
**MOTOR GRADER OPERATOR
MAINTENANCE OF GRANULAR
SURFACED ROADS**

**TIPS FROM
IOWA OPERATORS**



**IOWA STATE UNIVERSITY
Iowa Transportation Center
University Extension**

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Tips from Iowa Operators

This booklet is a compilation of notes taken during motor grader operators workshops held at some 20 different locations throughout Iowa during the last two years.

It is also the advice of 16 experienced motor grader operators and maintenance foremen (from 14 different counties around Iowa), who serve as instructors and assistant instructors at the "MoGo" workshops.

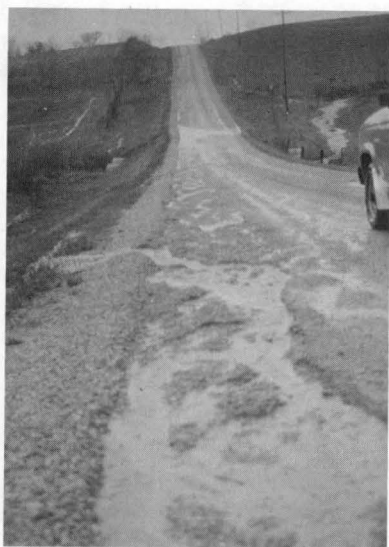
The instructors have all said that they learn as much from the operators who attend the workshops as they impart. Motor grader operators from throughout Iowa have shown us new, innovative and better ways of maintaining gravel roads.

This booklet is an attempt to pass on some of these "tips" that we have gathered from Iowa operators. It will need to be revised, corrected, and added to based on the advice we get from you, the operators who do the work here in Iowa.

We know that things that work in one part of the state may not work in others due to soils, weather, gravel types, etc. Let us know if you have suggestions you would like to see added to the next edition.

Iowa Transportation Center
194 Town Engineering
Iowa State University
Ames, Iowa 50011
(515) 294-5642

June 1991



Rains
erode
our road
tops.



Traffic forms wheel tracks to collect water.

Iowa operators say:

To get and keep a good gravel road

To save your county the most money

You need to do these things:

- ◆ Get and keep a standard top shape.
- ◆ Keep water draining away.
- ◆ Mow the shoulders on gravel roads.
- ◆ Keep flat blades on your machine.

Operators from all over Iowa say that doing these four things will make your granular surfaced roads much easier to maintain. You will save gravel and reduce the time spent on road repairs. It has been estimated that \$50,000 per year can be saved by each county that can get and keep their roads in the proper shape.



1991 Motor Grader Operator Instructors

Front Row left to right: Alvin Jansen, Crawford Co.; James (Mick) Lee, Cass Co.; Joe Weber, Delaware Co.; Bob Ageson, Lyon Co.; John Hanson, Pottawattamie Co.; and Ron Dirks, Pocohantas Co.

Back Row left to right: Ed Bigelow, ISU; Bill Withem, Dallas Co.; Ron Price, Davis Co.; Bob Arn, Johnson Co.; Doug Taggart, Audubon Co.; Vern Fahrenkrog, Scott Co.; Randy Pollock, Cass Co.; Les Zapotocny, Howard Co.; and Tom Maze, ISU.

Absent from the picture were Galen Eilers, Black Hawk Co.; and Richard Bryant, Johnson Co.

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What and why do we have to keep fighting?

NATURE IS TRYING TO DESTROY OUR ROADS.

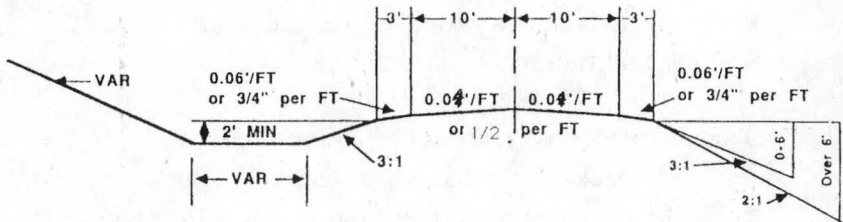
- ◆ Rains and winds keep trying to erode the roadway.
- ◆ Freeze-thaw tries to soften the road top.
- ◆ Sub-soil moisture tries to weaken the road.
- ◆ Grass and weeds try to take over the road.
- ◆ Wind and rain try to silt the ditches full.

TRAFFIC IS TRYING TO DESTROY OUR ROADS.

- ◆ Traffic packs down the wheel paths.
- ◆ Traffic throws gravel out of the wheel paths and onto the shoulder, or in the ditch.
- ◆ Heavy loads distort the road top.
- ◆ Traffic pounds wet spots, tossing out dirt.
- ◆ Traffic pounds the road top, pumping water up into the road bed from the sub-soil.

Motor grader operators in Iowa keep fighting nature, weather, and traffic to keep our granular surfaced roads in the right shape. We all have an ideal standard road shape we keep trying to achieve. The closer we come to the proper shape, the easier it is to maintain our roads, and the more money we will save our city or county.

Typical Desired Shape



Typical Desired Shape

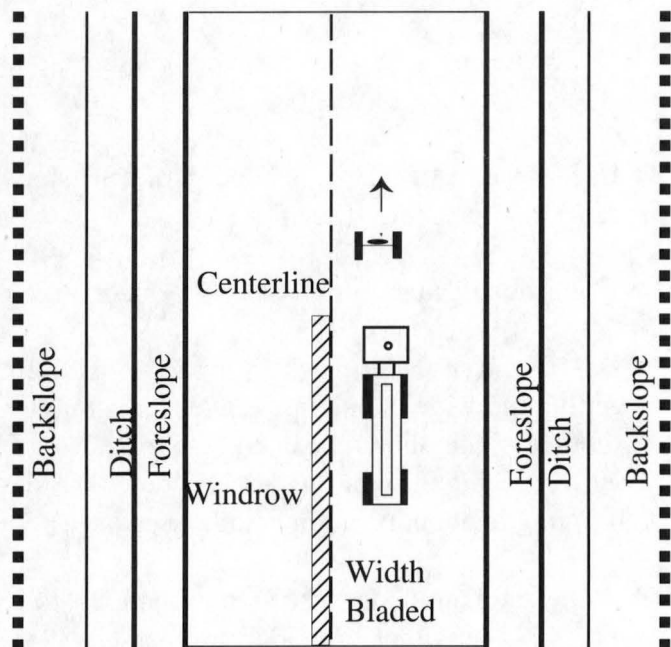
1. Slope each way from center line out at 4 percent to 6 percent on Crown Gauge. (Between $1/2''$ and $3/4''$ per foot.)
2. Shoulder area is slightly steeper than the center of the road.
3. Keep the road narrow enough to make one round with just two passes.

Get and keep a standard top shape.

- ◆ A top width must be established to match the number of passes to be used each round. (See page 6.)
- ◆ Use blade angle between 30 and 45 degrees. (See page 6.)
- ◆ Use top slope of 1/2" to 3/4" per foot. (Set slope gauge at 5 percent.) (See page 4.)
- ◆ Use a slope gauge, set it at 4 or 5 percent. (See page 6.)
- ◆ Heel in the shoulders each spring to keep top from getting too wide. Sometimes called "pinching in" the shoulders, this should be done before the frost is clear out. Pinching in is cutting about 3' down the slope and bringing in about 6" in top width. (See page 7.)
- ◆ Using a 16' moldboard, keep tops about 26' to 28' wide. You will then do one round in two passes. (See page 6.)
- ◆ Secondary ditches are caused by roads being too wide. (See page 6.)

Get and Keep a Standard Top Shape

Top of Road Width



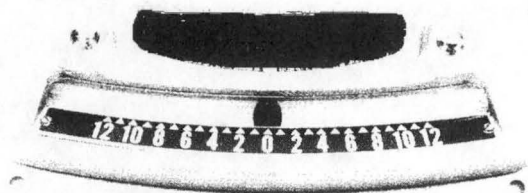
Width of Bladed Surface

(16' long moldboard)

30 degrees	13.7'
35 degrees	13.1'
40 degrees	12.3'
45 degrees	11.3'

Note: For a 26' to 28' top width, you will probably want to operate at about 40 degrees.

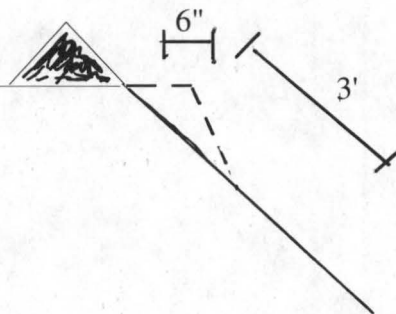
Slope Gauges



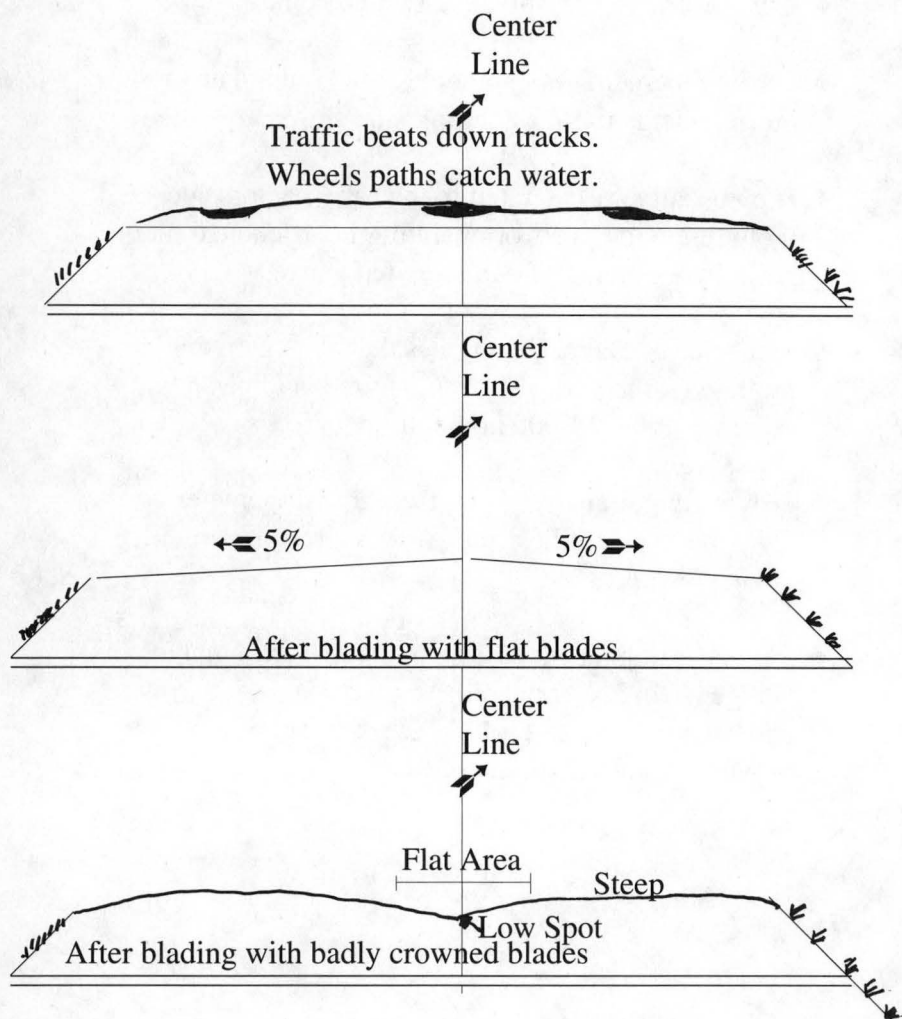
Slope meter on circle supports.

from Ron Price, Davis County

"Pinching In"



1. Bring up edge material.
2. Windrow to center.
3. Carry material across road to spread and knock down any clumps.

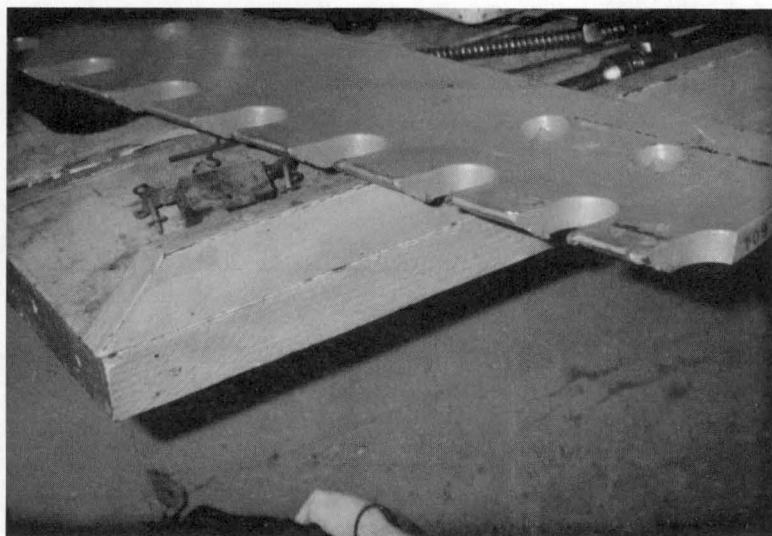


Slope gauges (also called crown gauges)

- ◆ Should be used, and used on the “cut” pass.
- ◆ Cut a four percent; spread at two percent.
- ◆ Use the percent grade model for blading. (The grade ratio model is used for cutting side slopes.)
- ◆ They usually are mounted in the cab. Factors such as mounting wing posts or operating in articulated mode will affect reading of cab mounted gauge.
- ◆ Ron Price of Davis County has the slope gauge mounted on the drawbar circle frame, and has had it there for about 11,000 hours of operation.
- ◆ Crown gauges are available from the Slopemeter Company, Caterpillar, and Agri Drain Company of Adair, Iowa.
- ◆ New operators need training in using crown gauges. Gauges help a new operator keep a consistent crown and road profile. After long use, the feel of a proper crown becomes natural.



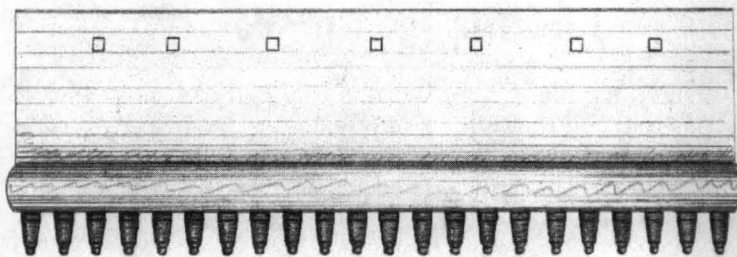
(from John Weiss, Guthrie County.)



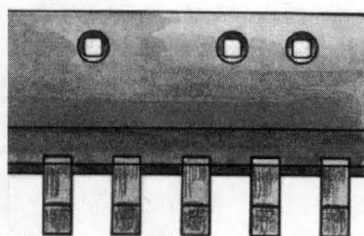
Use 6" blades with 2" deep serrations.

Keep flat blades on your machine

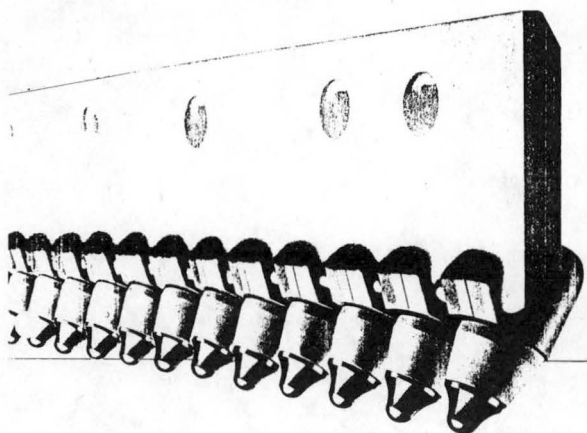
- ◆ Get road top shaped first.
- ◆ Cut when it is wet; drag when it is dry.
- ◆ Shape roads to "A" shape in wet spring weather using regular blades.
- ◆ Use scarifier bits to shape road top any time of the year.
- ◆ Flatten blades on concrete pavement (once a week) (for taking out a small crown in blades).
- ◆ If flattening blades on the paving: use caution, use float position, flatten 1/2 blade at a time, don't pull joint sealer out of joints, use 6" blades, don't try to take out a severe crown, and don't start grass fires.
- ◆ Cut blades flat with a torch. Mechanic may help. Some hardened blades will fracture when torched. Torching changes hardening qualities. In Winnebago County they trim their blades two or three times per set, and have no trouble with breakage.
- ◆ Reverse blades often. Use care. If the blades have too much rounding, you can damage your road top using reversed blades.
- ◆ Use hardened center 8' blade, use regular 4' blades on each end.



Sandvig



Caterpillar

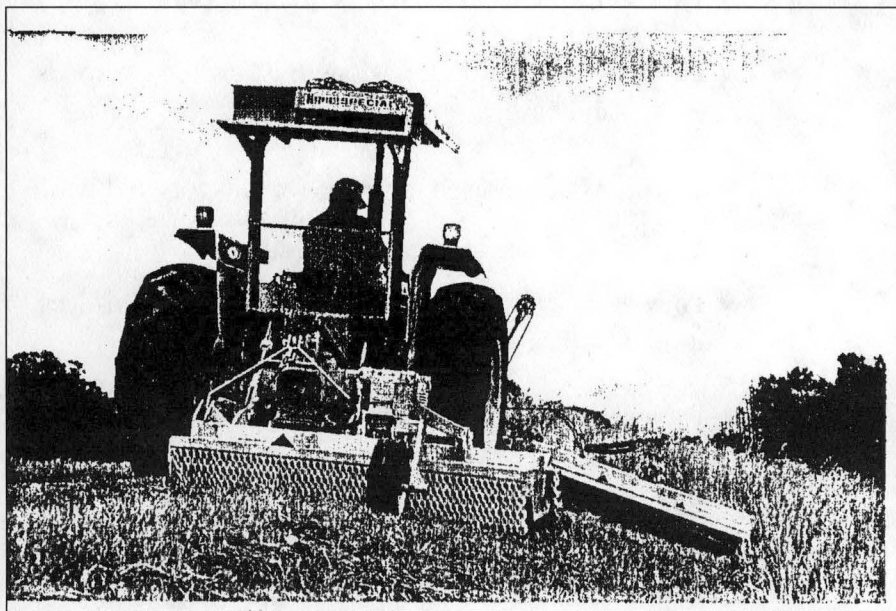


Kenametal

Serrated ice blades for scarifying

Serrated ice blades can be used to scarify. Use 6" blades with 2" deep serrations and not the 8" blades with 4" deep serrations. Do scarifying after a rain when the top is fairly damp.

Rotary Mower



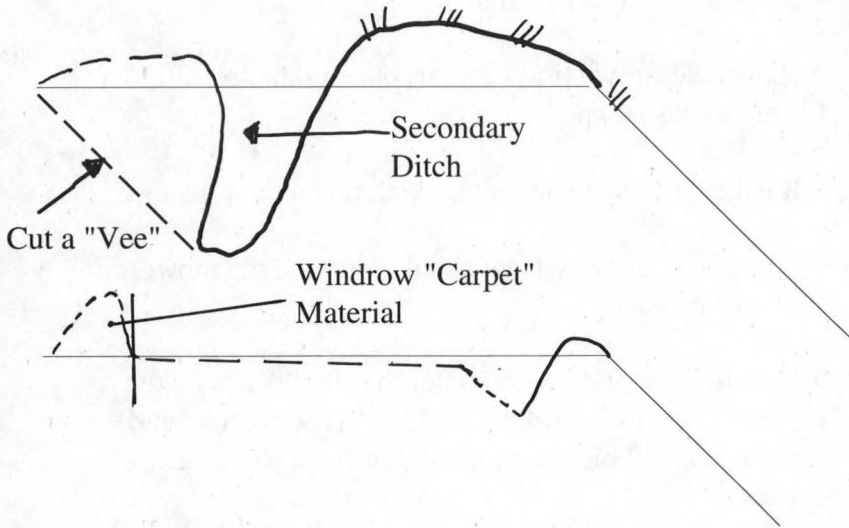
Scarifier bits

- ◆ Manufactured scarifier bits are made by Caterpillar, Sandvik, and Kenametal.
- ◆ They are used to shape and re-mix the road top.
- ◆ They can be used on limestone roads when the roads are dry and hard.
- ◆ Scarifier bits are used to repair rough spots and wash boards.
- ◆ They are used for preparing single seal coat surfaces, not to scarify A.C. concrete.
- ◆ They are used for ice removal on gravel roads.

Mow the shoulders on gravel roads.

- ◆ Mow with a rotary or flail.
- ◆ Mow at least two times a year; once in the fall after growth has stopped.
- ◆ It is better to also mow one swath down the foreslope.
- ◆ Pull gravel in away from shoulder before the mower makes its pass.
- ◆ Pull the rock and grass in after the shoulder is frozen hard. Pick a windy day, work the up-wind side, and the grass will blow away, but you'll get lots of gravel back.
- ◆ Some counties require the farmers to mow the shoulders on gravel roads, but either way it has to be done or grass growth will take over. We have too much good soil and too much rain in Iowa.
- ◆ Grass must be off the shoulder before the first snow fall.

Sweep Under the Carpet Method



Repairing a Secondary Ditch

1. Cut a "Vee" to open up the ditch.
2. Put "Vee" material and gravel into windrow.
3. Put mixed shoulder and base material into "Vee" and roll with wheels.
4. Put "carpet" back on road top.

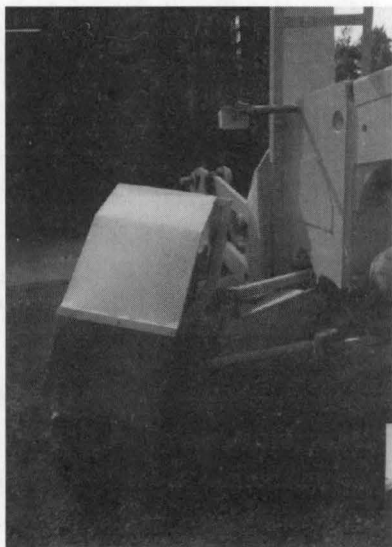
Secondary ditches

- ◆ They also are called “edge ruts,” or parallel washes, and sometimes called “curbs” when the ditch is about 6" above the road top. Or it may be called “handrails” when the ditch is 12" or more above the road top.
- ◆ Most secondary ditches are caused by roads being too wide, and the top being too flat.
- ◆ Secondary ditches can be caused by leaving a windrow along the edge, which stops rain from draining over the shoulder.
- ◆ Repair them using the “sweep under the carpet method,” but you need to get the road top back to 26' to keep the problem from happening again. When curbs or “handrails” occur, the road must be regraded to establish the proper shape. Side ditches should be at least 2' deep.
- ◆ Keep the road shoulders cut and trimmed to let rainfall drain off the side, over the shoulder.
- ◆ With a proper crown, secondary ditches will disappear.

Bouncing of machines

- ◆ Speed--try one gear slower.
- ◆ Increase blade angle, lessen pitch on blade.
- ◆ Articulate--offset front and rear wheels so they are not in the same paths.
- ◆ Keep wheels off windrows.
- ◆ Tire pressures--use recommended pressures and adjust for axle weights, wing posts, etc.
- ◆ Non-uniform tires--tires may be out of round, or they may have different circumferences. All four rear tires must have the same circumference.
- ◆ Weights - you may need to add dead load on the front, carry a plow hitch, etc. Heavier weight machines seem to have less bounce.
- ◆ Loose shims and worn parts--will cause the circle to shake.
- ◆ During cold weather tires will form flat spots overnight. Solutions are to drive down paved roads to warm up the tires, jack the machine up overnight, or keep the machine in a heated shed.
- ◆ When "feathering back," a lesser blade pitch helps you carry a little more load, and helps reduce bouncing.

Homemade Metal Fenders



Front fender pivots with wheel.
Also adjusts up and down.

Rear fenders
Adjust up and down.

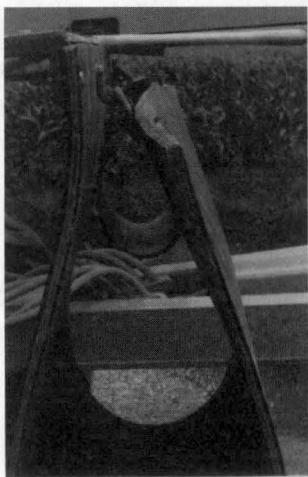
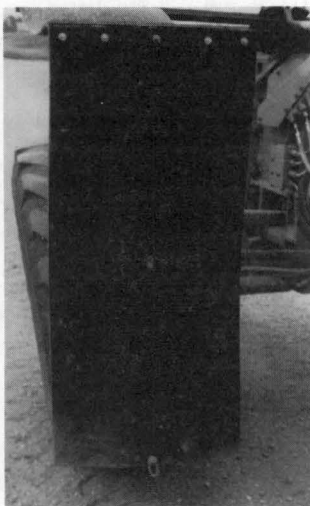


(developed by Dave
Coe, Cerro Gordo County)

Other ideas and comments

- ◆ Bias ply tires may have sidewall damage from operating in the articulated mode.
- ◆ Most counties use hardened blades. Generally they use two 8' x 8" in summer, then switch to two 8' x 6" in the winter. A good number use 8' hardened center blade and two 4' regular grade outer blades. A few operators are using carbide tip blades and go for two or three years between blade changes.
- ◆ A high percent of counties do try to keep flat blades. About half of the operators in those counties say they will occasionally flatten their blades on concrete paving.
- ◆ Grease zerks that are hard to reach, or dangerous to reach should be extended. (New machines have this feature.)
- ◆ Graphite is used on top of the circle.
- ◆ Old rayon tires did not bounce.

Mud Flaps Made from Belting



Hooks up when
not needed.

(developed by Buena
Vista County)

General findings and ideas

- ◆ Machines should be washed and waxed at least twice a year.
- ◆ The county should have a winter washing facility.
- ◆ A push blade on the front of a motor grader is a very useful tool. Can be made from a part of an old blade.
- ◆ A double gang disk is a big help for small county grading jobs. Pulled by a motor grader.
- ◆ Snow policies - most counties. Motor graders leave their shops 1/2 hour before day light. If high winds are causing drifting in behind motor graders then they are pulled off the roads.
- ◆ Under normal conditions, it takes about 20 minutes each morning and 20 minutes each night to do equipment checks and maintenance.
- ◆ Most counties use 16' blades, 26' to 28' road tops, and two passes per round.
- ◆ A few counties use 14' blades, 28' to 32' road tops, and either three or four passes per round.
- ◆ A few counties use 18' blades and normally have 30' road tops.

Gravel Saver



Back brace results in flush mount when gravel saver is bolted on. from Mark Johnson, Winnebago County.

Gravel savers (9" long wing tips on blades)

- ◆ Use in spring, before frost goes out, to pull in the gravel.
- ◆ Use in fall, after mowing, to pull in the gravel.
- ◆ Good for cleaning off bridges.
- ◆ Good for working around intersections.
- ◆ For normal blading, can carry more gravel, does not slobber (dribble) around cutting tip.
- ◆ Use on both ends of blade. Will spread the windrow out a little flatter on discharge end.
- ◆ Alvin Jansen, Crawford County and Mick Lee of Cass County found that they needed to use three bolt holes for attaching the gravel saver over regular blades, Alvin also found the gravel saver worked best with the blade pitch up about 4" from normal.
- ◆ Bob Ageson of Lyon County welds his "gravel saver" wing tip right to the end of his four foot blades. His 8' center blade is hardened. The two 4' end blades are not hardened.
- ◆ Winnebago County has made a brace to bolt on the back side of the moldboard. Their gravel savers then bolt to the brace and are flush with the rest of the blade.

Gravel Savers



Originally designed
by Buena Vista
County. Now
manufactured
and available
for sale.



Use articulation, it is a great help.

- ◆ Use crab mode to pick up the windrow.
- ◆ Crab so that inside tandems are in the middle of the front wheels, and so the outside tandems are in line with the windrow you are picking up.
- ◆ Put the power (tandems) behind the load.
- ◆ The windrow seems to “glide” across the moldboard better in crab.
- ◆ In normal damp conditions the outside tandems will pack the shoulder firm.
- ◆ In wet or soft conditions, reverse the crab to keep the tandems away from the shoulder.
- ◆ In crab, there is less spillage on pick-up end of mold board.
- ◆ In crab, you get less bounce, keeps tandems off loose clumps, and tires don’t track.
- ◆ Use articulation to steer around curves and corners.
- ◆ Use articulation for grading or ditching roads.
- ◆ Great for snow removal (see snow removal items).

Other observations from around Iowa

- ◆ Some very tall operators may need to have high profile cabs. Overhead mounted items don't leave much headroom anyway. They should still operate from the seated position, and wearing their seat belt.
- ◆ Fenders are worthwhile, especially in limestone country where you often work in wet conditions. Some are bought, some made from belting, and some are home made in the shop.
- ◆ Some counties are buying 14' moldboards, and adding just one 2' extension. They can run the blade out to the side, and turn it over, to make changing blades a lot easier.

Safety Items for Motor Graders in Iowa

Required by I.O.S.H.

- First aid kit
- Fire extinguisher
- Brakes (service, emergency & parking)
- Brake lights
- Headlights, 2
- Taillights, 2
- Horn
- Back-up alarm (or observer)
- Safety glass & unbroken glass
- Windshield wipers
- Defroster-defogger
- Seat belt
- No loose tools or equipment in cab
- R.O.P.S. (sub-part W)
- One person on crew to be first-aid trained
- Carbon monoxide level
- Noise level

Personal Protective Equipment (Sub-part E)

- Eye protection--when needed
- Hard hat--when needed
- Other items--when needed
- ADDITIONAL ITEMS

Required by Iowa Code Chapter 321

Turn signal lights	321.317
Red rear lamp	321.387
Muffler	321.436
Mirror	321.437
Flares, reflectors, or triangles (3)	321.447
Slow moving vehicle sign	321.383
Amber flashing light	321.423 (6)

Not in Code--Local Policy Only

Red flags on blade tips	321.394 & 321.453
Stay back 50' sign	-----
Personal safety vest when walking on road	-----

Safety recommendations from operators

- ◆ Use flags on blade tips, even if not required
- ◆ Use fishing pole extended flags when blading against traffic, if there are any hills.
- ◆ Use large "stay back 50' " signs, and make sure they are clean and reflectorized.
- ◆ New machines with rubber door and window seals will be at 85 decibels. Radios may be even louder. Use ear plugs for 90 decibels or more.
- ◆ Use your seat belts. Get in the habit. Especially for snow removal. Plan to walk around your machine several times a day to relieve your back and stretch your legs.
- ◆ Be sure to have all state code and O.S.H.A. required safety equipment, and be sure it works. Lights, beacons, horn, back-up alarm, S.M.V. sign, first aid kit, fire extinguisher, etc.
- ◆ Two-way radios should be required as a safety item, and a back-up C.B. radio (furnished by the county) is also recommended.
- ◆ New machines should be air conditioned as a safety item. Noise and dust pollution can be avoided.
- ◆ A raised walkway for fueling the machine in the winter would be safer. And a raised walkway in the wash area would be safer also. Better for cleaning windows and lights.
- ◆ Do not use the blade for an "elevator" to get in and out of the cab.

Double Mirrors



Flat over convex.

Convex for visibility
and flat to judge distances.

(by Dave Coe,
Cerro Gordo County)



Snow removal

- ◆ Articulate, keeps tandems away from shoulders.
- ◆ Articulate, vee plow pushes heavy side of drift better. Always start on high side of deep drifts, and try to hit deep drifts going up hill. Always keep tandems out of deep snow.
- ◆ Winging back snow, crab in the other direction.
- ◆ Plows must be kept clean. Any mud frozen on the plow uses a lot of horsepower. Use slick flat paint or graphite paint on plows to help them scour.
- ◆ Wings must have safety cable, or safety chain to prevent accidental tire damage. Be sure wings have shoes bolted to back of wings. Don't run wings below horizontal.
- ◆ Chains should be used all around. Square link cross chains wear very well. Ruggo's rolling chain is very good.
- ◆ For radial tires, use no chain tighteners.
- ◆ If trucks are going to "help" in snow removal on gravel, talk to the driver awhile. Be sure there are shoes on the plow, that the plow will stay up out of the gravel, and that the operator knows not to push gravel off your roads, and will have to travel slow while plowing. (The operator may only have plowed on paved roads before.)
- ◆ Keep a close eye on your air filter. Swirling winds may clog it.
- ◆ Clean plows and machines when quitting at night. Snow will be hard ice by morning.

IOWA

Pertinent Code Sections

1. Section 321.230

Public vehicles are not exempt from driving laws, except for emergency vehicles subject to specific exceptions. (Specific exceptions for road construction and road maintenance vehicles are listed elsewhere.)

Roads Closed

2. Section 321.233

Road laws do not apply “while actually engaged in work upon the surface of a highway officially closed to traffic,” except for those dealing with reckless driving, assaults and homicides, and operating while intoxicated or drugged.

Maintenance on Open Roads

3. Section 321.233

Code sections 321.297 (driving on the right hand side of the road) and 321.298 (meeting and turning to the right) do not apply to road workers operating maintenance equipment “while engaged in road maintenance, road blading, snow and ice control and removal, and granular resurfacing work on a highway, whether or not the highway is closed to traffic.”

Wider than Eight Feet

4. Section 321.453

“The provisions of this chapter governing size, weight, and load do not apply to fire apparatus, to road maintenance equipment owned by or under lease to any state or local authority,” or to ... (includes implements of husbandry and vehicles operating under terms of a special permit).

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