CHAPTER 6
UNPAVED SURFACES

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6.1 INTRODUCTION

Over the years, the number of unpaved roadway miles has gradually decreased. Less than 1% of state owned roadways are considered unpaved. Although the number of unpaved roads has decreased, maintenance of unpaved roads is still important to PennDOT. These unpaved roadways carry local traffic between rural communities and they provide a link to the paved roadway network which carry the main streams of traffic.

Unpaved roads are those surfaces that are gravel, cinder, or earth. Sometimes the surface has been stabilized, but it is still considered unpaved. Additional information on unpaved roads can be found in the Unpaved and Gravel Roads course through the Local Technical Assistance Program (LTAP), and through Penn State's Center for Dirt and Gravel Road Studies.

6.2 UNPAVED ROADWAY DISTRESS

Frequent inspection of unpaved roads is required for good maintenance. The surface of an unpaved road must be graded and compacted as required. The surface must maintain proper crown or superelevation so that surface water will move quickly from the roadway to suitable drainage. Each drainage structure must be inspected to determine if it needs to be cleaned, repaired or replaced.

Additional details on unpaved road activities are available in Publication 113, Highway Foreman Manual, Publication 447, Approved Products for Lower Volume Local Roads, and in the Best Management Practices (BMP) from Publication 464, Maintenance Field Reference for Erosion and Sediment Controls.

DISTRESS TYPES

Distress categorization for extent and severity can be found in Publication 343, Continuously Reinforced Concrete and Unpaved Roads Condition Survey Field Manual.

Loss of Aggregate Surface - This distress is characterized by the loss of surfacing material exposing rock, native stone, or other subgrade material. In an aggregate surfaced road, fine and course aggregates interlock to form a dense stable surface. The fine aggregates fill the voids between the coarser aggregates and hold or bind the coarse aggregates in place. When fine binder aggregates are lost either as dust or by erosion, the coarse aggregate becomes loose and then can be worn away by the action of traffic potentially causing slick conditions. Contributing to the loss of aggregate are poorly constructed crown or cross slope, snow removal, and lack of dust palliative. Correct this distress by grading or blading with the addition of binder material to improve the gradation of the surface material.

Corrugations - Corrugations are a series of ridges and depressions across the surface of the road that are perpendicular to the centerline. The lack of cohesion and vehicle speed appears to be major causes of corrugations. Minor corrugations cause the vehicle to bounce which in turn worsens the magnitude of the corrugations, therefore the condition perpetuates itself. Blading alone is not a satisfactory repair technique. The cohesive qualities of the surface materials must be improved. This requires remixing to obtain a well-graded mixture that contains a reasonable percentage of fine, binder aggregates. Therefore, correction requires the addition of material to improve gradation, using serrated edge grader blades, grading and rolling.

Poor Drainage - Poor drainage is caused by inadequate ditches and drainage structures. This could be from drainage areas not being properly shaped, overgrown, filled with unwanted material, or lack of crown in the roadway. Poor drainage is categorized by depressions, rutting, or eroded roadway surface.

Soft Areas - Soft areas are caused by high water tables, natural springs at roadway level, and water flowing through the roadway. Soft areas can also be caused by poor soil conditions, such as clay material, which traps water in the roadway.

Distresses not found in Publication 343, Continuously Reinforced Concrete and Unpaved Roads Condition Survey Field Manual:

Dust - In addition to being a nuisance, potential safety hazard, and major source of complaints, the production of dust results in a loss of fine, binder aggregates. Fine aggregates hold or bind the larger aggregates in place. The loss of fines reduces the stability of the road surface and leads to other types of distress.

While too much moisture will reduce stability, some moisture is necessary on unpaved road surfaces to provide cohesion between fine aggregate particles. During dry and windy weather conditions, the moisture necessary for cohesion of the fine aggregate is lost by evaporation. Traditionally, dust control has been provided by the treatment of unpaved roads with dust palliative materials such as calcium chloride, liquid asphalt, PennDOT produced salt brine, or water. Suitable materials for dust control can be found in Bulletin 15 (Publication 35), Qualified Products List for Construction, in Section 901.3(b) Dust Control Palliatives.

Potholes - Potholes are generally caused by an excessive moisture content, poor drainage, and poorly graded aggregates. Repairs normally involve spot grading. Spot "patching" with crushed aggregate can also be performed as a short-term corrective measure. Do not use hot or cold patching. Drainage improvement will also be required.

6.3 MAINTENANCE OPERATIONS SCHEDULE

Unpaved roadways require maintenance operations to maintain the roadway in a good condition. Much like paved roadways, unpaved roadways require a crowned driving surface, shoulders that slope away from the roadway, and a ditch for proper drainage. However, unpaved roadways are more susceptible to damage and distress during periods of wet weather, and material and crown loss during periods of dry weather. When the driving surface becomes deteriorated, unpaved roadways will require major rehabilitation.

When it comes to winter maintenance, unpaved roadways should not be maintained the same way paved roadways are maintained. Chemical deicing materials, including salt, are not recommended for use on dirt and gravel roads. These materials will work into the unpaved roadway surface, causing the freezing point of the roadway surface to drop and creating a loose, muddy driving surface prone to rutting and other distresses. Unpaved roadways should be treated with anti-skid and plowed when necessary.

MAINTENANCE OF DRAINAGE SYSTEM

Proper drainage and maintenance of drainage systems is imperative to the performance of the roadway. Unpaved roadways are more susceptible to failures from water infiltration than paved roads. Visual indicators of surface drainage problems include corrugation, rutting, potholes, and water ponding or flowing on the roadway.

There are two main drainage network components to unpaved roadways: surface drainage and subsurface drainage. Surface drainage controls the surface water caused by rainfall, melted snow, or surface runoff. It includes roadway cross slopes, shoulders, and ditches. Subsurface drainage controls the underground water in and around the roadway. It includes roadway subbase, underdrain, inlets, and culverts. Base drains, edge drains, and under drains collect water in a trench parallel to the road with a well graded aggregate and a perforated pipe to carry the water to an outlet away from the road. All subdrains require an outlet for the water to drain properly.

Ditches provide drainage of the road base and when practical should be designed in a parabolic shape. Ditches must be maintained properly to avoid erosion. Ditch material should be removed prior to grading and should not be incorporated into the roadway surface.

Drainage facilities should be inspected semiannually or every time the roadway is being reshaped. Drainage should also be inspected after each major storm event to make sure that no major problems are developing.

Proper maintenance of the system is required to control water and the damage it can cause.

GRADING AND RESHAPING

Grading and reshaping is necessary to remove buildup along the shoulder area from shifting material. Grading is also necessary to remove rutting and corrugations from the roadway and to reestablish the crown in the roadway surface. In contrast to a paved roadway surface, unpaved surfaces require additional cross-slope to facilitate water movement across the rougher surface. The typical cross-slope of an unpaved roadway is 4% to 6% or ½ inch to ¾ inch per foot.

Grading and reshaping should be done three times per year; 1) in the spring, following the last frost of the season while moisture remains and there is minimal vegetation, 2) in the summer, due to traffic and dry conditions creating excessive dust, and 3) in late fall before winter, locking in the crown and preventing potholes during winter conditions when grading is not an option due to frozen conditions. Grading and reshaping when the road surface is dry may do more harm than good since moisture is required to bond the materials. Summer grading and reshaping should be completed when there is enough moisture to bond the material, but not excessive moisture creating a muddy surface.

It is usually best to begin grading at the outer edge of the road and to work from the shoulder to the centerline. Ditch material should be removed prior to grading and should not be incorporated into the roadway surface. Unsuitable material such as weeds, trash, or topsoil left in the roadway should be removed so it will not become mixed with the surfacing material. Through the grading process, loose surface material from the shoulder of the roadway is deposited in ruts, holes, and other low places in the road surface. After the loose material has been brought across the surface from both edges to the center, it should be carried back to both edges in such a manner that all the material is spread over the surface and no surface material is left to form a windrow at the edge of the road. It is advisable to mechanically rake the roadway after the grading operations to remove small windrows and aid in smoothing the surface.

Remove large rocks that are worked to the surface during grading operations and fill the void with suitable material. This is a good indication it is time to re-stabilize the roadway.

Compaction of unpaved roadways should be done after grading and reshaping the roadway to compress and improve the finished surface. This will leave a denser, stronger, smoother surface that will be easier to maintain. A rubber-tired roller may be effectively used for initial compaction of mixed fine-grained soils, however it is not the preferred choice to provide a smooth, well drained roadway surface. The smooth steel drum roller in static mode will provide a smoother surface, but may result in surface material sticking to the roller if the material is at or above optimum moisture.

UNPAVED SURFACE STABILIZATION

The addition of material is usually accompanied by grading and reshaping, although light applications of medium sized and fine aggregates may be made occasionally to correct slippery conditions. When increasing the depth of the surface, filling depressions, restoring crown and profile, or correcting other problems that require coarse aggregates, well graded aggregate mix should be dumped in windrows along the area to be repaired for spreading by a grader. Fine aggregates needed to correct raveling and minor corrugations are usually obtained from shoulder material.

Stabilization typically involves grading in new aggregate to existing surface using a carbide tooth cutting edge for grading and then compacting. It is not recommended to use graded mounted hooks, as control of depth is critical, and care must be taken to not damage any cross pipes or pull up large rocks. Serrated-edge blades should be used for scarifying and reshaping. Application rates for the stabilizing material may vary depending upon the gradation, type, design thickness, and moisture content of the aggregate.

ELIMINATING SOFT AREAS

Soft areas are generally caused by the lack of proper drainage or stabilizing material. The cause may be a clogged pipe, an improperly placed pipe, the absence of a pipe, or the side ditches may not be deep enough to lower the water table to the proper level.

When the soil is in poor condition, the remedy is to excavate and replace with a suitable material such as stone, slag, or gravel. Often stabilizing material must be placed covering the full roadway width and to a suitable depth to correct the deficiency.

DUST CONTROL

The basic principle of dust control is to improve the cohesion of fine, binder aggregates. Several methods to accomplish this are available ranging from sprinkling with water to the application of calcium chloride, PennDOT produced salt brine, or liquid bituminous.

Sprinkling with water is a very short-term solution that is generally only acceptable as a temporary measure. Short duration construction projects with low traffic volumes are examples of situations where sprinkling with water is appropriate. Maintenance agencies traditionally rely on applying an additive as a preventative measure.

The additive may be calcium chloride, sodium chloride, or liquid bituminous material. Treatment of a surface with moisture-retentive or adhesive materials will not prevent failure of the surface due to improper gradation of the soil and aggregate particles in the mixture composing the surfacing.

Calcium chloride, applied either in dry or liquid form, and salt brine draw moisture from the air and improves the cohesion and ability of fine aggregates to retain moisture. Calcium chloride and salt brine are most effective if applied before roads become too dry and dusty. They should also be applied after any necessary grading has been completed. Salt brine is not as effective as calcium chloride as a dust suppressant. Actual application rates depend upon weather conditions and the type, depth, and moisture content of the aggregates in the road surface. Liquid calcium chloride is typically applied at a rate of approximately 0.3 gallon per square yard in the spring followed by approximately 0.2 gallon per square yard in the summer. The equivalent concentration of flake calcium chloride may be applied in spring and summer at rates of approximately 1.2 pounds per square yard in the spring and 0.8 pound per square yard for the second application.

Emulsified liquid bituminous can be used for dust control. Liquid bituminous acts as a binder to hold the aggregate particles in place and as a seal to slow the evaporation of moisture. Slow setting emulsified liquid bituminous is applied in repeated light applications at rates ranging from 0.1 gallon per square yard to 0.5 gallon per square yard on roads which have been shaped by grading and compacting.

Suitable materials for dust control can be found in Bulletin 15 (Publication 35), Qualified Products List for Construction, in Section 901.3(b) Dust Control Palliatives.