Maintaining Crushed Rock Roads

Tips and techniques

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Rock-surfaced roads bridge the gap between low use dirt roads and high use paved roads. Proper maintenance will reduce costs and result in a smoother and safer road. This fact sheet provides tips and techniques to properly maintain a rock road.

A well-maintained rock road has a four to six percent slope (crown) with a good crust and minimal loose material.

Characteristics of a well-maintained rock road

A well maintained rock surfaced road has the following characteristics: The road has a four to six percent cross slope (crown) with good crust and a minimum amount of loose material on the surface. There are no or few potholes, washboards, ruts, or secondary ditches (high shoulders).

Purpose of blading

The purpose of any blading is to correct surface defects and maintain a uniform surface for traffic. Traffic and weather redistribute the surfacing material and cause surface problems like potholes and washboards. During winter and wet weather, the major road defects are potholes, lack of crown, rutting, and occasional erosion on hills and low spots. In summer and dry periods, the major road defects are washboards and dust. When and how we blade a road is dependent on the season and the major defects present at the time. During the winter months, the primary purpose of blading a rock road is to restore cross slope, evenly distribute surface material, and correct defects before the road becomes unduly out of shape or rough. During the summer and dry spells, we protect the crust and minimize dust and loss of surfacing material by reducing frequency of blading, lighter cutting, and by spot-blading problem areas. In any season, an effective blading should result in a smooth road with a minimum of dry, loose material on the road surface.

When to blade

If possible, blade rock roads when moisture is present so most of the loose material will be compacted by traffic. In the Plains States, moisture conditions are generally best for blading in the spring and fall. Conditions are also good during the first two or three days after a summer rainfall. Blading does cut aggregate and expose fines, which accelerates loss of rock surfacing, so blading should only be performed when necessary and effective.

Crust

The crust is the top two or three inches of roadway that has been compacted into a dense, tight mass with an almost impervious surface. Aggregates with too few fines will not form a crust, and excess fines will make the road slick in wet weather. For the crust to reform after blading, the surfacing material must be moist to allow the fines and larger materials to bond and compact.

Dry weather

Only a minimum amount of blading should be performed in dry weather. General blading in dry weather is seldom productive and loosens the crust and causes more road dust. Spot blading may be necessary to cut out potholes and washboards for safety reasons. Loose material may need to be windrowed until adequate moisture is present when it can by laid back on the road and recompacted by traffic.

Windrows

Windrows along the shoulder are problematic because they keep water from running directly off the road into the ditch. Large windrows may be a safety issue, as they tend to narrow the driving surface and may cause loss of control if hit by a vehicle that strays into the windrow. Windrows should be minimized or eliminated in the fall so they do not complicate snow removal. Follow agency policy on windrows. Many agencies have a policy to limit windrows to dry weather to minimize loose material on the road. If the policy of the agency is to have a windrow, gaps should be cut in the windrow at low areas and intermittently on long hills to allow for roadway drainage.

Cross-slope (crown)

An adequate, A-shaped crown is important for drainage; an ideal cross section is shown in Figure 1. If a rock road has too little crown, water from rain or melted snow will collect on the road surface and soften the crust, which can lead to severe rutting and potholes. If there is too much crown, motorists may drive in the middle of the road because they feel as if their vehicles might slip off the road. Also, farm equipment may high-center and drag.

A four percent crown is generally optimum. More crown is needed in flat areas at tops of hills and in floodplains where potholes tend to develop. Maintain the crown as a straight line from shoulder to centerline. The cross section should look much like the pitch of a roof, or a flat A shape. Worn blades will leave a flat spot in the center part of the road, which will pothole easily. See Figure 2.

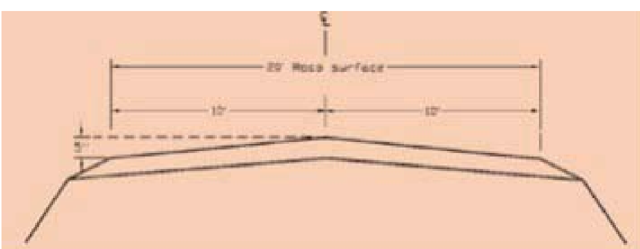

Fig 1. An "A"-shaped surface with a 4 - 6 percent crown is ideal.

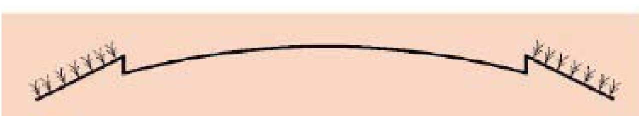

Fig 2. A parabolic crown caused by worn blades. The outer edge of the road slopes too much and the center is too flat. Gouging causes high shoulders.

Slope meter

All motorgraders should be equipped with electronic slope control or an after-market slope meter as shown in Figure 3. While many operators claim to be able to sense the slope by the seat of their pants, the only way to obtain consistent and proper crown is by automatic controls or a slope meter.

Figure 3. A slope meter accurately displays the percent of cross slope.

Rock specifications

Crushed rock quality varies for many reasons. The ledge where the rock is extracted is the predominant factor in the rock hardness and durability, with generally harder rock in eastern Kansas and softer rock in central Kansas. In rock test reports, the hardness is reflected in the L.A. Wear Test, and soundness is measured by a Freeze-Thaw Test. The local KDOT area engineer can obtain results for these types of tests from KDOT records and can help interpret them. Rock from the same ledge may vary widely depending on the amount of overburden, shale and clay seams, type of crusher, and amount of screening. While there may be little choice in the base hardness and soundness of the rock, we usually have a choice in the top size of the rock, the amount of fines, and the amount of clay in the rock. "Crusher run" (sometimes called AB-3) costs less than screened rock.

The type of rock needed depends on the intended application. For instance, clay in a base rock can result in a spongy base, and may not be suitable for base for pavement or a chip seal. Pure limestone without any clay is not cohesive in dry weather and may not be suitable in areas prone to washboards. The measure of the cohesiveness of fines in limestone is the plastic index, also called P.I. Usually a P.I. is included in rock tests. For road rock the P.I. should be in the 5-12 percent range. Adequate fines are also needed for cohesion, a good range for fines is 5-15 percent passing the 200 sieve. The material passing the 200 sieve is material smaller than 1/200th of an inch.

High shoulders / secondary ditches

A secondary ditch is when a high shoulder develops at the edge of the road and prevents water from flowing over the shoulder and into the ditch. Water then flows along the edge of the roadway and begins eroding the road as shown in Figure 4—or holds water at a low area as shown in Figure 5. High shoulders are caused for two reasons, the natural lowering of the roadway surface due to loss of surfacing material through dust or washing, and by improper blading techniques. Improper blading includes not blading all the way to the foreslope, and the use of worn blades that are hollow in the middle. Worn blades make it difficult to carry adequate material along the moldboard without gouging a ridge near the foreslope, as shown in Figure 2.

Prevent the formation of secondary ditches by blading

Fig 4. High shoulder causes erosion along edge of road.

Fig 5. High shoulder causes mud hole at low spot.

all the way to the foreslope with a proper crown. If secondary ditches are present, they need to be cut off so the water can flow directly off the road and down the foreslope. This work is best done when there is minimal vegetation, such as early spring or soon after a mowing or burning. To avoid mixing rock and soil, move the windrow to the other side of the road and try to place the excess material in the groove next to the secondary ditch; never mix the dirt and vegetation with the windrow. If cutting off the high shoulder results in too much material, it may be necessary to haul off the excess or lose it over the foreslope.

Mixing dirt and rock

Native soil and vegetation should not be mixed with the rock surfacing, as this type of material may make the road surface muddy and sticky when wet and may also reduce the road's wet-weather stability. When shaping shoulders and removing secondary ditches, conduct the work to minimize contamination of the rock with soil and vegetation. Figure 6 shows an improper procedure for removing a high shoulder, as the excess dirt was incorporated into the rock windrow.

Fig 6. Improper mixing of dirt with windrow when repairing a high shoulder.

Ditches

Road ditches serve two purposes: They allow precipitation that falls on the road to flow over the shoulder, and they prevent surface water from adjacent land to flow onto the roadway. There is no minimum ditch depth; the ditch only needs to be deep enough to serve these two purposes. Ditches will need to be deeper where the adjacent field slopes toward the road and on longer hills where more water accumulates in the ditch. Usually a ditch has inadequate capacity where erosion occurs along the shoulder after a moderate rain as shown in Figure 7.

Fig 7. Inadequate ditch evidenced by washing along shoulder.

Potholes

Potholes are usually caused by poor surface drainage (lack of crown) and occur where water stands in the track. Potholes are more likely to develop on high traffic roads and during prolong wet spells and rains. Typical locations are flat areas on top of hills and over cross-road culverts. See Figure 8. Prevent potholes by maintaining adequate crown on the roadway, and consider more crown in problem areas. Perform temporary repairs of potholes by blading loose material into the holes. Such repairs will not

Fig 8. Potholes caused by inadequate cross slope at low spot in road.

last long. For a permanent repair, blade deep enough to cut out the potholes, reshape the roadway to a proper crown, and compact the surface.

Washboarding

Washboards, as shown in Figure 9, are caused by repeated small horizontal forces from tires interacting with the surface of the road. The most common location for washboards is near intersections where traffic frequently starts and stops. This starting and stopping imposes horizontal forces on the rock and will start dislodging particles, resulting in washboards. Other common places are curves and up steep hills where tires exert more horizontal force on the road surface. A rock road with a very high traffic count can develop washboards along the entire length of the road.

Fig 9. Washboards are common in dry weather.

Washboards are more prevalent in dry weather because road surface dries out and does not have moisture to hold the particles together. This makes it easier for the abrasion of the tires to displace material. Also, permanent repairs are more difficult in dry weather as we need moisture to repair washboards.

Prevention is always best, and that is accomplished by timely blading when moisture is right, and use of the right type of rock. If the washboards are not too deep, sometimes right after a rain a blade can rough- up the surface and traffic can recompact it. Bullet blades work the best for this, but there has to be adequate moisture in the surfacing, so the timing after the rain is really critical. Also, avoid leaving dry loose material on the road surface in washboard-prone areas, as loose material will washboard rapidly. During dry periods it may be appropriate to windrow loose material, rather than spread the dry material on the road where it will washboard again within a few days.

To minimize washboards, knowing the rock surfacing characteristics is critical. The rock should be well-graded so it will compact to a tight surface. If there are too many large particles and not enough fines, the large particles will easily come loose and create washboards. The rock has to be cohesive when dry, and for dry cohesion we need fine clay-like particles or a chemical. Sometimes washboarding can be reduced by using rock with more clay (a higher P.I.). The use of calcium chloride or magnesium chloride makes the rock more cohesive in dry weather, as these treatments have a tendency to hold moisture in the rock.

For long-lasting repairs of washboards and to minimize their potential for recurring, cut out the washboards to the bottom of the low areas. Then reshape the area, carefully remixing and compacting fine and coarse materials. Adequate moisture content is critical.

Rutting

Rutting may be caused by poor drainage, lack of crown, inadequate depth of surfacing material, or heavy loads. See Figure 10. To prevent rutting, make sure the crown is between four and six percent, there is an even distribution of material sizes, the material is spread at an even depth, and it is appropriately compacted with adequate moisture content. To correct rutting and prevent it from recurring, reshape the crown, place additional rock, and then blade and compact the surface.

Fig 10. Many factors can cause rutting.

Blading at railroad crossings

At railroad crossings, zero-out the crown on both sides of the crossing for a distance of 20–30 feet. Be careful not to blade aggregate onto the rails.

Blading at bridges

Bridge approaches may need more frequent attention than other parts of the roadway because they are difficult to drain. The area close to the abutment is prone to settling, leaving potholes in the approach. If a bridge deck is crowned, gradually reduce the road crown to match the bridge crown. If the bridge does not have a crown, gradually zero-out the road crown to meet the elevation of the bridge deck. Take care not to drag too much rock onto the bridge deck during blading operations. ■

Kansas LTAP thanks the South Dakota Local Transportation Assistance Program for use of many of the photographs in this fact sheet.

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