

Facts, Tips & Bits

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Bureau of Local Roads & Streets

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Motor Grader Maintenance of Aggregate Surfaced Roads

Earth and aggregate roads are an important part of the nation's transportation network. Often these roads are the only transportation connections for rural populations and provide routes for emergency services, mail delivery, school buses, and farmers shipping products to market. Proper maintenance is essential to meet the needs of rural road users.

Aggregate roads are designed to carry traffic loads in all kinds of weather. Crushed stone and gravel are the most commonly used aggregates in rural road construction. A combination of large aggregates, small aggregates and fines are compacted together to provide structural strength through aggregate interlock. This interlock forms a strong roadway as well as a water tight hard crust on the surface of the roadway. The crust must be water tight so the surface is not penetrated by the water, leading to the weakening of the subsurface. If the subsurface is weakened, traffic cannot be supported.

A motor grader operator has two main objectives:

1. To use the motor grader in a way that makes the most effective and economical use of its capabilities;
2. To maintain roads and ditches to the proper shape and surface condition providing both rideability and good drainage.

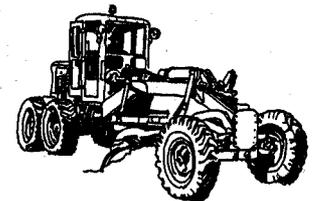
The Grader Operator as a Mechanic

As an operator you are not expected to be a trained mechanic; however, you are expected to know enough about the equipment you operate to recognize mechanical problems that might occur

during operation. You are not asked to diagnose trouble when it arises, just be astute and alert to the symptoms that spell trouble and know when the trouble is serious enough to shut down a piece of equipment. An operator's judgement is valuable, literally worth thousands of dollars.

Grader Operation as a Skill

A motor grader is a complex and powerful machine. Its operation requires good coordination, and to some extent, a certain natural ability.



A grader operator's skills are acquired through hundreds of hours of operation. For novice operators, this isn't the sort of machine that will let you jump in the cab and go. To become a qualified operator you must learn as much as possible from a top-notch, knowledgeable operator. Good instruction combined with ample time out on the road will put you on a path towards the day when you will be proud to call yourself a "Motor Grader Operator."

Drainage and Crowning

The key to maintaining a smooth road is proper drainage. Water standing on a road causes road material to separate and form potholes when subjected to traffic.

The best way to provide drainage on a road is to crown its surface, (see Figure 1) making the center of the road higher than the shoulders. This is done by blading the crown into the road - leaving more



material in the center when spreading the material back across the road.

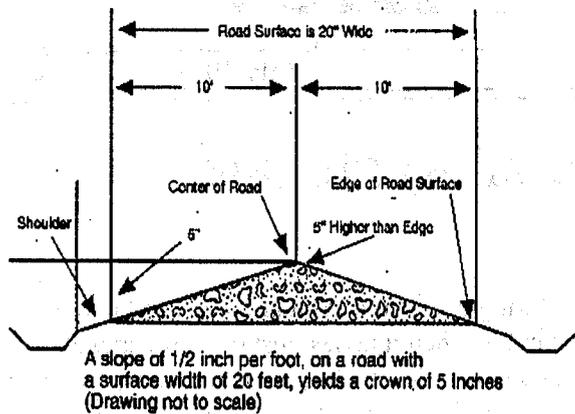


Figure 1 Crown Diagram

Proper Crown Shape

The crown should be an A-shape, NOT a parabolic shape. The A-shape crown is best because it provides a uniform slope from the centerline to the edge of the road (see Figure 2).

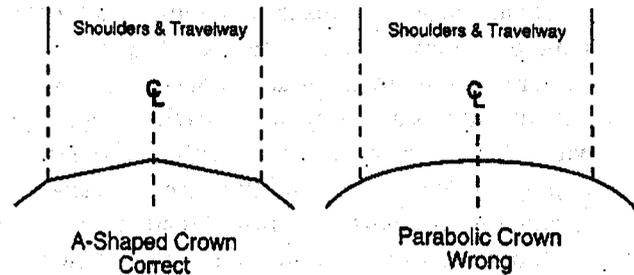


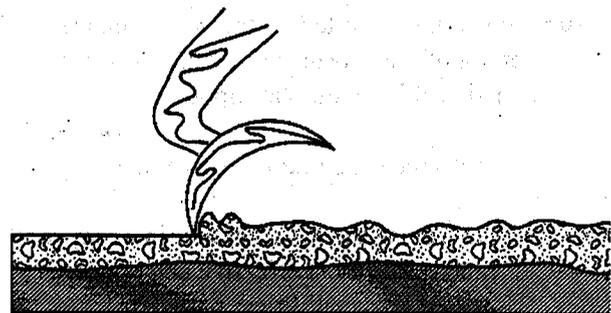
Figure 2 Crown Shape

Smoothing (Dragging) Aggregate Roads

Smoothing is limited to leveling the road surface when it becomes rough and uneven. The intent is to keep the stable crust, not to destroy it by cutting into it. A dragging, rolling action created by the curve of the grader's moldboard helps compact the road surface as it is bladed. Blading speed will depend on the grader, pressure of tires, and condition of the road surface. Going too fast will cause the grader to bounce, making a good job impossible.

1. Place the traffic control devices. Use a flagger if circumstances require.
2. Check the moisture content of the road surface. A damp surface will prevent the loss of fine particles such as dust and provide proper compaction. Use a water truck to dampen the surface in dry weather.
3. Determine the limits for smoothing. Place wooden stakes to mark where the repair is to begin and end. Repair only one half of the road at a time.
4. Check the condition of the grader blade cutting edge. The blade edge should be straight. A cupped blade edge will not maintain a proper crown.
5. Tilt the moldboard forward to get a dragging

action. The moldboard tilt will preserve the crust and compact the surface material (see Figure 3).



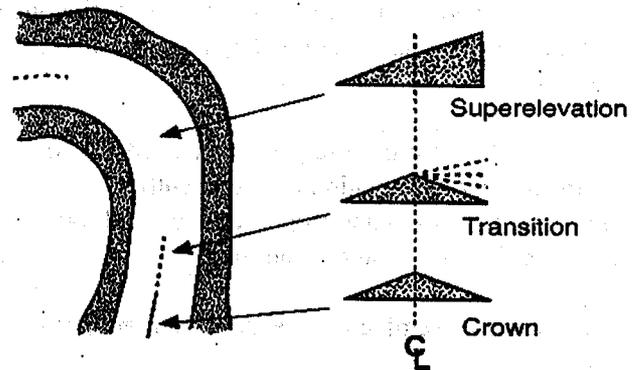
Tilt the moldboard for a dragging action
Figure 3 Smoothing

6. Angle the moldboard 30 to 45 degrees to spread loose material to the center of the road. The moldboard angle will distribute excess material into ruts and holes in the surface.
7. Slightly tilt the front wheels 10 to 15 degrees from the vertical in the direction the aggregate rolls across the blade.
8. Stop to repair minor bad spots such as holes, rutted areas and poor surface drainage conditions. Always have a shovel available.

When Blading Curved Roads- Maintain Superelevation

1. Gradually eliminate the crown 50 to 100 feet before starting in the curve. This is the transition zone. Slowly raise the end of the blade from the outside edge of the curve. The centerline elevation should remain the same (see Figure 4).
2. Where the curve begins, the outside curve edge should be at the same height above the center of the road as the inside curve edge is below the center -- superelevate or bank the road. Do not blade a crown on the curved part of the road.
3. Slope the shoulder to the superelevated part of the road downward from the road edge to the ditch.

4. Gradually change the road surface back from superelevation to crown.



Maintain the centerline elevation throughout the curve

Figure 4 Superelevation

Reshaping Aggregate Roads

Reshaping involves more than just smoothing the surface. After a period of rainfall or slow-melting snow, traffic scatters the aggregate, flattens the crown, makes potholes and deep ruts in the road, and produces a rough washboard surface. These conditions cannot be corrected by just smoothing the surface. The aggregate base must be reshaped.

Reshaping involves remixing the aggregate base to get a proper blend of fines and different size aggregates and blading this blended material into a properly crowned surface. When remixing, you may need to add additional aggregates or fines to the road surface and shoulders particularly in rough spots or washed-out areas.

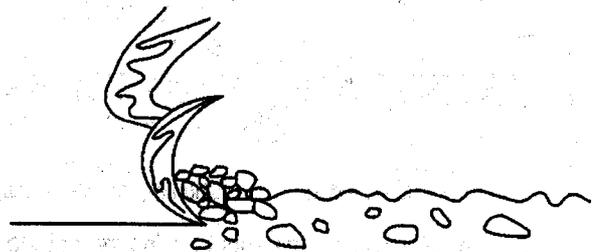
The art of proper blending is a cut-and-dry proposition depending on the types of materials at hand. Experience will provide know-how to determine the correct blend.

The crust that forms what is left of the old wearing surface is broken up during remixing, often with a scarifier. After the aggregate base is remixing, it is bladed to obtain a smooth surface with the proper crown. A new set of cutting edges gives the best result. As with smoothing, reshaping should be done when the aggregate is moist.

1. Place the traffic control devices. Use a flagger if circumstances require.
2. Check the moisture content of the road surface. A

damp surface will prevent the loss of fines particles as dust and provide proper compaction. Use a water truck to dampen the surface in dry weather.

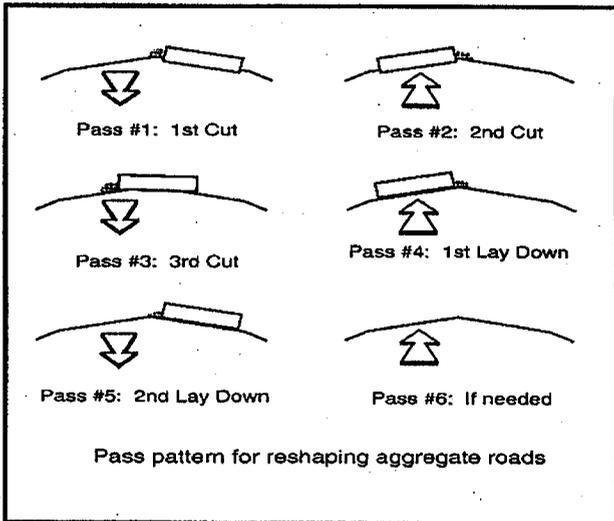
3. Check to see if more aggregate or fines need to be added to surface and shoulders, particularly in rough spots or washed-out places.
4. Tilt the moldboard to a cutting position. This will let the blade cut into ridges and potholes.
5. Angle the moldboard at 30 to 45 degrees. Using a mixing action, move and roll the aggregate toward the center of the road.
6. Lean the front wheels 10 to 15 degrees from the vertical into the direction the aggregate is rolling across the blade.



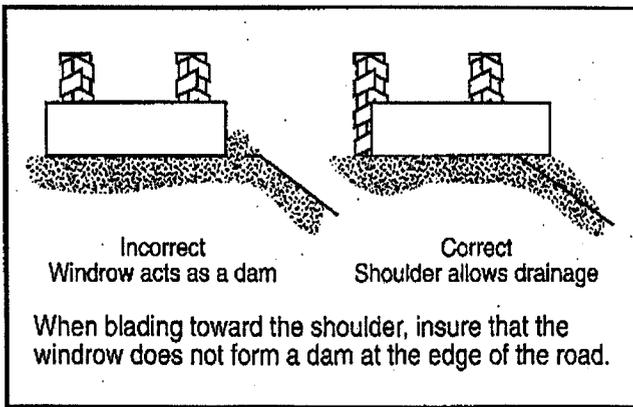
Tilt moldboard back to cut into ridges and potholes
Figure 5 Reshaping

7. Put enough pressure on the blade to cut shoulders and washboard ridges.

8. Scarifying, when necessary, should go as deep as the average pothole or washboard -- usually two or three inches.
9. Watch blade action very closely and continuously adjust the controls to get good cutting and mixing action.
10. Check to see if more passes are needed in the same direction to continue mixing, cutting to the bottom of potholes and ridges, and to windrow aggregate to the center of the road.
11. Windrow remixed aggregate to center of road.
12. Distribute aggregate evenly over roadway edges and shoulders, blading the material into a proper crown.



13. Blade the shoulder downward toward the ditch so the slope is at least as much as the slope of the road.

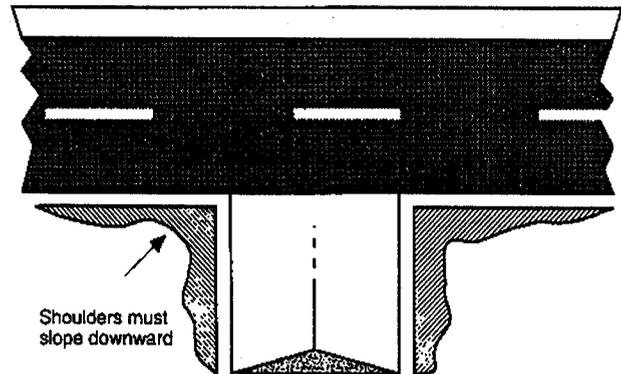


Blading at Intersections

Intersection of Aggregate and Paved Roads

Bumps form on one side of the road at paved intersections and dips form on the other side due to continuous blading with the flow of traffic. Alternate blading against the flow of traffic will produce the best results.

1. Gradually eliminate the crown, starting about 50 to 100 feet before the intersection. At the point where the two roads meet the grade should be the same (see Figure 6).



Eliminate the crown at the point where it intersects the paved road

Figure 6 Intersection of paved and aggregate roads

2. Change the angle of the blade to meet the paved road, raise the blade, pull onto pavement, drop the blade, put the grader in reverse, pull the aggregate off the paved road.
 3. Check to see if an extra pass or two is needed to eliminate the crown and to ensure that the shoulders have slope.
 4. With the grader facing against the flow of traffic, cut the bump starting at the edge of the paved road, moving material to the other side of the road. Turn the grader around and spread excess material into the dip.
- ### Intersection of Two Aggregate Roads
1. Gradually eliminate the crown on each road, starting about 50 to 100 feet before the intersection.
 2. Check to see if an extra blading pass is needed to eliminate crown and ensure that the shoulders have a slope.