Gravel Road Basics

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What Are Your Road Issues?
Principles of a Good Road
Principals of a Good Road

• Good Profile
  – Without it, there will not be good drainage

• Good Drainage
  – Without it, there will not be a proper profile
Maintaining Gravel Roads

- Understanding correct shape of the roadway cross-section is the most important knowledge an operator can possess.
- Gravel roads constantly change shape!!! Operators and supervisors have to deal with this.
Principles of a Good Road

• Good cross-section = good drainage

When looking at your road don’t just look at the road top look at the entire cross-section. You need to get the water away from the centerline to the shoulder to the ditch and away from the road.
The Road and its Surroundings

- Terrain
- Cross Slope
- Clear Zone
- Drainage
- Ditches
- Bridges/Culverts
- Transitions
Proper crown and cross slope?

Cross-Section

- Modified “A”
- Parabolic
- Excessive
- Flat/No Crown
- Inverted
• Crown should be at or near ½ inch per foot [ 4 % ]
  – 4% Gravel 2% Asphalt

• Example: 24 ft. roadway should have 6 in. of crown

• Crown should be straight like a roof

• Eliminates flat areas in travel way
  • Which allow water to remain on road surface and cause potholes and other problems
Straight blades are very important in shaping a road to achieve the modified A shape.
Cupped blades one of biggest issues in road maintenance
Dry maintenance on a road with improper crown caused cupped blades
Proper Profile

• Modified A

• Target 4%

• Straight blades
Proper Profile

- Roof top
- Keep edge

Straight Blades!!!

Picture on bottom was taken after about ten days when road was bladed on top picture.

Road receives about 200 adt and had gotten approximately 6 inches of rain over 7 days.
Parabolic crown has a **flat circular contour, drains poorly** and gravel tends to get displaced from center of road.

Water tends to run along the roads center and **weaken the road** in the process.

Parabolic crowning develops during blading because of motor grader moldboards that have edges that are worn or cupped in the middle.
Actually an inverted crown

Doesn’t allow water to run off the road but actually channels it towards the center and holds it in the traveled way.

When you have higher shoulders than the road you don’t have a road you have a canal.
Flat crown

Really has no crown at all, it allows for little or no drainage
Maintaining Gravel Roads

Important things to understand about the use of the motor grader:

- Moldboard Angle
- Moldboard Pitch
- Motor Grader Stability
- Operating Speed
- Articulation
- Windrows
Pass 1 – from the right shoulder to the lane up the slope of the crown.
Second pass takes the material across the ridge of the crown.

When carrying windrow across the centerline will actually have a gap under the heel of the blade that is over the center of the road be careful not to cut center out of the road.
Lastly you move the material to the opposite shoulder while shaping to ideal crown slope. Notice the gap underneath the toe of the machine on this pass instead of the heel.

It is like cutting a modified X be careful not to cut centerline
First pass picks up windrow and moves it near center of the road.

Second moves material past center line.

Third pass brings windrow to opposite shoulder. Gives 24 ft. of smooth driving surface.
Articulation

- True cross slope
- Wider compaction area
- Shoulder compaction
- Lay material on edge
- What is taken away must be put back

Setting Machine
Moldboard Set Up
Articulation

First Pass

Aerial view of machine, notice how rear tandems ride the shoulder for compaction and the front wheel is on the centerline.

Articulate so right front wheel is riding inside the left set of tandems.
Notice how the front tire sits right inside the tandems.
Operator’s View When Articulated

First Pass

• Increased visibility
• Go straight
• Moldboard pitched to create rolling action
• Angled to prevent material loss
Articulation

- Maneuver around objects
- Maintain straight path
Be aware of dead weight on bridges!
Beware of Dead Weight
What do you see here?
On this intersection the operator fans the material back when starting second pass to keep intersection flat as there is also a bridge that goes across this intersection basically you are square blading the material back which keeps intersection flat and material from piling up and builds up road before intersection if humped.

You do the same thing at bridges to keep a smooth transition to bridge remember bridges typically carry a 2% and your road should carry 4% you need to adjust for this transition try to carry this transition for a 100ft from bridge deck.
Techniques

• Pick up material and fan it to even out the windrow.
• Fill-in low spots, particularly on intersections.
• Remove excess material from bridges and creating smooth transition to roadway.
• Deadhead

• Light vegetation:
  – Pick up material  Shave vegetation  Fan to center

• Heavy vegetation:
  – Just like 1st pass
Advantages

• Increases ability
  – Stay on slope
  – Carry load
  – Better stability

• Turn in small area increasing productivity

• Place engine frame squarely behind load
  – Providing better leverage
  – Handle heavier loads
  – Counteract side thrust
Articulation

Advantages

• Increased blade reach
• Easier steering in reverse
• Maneuverability when stuck
• Place tandems on good traction
Where are other uses for articulation?
Moldboard Pitch or Tilt: the angle the moldboard is tipped forward or backward

–Rearward for more aggressive cutting

–Forward for light blading or dragging action
Moldboard Angle:

– Should be between 30-45°

– Not losing material off the toe is a good indicator of proper angle

– Angle should not mimic corrugations
Blade Pitch and Angle

Improper Angle and Pitch:

– Creates a big loss of aggregate from the toe of the moldboard
– Overworks the machine
– Reduces fuel efficiency
– Leads to unnecessary wear on machine and operator

Pitch and angle will vary for different operations performed

Pitch and angle varies with types of material, moisture content, etc.
Which pitch is correct for maintenance blading?
Blade Angles for Road Maintenance

0°

30°

45°
Which blade angle is recommended for travel down the roadway?

A. 0°  
B. 30°  
C. 45°  
D. 45°
Redefining Your Road

• A look at fore slope

• Retrieving material

• Dust
Frequently Asked Questions

Why are his roads getting so wide?

Fore Slope 4 : 1

1 inch cut will widen road 2 inches per side

What is taken away has to be put back
Pinching in
Dust: An Important Piece of the Puzzle

• Dust is a very important component of a gravel road.

• It is the binder that holds the coarser material together the same way cement holds stone and sand together in concrete.

• Big clouds of dust are an indicator of deterioration.
Marking Cut?
Marking Cut?
Shoulder Line (Hinge Point)

Does your shoulder line look like this??

or this
A serious problem that obstructs drainage from the roadway to the ditch.
Fore Slope

• The fore slope should be as gentle as possible to provide a safe exit in case of emergency.

• And, it should provide good drainage and easy maintenance.

• Right of way, soil conditions, elevation, and type of road are factors in determining your fore slope.
• Defined edge
• No lip
• Smooth transition
• Limit Material
Finished

- Established edge
- No lip
- Good drainage
- Recoverable fore slope
- Cures soft spots
- Reduces weed growth
One of the Biggest Challenges in Road Maintenance
How do we fix this?
Straight Blades

- Retrieve material from edge
- Fan to center
Good or Excessive?
Public road should retain crown and driveway should match the edge
Simple Fix For Driveways and Intersections

Cut through humped intersections or driveways and smooth lip out on succeeding passes
Shaping the corner leaving the material to work the crown
The return trip on the other side
Flattening the immediate approach to the intersection to match.
All done – moving on! This technique works well on both humped intersections and driveways.
Proper Operating Speed

- Operate at a speed that is safe for public, fellow workers, and yourself
- Comparable with operators abilities!!!
- Advancements in machinery and technology
- Task at hand
- Road conditions [wet, dry]
- Weather [wind]
Cupped Blades and how they relate to:

- Quarter crown
- Humped intersections and driveways
- Secondary ditches
- Overall deterioration of road
Even if your policy is a two pass policy the bits must not be cupped or you get this with water retainage in the center.
Two Pass in Reality
Cupped Blades and How They Relate to Secondary Ditches
Maintaining Gravel Roads

Carbide Cutting Edges can solve many issues in maintaining roads.
Good Blades?
Super Elevation

$C_L$
0.08 feet per foot maximum super elevation
= measured from shoulder edges
= 1 inch slope per foot maximum
Here is a graphic that demonstrates the transition of a road as it goes into a curve and super-elevates the high (outside) side.
### Superelevation (g): mph

<table>
<thead>
<tr>
<th>% crown</th>
<th>8%</th>
<th>10%</th>
<th>12%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of Curve (LC)</td>
<td>730</td>
<td>668</td>
<td>621</td>
</tr>
<tr>
<td>Radius (R)</td>
<td>465</td>
<td>425</td>
<td>395</td>
</tr>
<tr>
<td>Runoff</td>
<td>178</td>
<td>222</td>
<td>226</td>
</tr>
<tr>
<td>Runout</td>
<td>44</td>
<td>44</td>
<td>44</td>
</tr>
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<tbody>
<tr>
<td>Length of Curve (LC)</td>
<td>119.4</td>
<td>1092</td>
<td>1006</td>
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<tr>
<td>Radius (R)</td>
<td>760</td>
<td>695</td>
<td>640</td>
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<tr>
<td>Runoff</td>
<td>204</td>
<td>256</td>
<td>307</td>
</tr>
<tr>
<td>Runout</td>
<td>51</td>
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$$LC = \frac{n}{180} \cdot R \cdot \theta$$

$$LC = \frac{n}{180} \cdot R^*90. = 1.57079R$$
Super Elevation

Correct

Wrong Wrong
Picture to the left is what you want to try and achieve

Picture to the right is more common to what we see there is actually about a 6 foot drop on the shoulder, the operator has funneled all of the traffic to the inside land.
Types of Crown

- Centerline Crown
- In-sloping
- Out-sloping

Figures not drawn to scale.
Windrows

Disadvantages

• Weep holes need cut
• Too much material
• Narrows roadway
• Impedes drainage
• Hazard to motorists
• Softens shoulder
A crown gauge made by SLOPE METER, INC®
Using a cutting bit on the front quick couple attachment of your motor grader simplifies the need to change out molboard bits.
To get to the bottom of those rumble bars and potholes, you need scarifying teeth. A front or rear attachment is there when you need them.

Also a useful tool when grading if soil is dry and hard helps to break soil up in ditch makes it easier to cut especially when grading with carbide blades and can also be used as a depth gauge when grading.
Another way of compacting material
A retriever or shoulder disc will improve your shoulder maintenance as it grinds up the grasses and mixes the dirt and recovered gravel into a usable material but will still need to be retrieved with motorgrader and placed on the road.
Magnet
When approaching particular maintenance situations ask yourself:

• Is this proper time to perform this maintenance procedure?
• Is it too wet or too dry?
• Do I need additional equipment or only motor grader?
• Will I need aggregate hauled in or material hauled away?
• Can I accomplish this in a day or will it take longer?
More Questions to Ask

- Should the road be barricaded or closed?

- Should the utility company be notified?

- Should I do this or are there more important areas that need attention?

- Should I notify my supervisor prior to maintenance?
Remember Nothing Worthwhile Comes Easy

• You need to know
  • Your equipment
  • Proper operating procedures
  • The law
  • Agency policies

• To be a good operator you must expend a lot of time and effort
• No matter how much you know today you will need to know more in the future

• Keep an open mind and be willing to try new ideas

• How well you do your job is entirely up to you!!

YOU ARE THE KEY