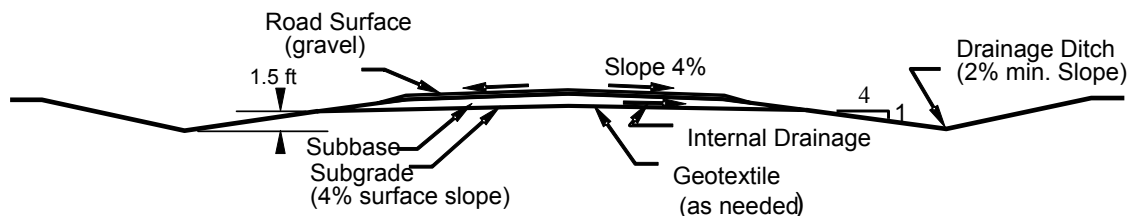


Fig. 1 Cross Section Gravel Road Drainage System

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