Maintaining Sand and Gravel Roads
Tips and techniques

By Norm Bowers, L.S. and P.E., and Claire Schrock

Sand and-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.

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

Figure 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.
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.

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.

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.

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
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.

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.

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Norm Bowers is the Local Road Engineer for the Kansas Association of Counties. Clair Schrock is Road Supervisor for Thomas County, Kansas.