Kansas
LTAP Fact Sheet
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Maintaining Sand and Gravel Roads

Tips and techniques

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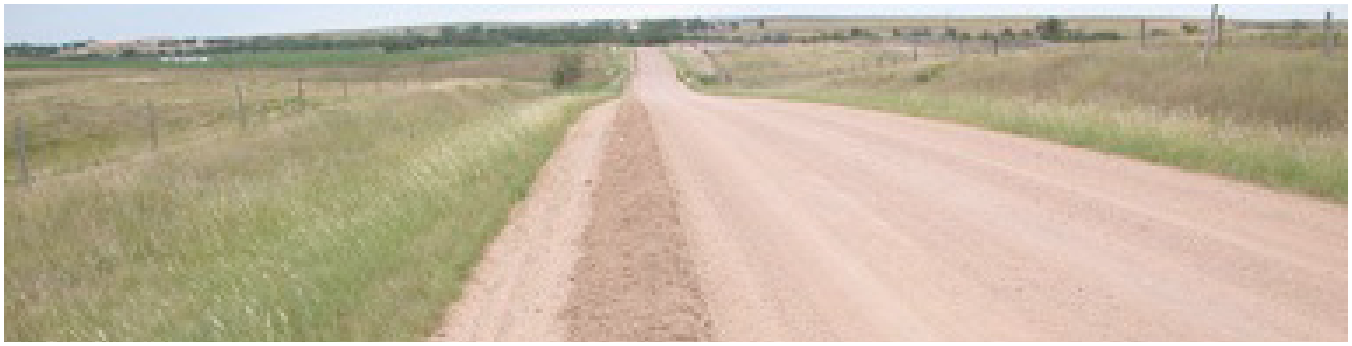

Sand-surfaced roads, sometimes called gravel roads, are the predominant surfaced roads in Kansas west of US-81 highway. East of there, crushed rock roads are the predominant surfaced road, due to lack of good sand deposits and availability of limestone. All these types of aggregate surface roads bridge 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 sand/gravel road.

Material requirements

Sand and gravels in Kansas are obtained from pits in existing or former floodplains or from dredging. This material contains gravel, sand, silt and clay. Usually the particles larger than ¼ inch are called gravel, the smaller particles visible to the naked eye are called sand, silt has particles about the size of flour (between 1/100 and 1/200 of an inch), and clays are the microscopic particles smaller than silt. Gravel, sand, and silt are granular materials with little cohesion when wet or dry. Clay is sticky when wet and will harden when dry.

Good surfacing sand will have a blend of gravel, sand and a good clay binder, which make a strong, tightly-bound gravel surface. Gravel provides the strength to support loads, particularly in wet weather. The sand and silt fill the voids between the gravel and give stability. The clay binder holds the material together which allows a sand road to form a crust and shed water and remain bonded during periods of dry weather. Most pit-run material and all dredged material lack enough binder (usually clay) to make a good surfacing material. Road departments usually have to add binder in the form of local clay, soft shale, or caliche.

Unlike surfacing material, base-course material is not exposed to traffic and weather extremes. Therefore, stability is the prime objective for the base, rather than cohesion. Base-course material can have larger top-sized stones and a very small percentage of clay or other binder. This material provides more strength and drainability than surfacing sand; however, it cannot be used as surfacing, as it will not form a crust to keep the material bound together when dry. Clay in a base sand can result in a spongy base, and may not be a suitable for base for pavement.

Characteristics of a well-maintained sand road

A well-maintained sand-surfaced road has the following characteristics: The road has a four to six percent cross slope (crown), a 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 to 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 sand 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, you can 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 sand 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 disturbs the crust and exposes fines, which accelerates loss of binder and sand, 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. Sand and gravel 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 and resulting loss of fines and sand. 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 re-compacted by traffic.

Windrows

Most road agencies have windrows along the shoulder of sand roads. While windrows are usually necessary to minimize loose material on the road, they do keep water from running directly off the road into the ditch. Gaps should be cut in the windrow at low areas and intermittently on long hills to allow for roadway drainage. 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. Many agencies have a policy to limit large windrows to dry weather periods to minimize loose material on the road. Windrows should be minimized in the fall so they do not complicate snow removal. Agencies may have policies on windrows based on their unique weather conditions and material; each operator should follow agency policy on windrows.

Cross-slope (crown)

An adequate, A-shaped crown is important for drainage; an ideal cross section is shown in Figure 1. If a sand 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.

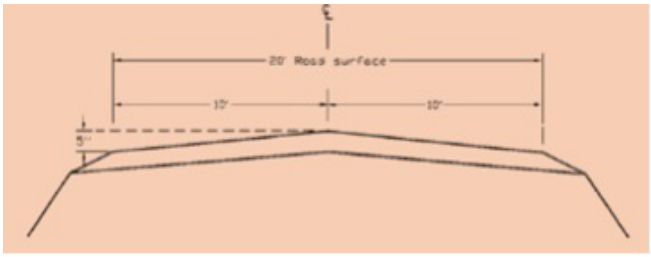

Fig 1. An "A"-shaped surface with a 4 - 6 percent crown is ideal.

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.

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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.

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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 develop 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 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 sand 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. 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.

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

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

Mixing sand and dirt

Native soil and vegetation should normally not be mixed with the sand surfacing material. Native soil and vegetation 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 sand with soil and vegetation. Figure 6 shows an improper result for removing a high shoulder, as the excess dirt was incorporated into the windrow. The exception to mixing native soil with sand surfacing is when the native soil has some clay and the sand surfacing needs some binder material. In this case, enough native soil can be worked into the sand surfacing to establish a good sand-clay mix that is stable in both dry and wet weather.

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 from flowing onto the roadway. There is no minimum depth; the ditch only needs to be deep enough to serve these two purposes. Ditches will need to be deeper where an 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 wheel tracks. Potholes are more likely to develop on high-traffic roads and during prolonged 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 last long. For a permanent repairs, blade deep enough to cut out the potholes, reshape the roadway to a proper crown, and compact the surface.

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

Washboarding

Washboards, as shown in Figure 9, are caused by repeated small horizontal forces from tires interacting with the surface of the road. They are seldom caused by the grader operator. The most common location for washboards is near intersections where traffic frequently starts and stops. This starting and stopping imposes horizontal forces on the sand 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 sand road with a very high traffic count can develop washboards along the entire length of the road.

Washboards are more prevalent in dry weather because the 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. Permanent repairs are difficult in dry weather as moisture is needed 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 sand and binder material. 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 material, so the timing after the rain is really critical. Also, avoid leaving dry loose material on the road surface in washboard-prone areas, because loose material will washboard rapidly.

While some washboards should be expected during dry periods, two factors make areas prone to washboarding, 1) loose material (usually sand and gravel) on the surface, and 2) not enough binder in the sand surfacing material. 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 the sand surfacing material has to be cohesive when dry, and for dry cohesion a fine clay-like binder is needed to hold the sand together. Binder is lost in road dust and must eventually be replaced. Where binder is inadequate, washboarding can be reduced by adding more binder to the existing surfacing, then mixing and compacting. The use of calcium chloride or magnesium chloride makes the sand more cohesive in dry weather; these treatments have a tendency to hold moisture in the sand.

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, and carefully remix and compact fine and coarse materials. Adequate moisture content is critical.

Fig 9. Washboards are common in dry weather.

Rutting

Rutting may be caused by poor drainage, lack of crown, inadequate depth of surfacing material, or heavy loads. To prevent rutting, make sure the crown is between four and six percent, there is an even distribution of material sizes, surface 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 sand or gravel as needed, and then blade and compact the surface.

Blading at railroad crossings and bridges

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 surfacing material onto the rails.

Bridge approaches may need more frequent attention than other parts of the roadway because an approach is 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 sand 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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