Best Practices Paving & Compaction

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Presented by Todd Mansell, CAT Paving

Carolina CAT

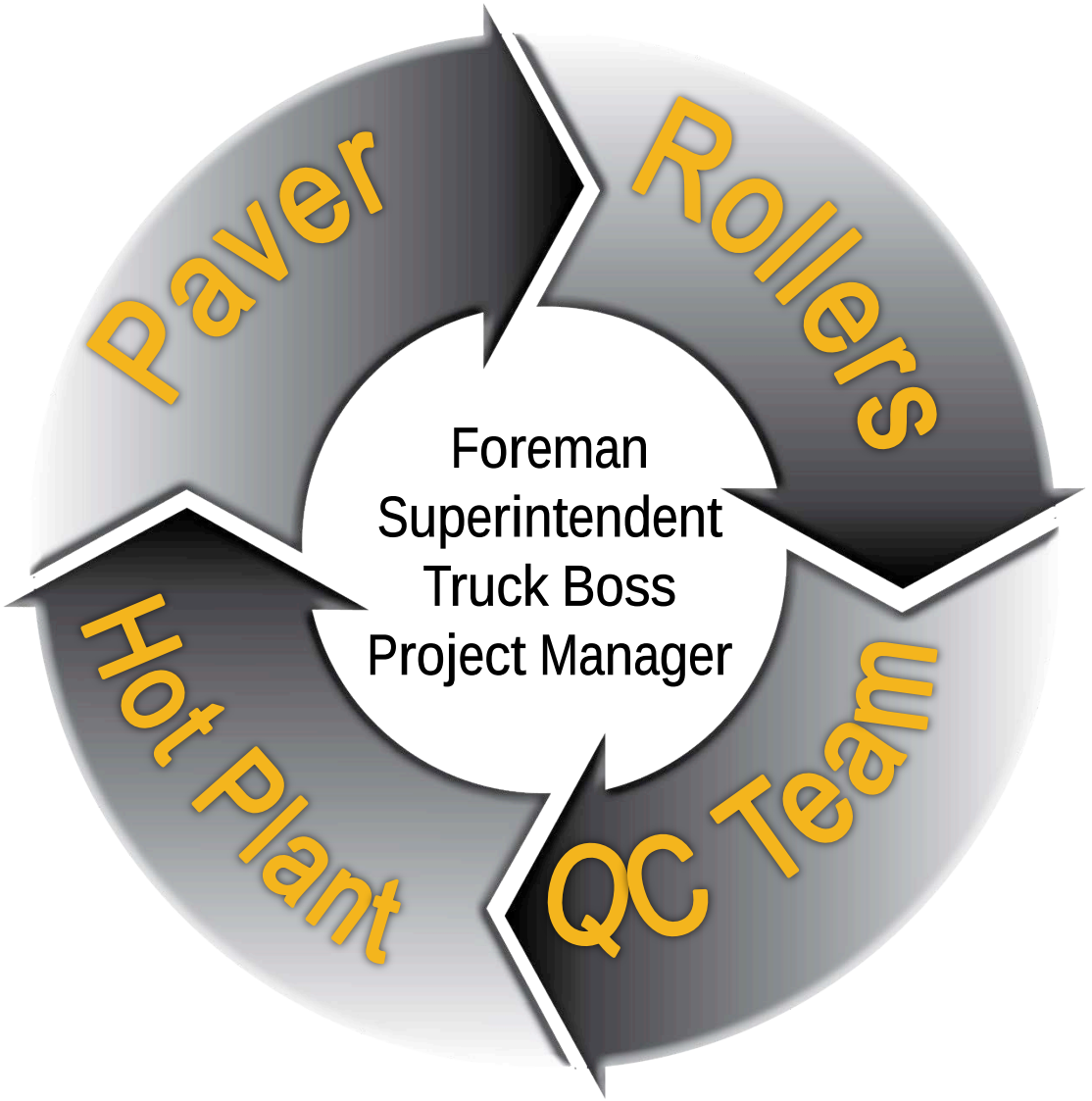
Outline

1. **Balanced Paving**
   - **Paver & Roller Speed**
2. **Paver Setup**
3. **Density (joints)**
   - **Transverse**
   - **Longitudinal**

Start with Tonnage

- How many tons of mix can we place today based on plant capacity or job capacity?
- Do we have enough trucks to delivery this tonnage from the plant to the job site?
  - Consider traffic patterns
- Is one paver enough to place?
  - 10-ft paver throughput ≈ 1,700 tph
  - 8-ft paver ≈ 1,100 tph

Lines of Communication



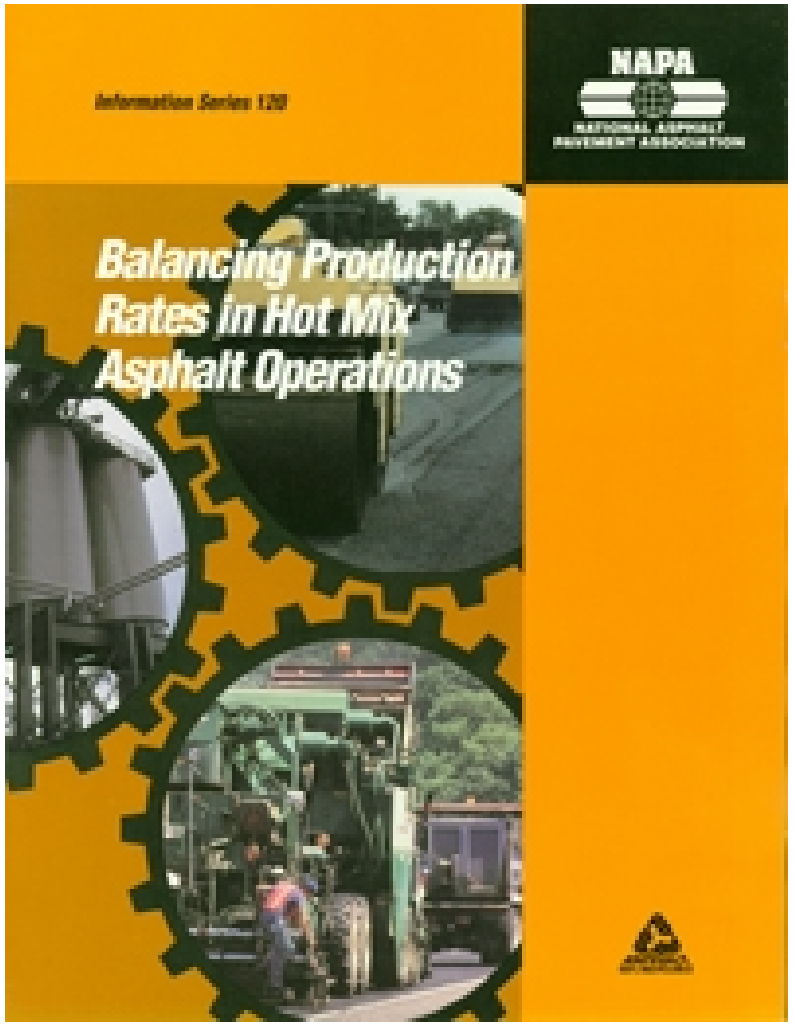
Emergency 911

Makesno Sense	Project Manager	555-234
Lotsa Iron	Equipment Manager	555-234
Alwayson Myphone	Area Superintendent	555-234
Ihate Timecards	Paving Foreman	555-234
Orange Cone	Traffic Control	555-234
Big Mack	Trucking	555-234
Marshall Hammer	Quality Control Manager	555-234
Thirsty Formore	Water truck	555-234
Reemove Andreplace	DOT Inspector on site	555-234
Hot Mixer	Batch room @ drum plant	555-234
Billitoo Anyjob	Equipment dispatch	555-234
I. Fixit	Mechanic	555-234

Balancing Plant, Trucking, Paver, Roller

- Expected 2,500 tons/day
- 8-hr paving window
- End dumping (18-ton)
- 12-ft wide, unconfined edge
- 2-inch overlay
- 12.5mm polymer-modified mix
- Autumn < 70°F
- Given 3 rollers
  - 84” steel vibratory (Cat CB64)
  - 79” steel vibratory (Cat CB54XW)
  - 82” pneumatic (Cat CW34)

Planning ≈ 20 minutes

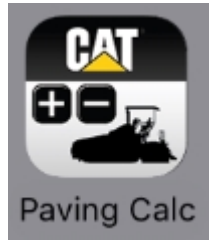


Pre- paving planning

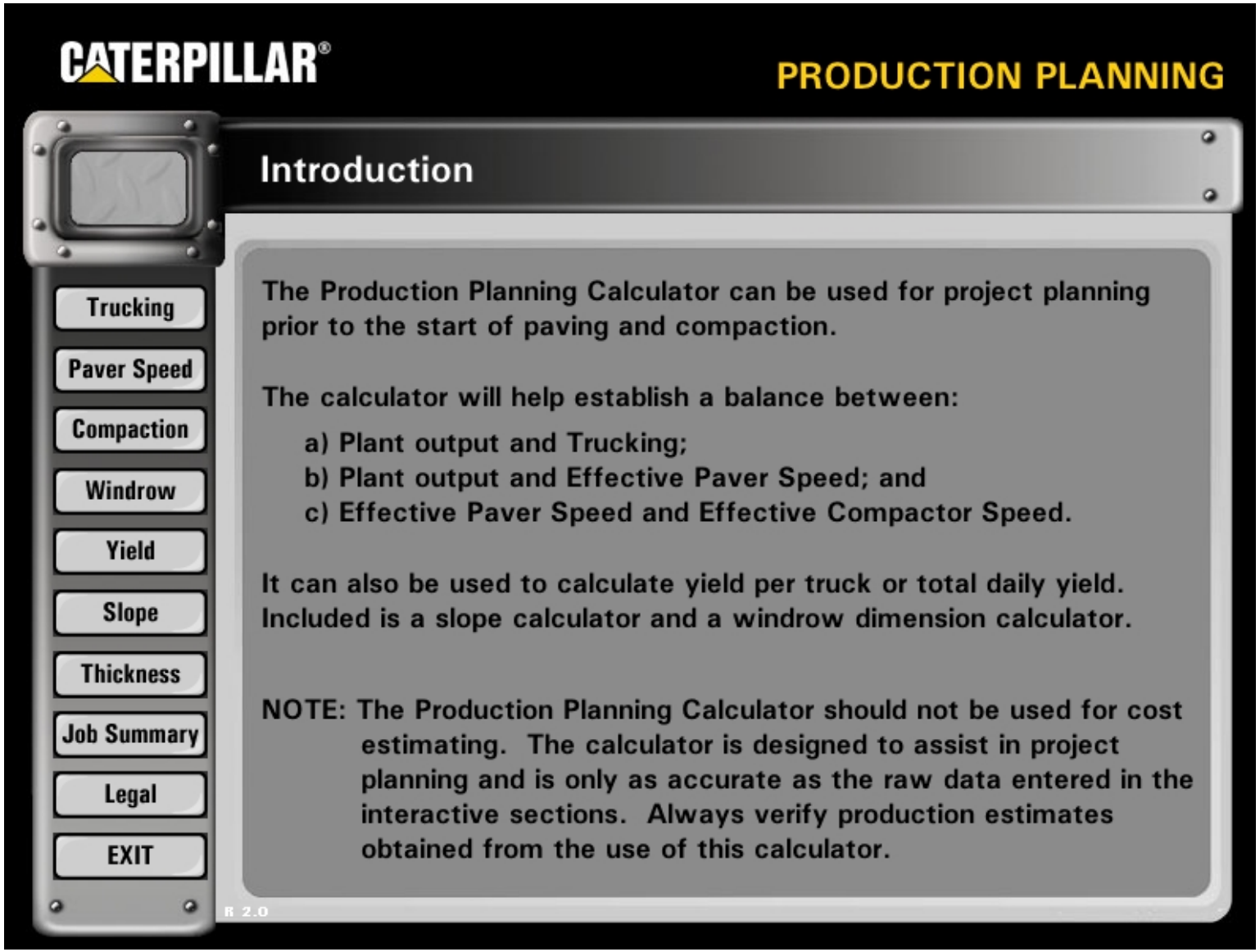
- ❑ Tons per day
- ❑ Number of trucks needed
- ❑ Paver speed
- ❑ Roller speed
- ❑ Rolling Pattern
  - Density
  - Smoothness

Tools available

- ❑ NAPA IS-120
- ❑ Paving Production Calculator App
- ❑ Amplitude Selection App
- ❑ PaveCool or MultiCool Apps



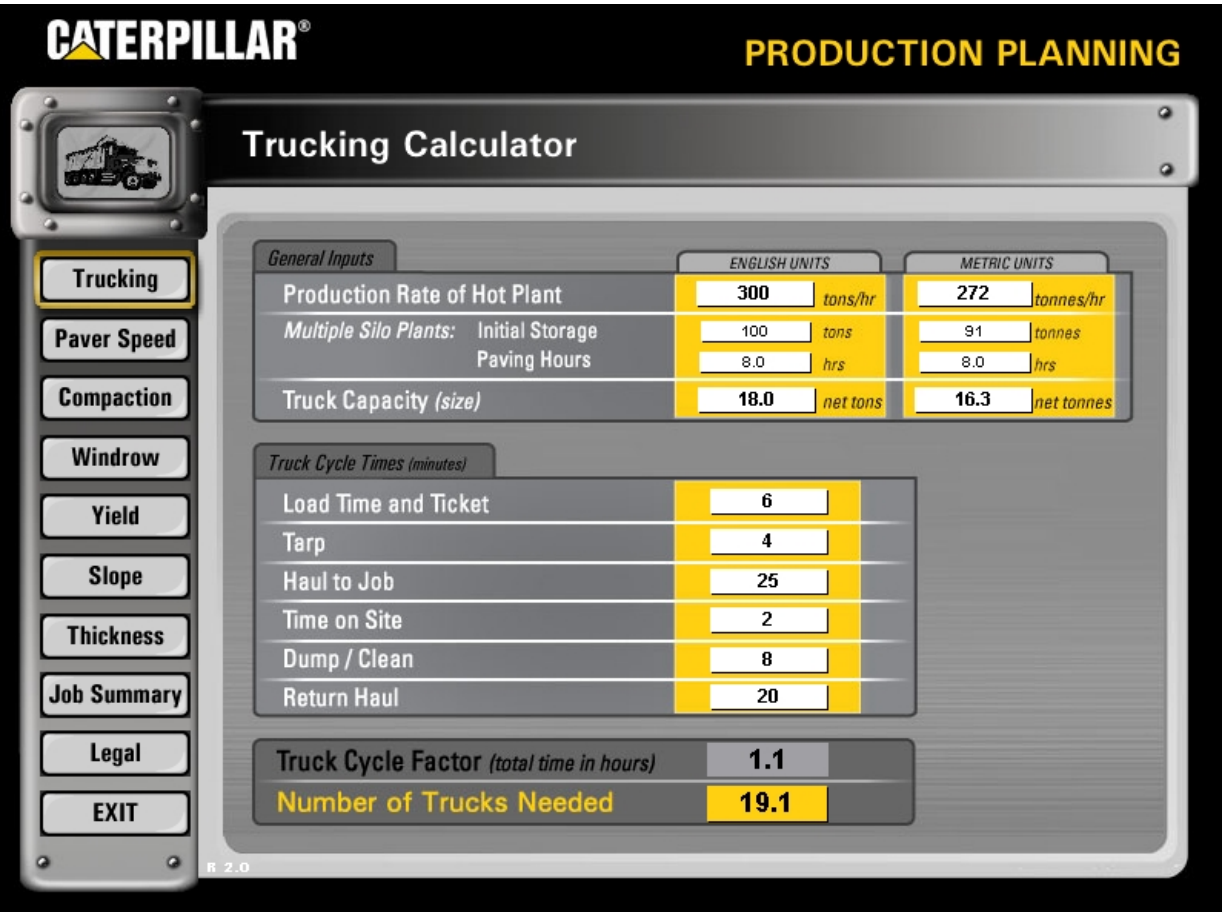
Need 7 pieces of information

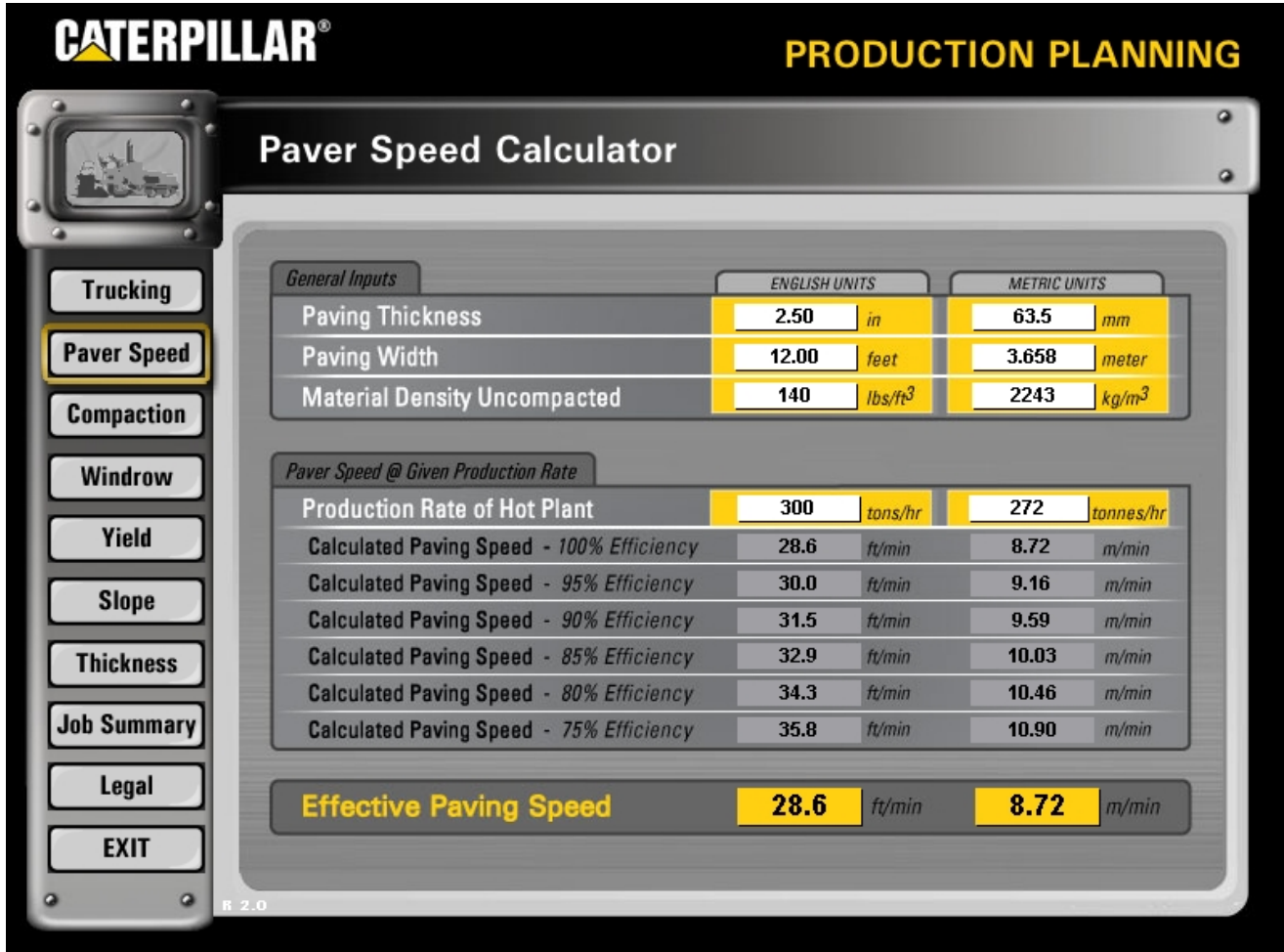


Use Paving Production Calculator or use NAPA IS-120 Worksheets

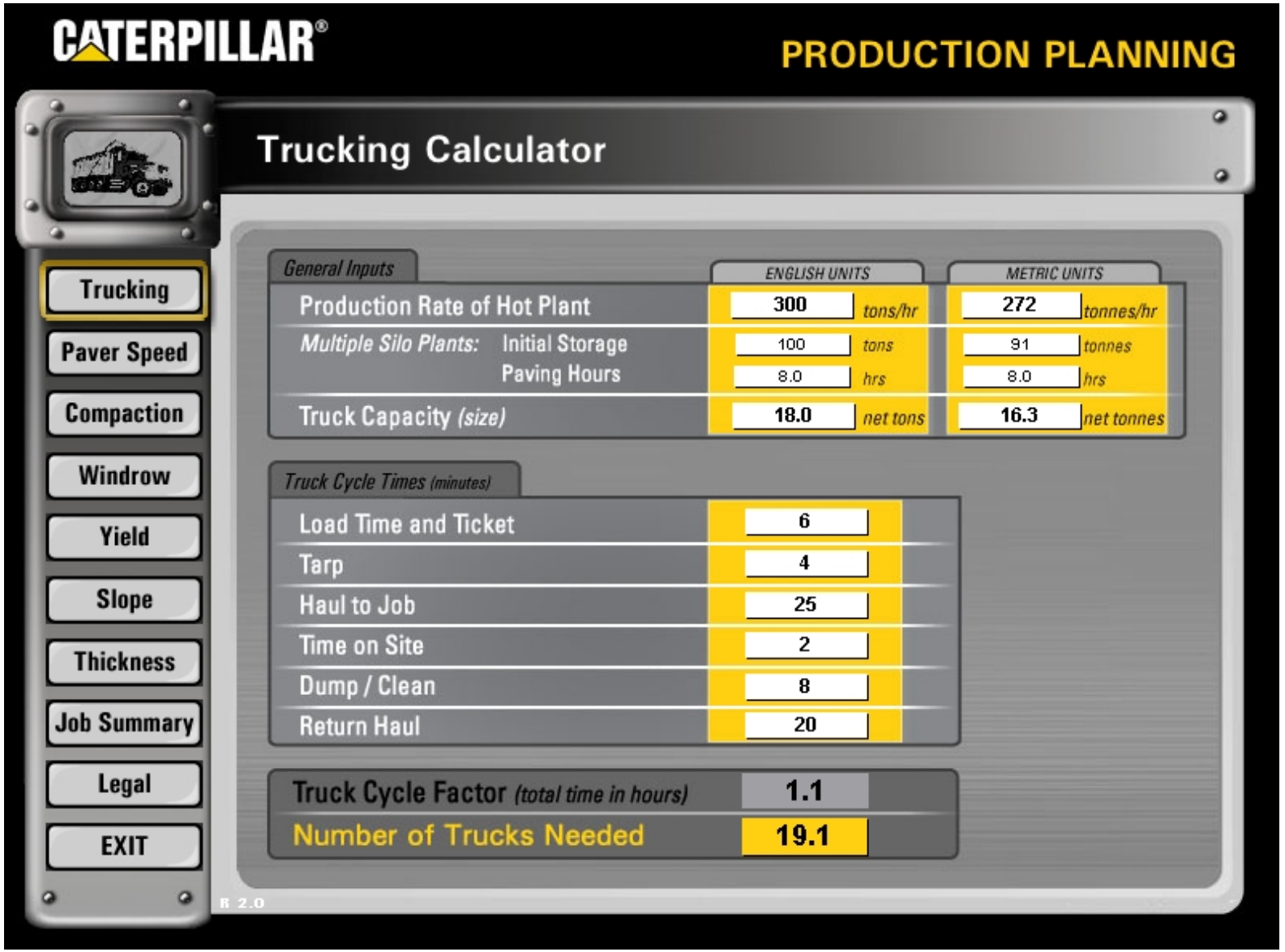
1. **Plant tph & silo capacity**
2. **Paving window**
3. **Average truck capacity**
4. **Truck cycle time**
5. **Mat thickness (loose)**
6. **Mat width**
7. **Loose mix density**

Input 7 pieces of information…

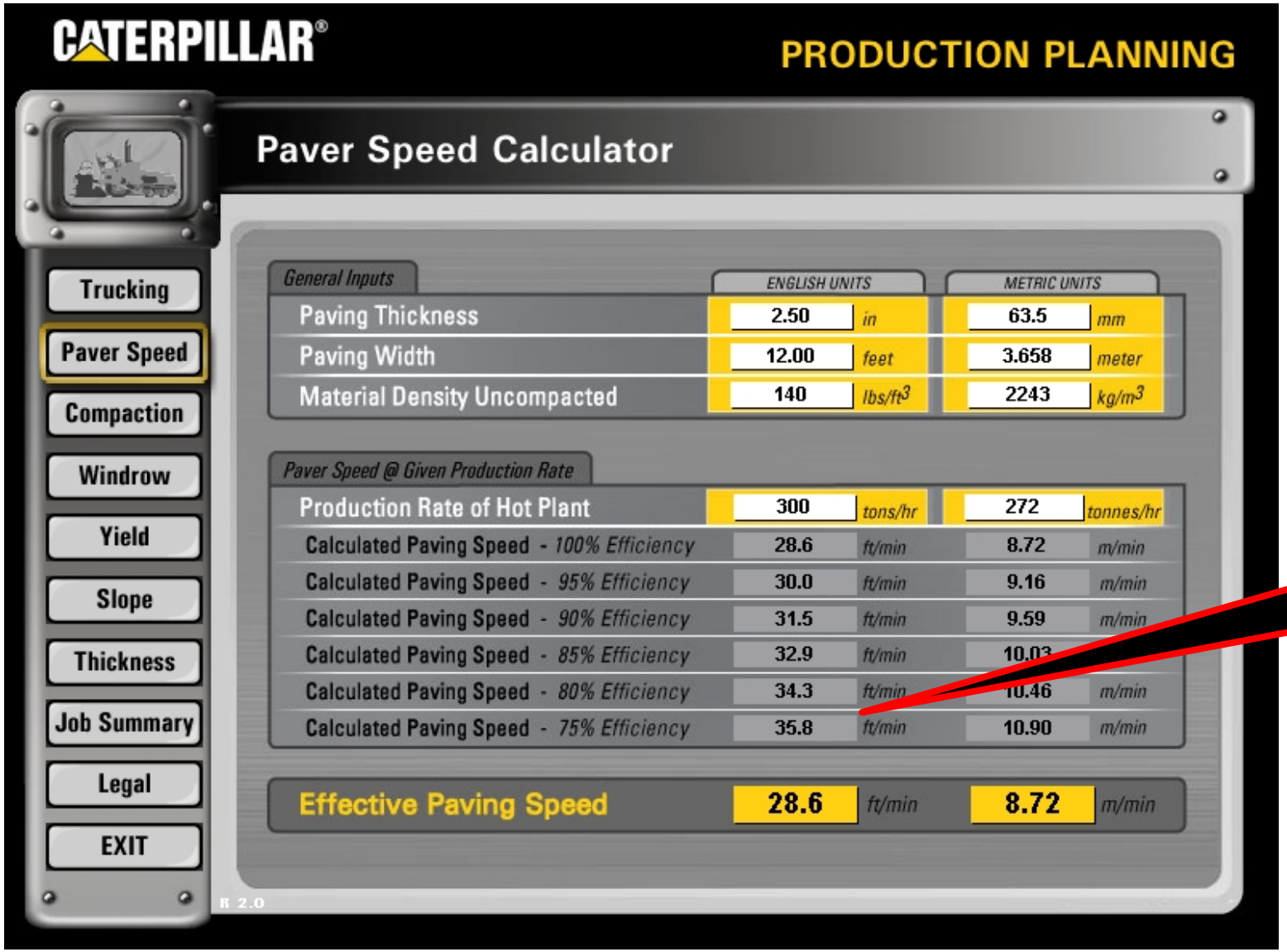




Number of Trucks = 20



Paver speed using end dumps



- Use 75% efficiency for end-dumping
- Use 100% for MTV

36 fpm

Paver Speed, trucking & plant is balanced

Paver: 15 Steps to Setup &Take Off

- Ensures consistent takeoff every time

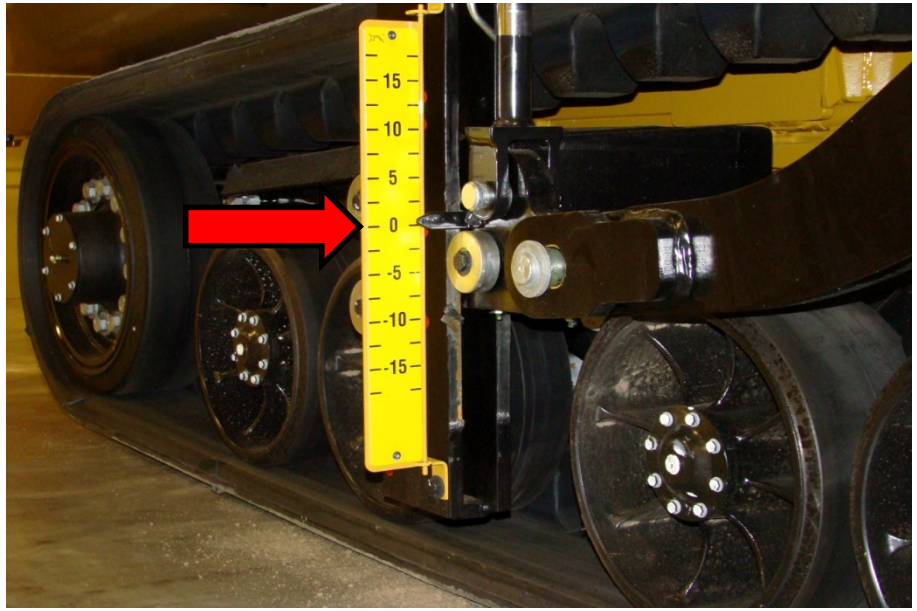
Goal: To have a smooth transverse joint & no mat defects from the start

Step 1: Heat the Screed

- **Prevents sticking**

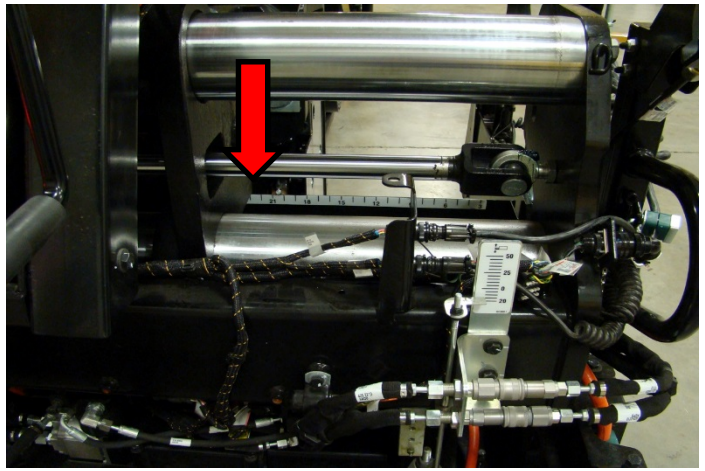
Step 2: Position Tow Point Cylinders

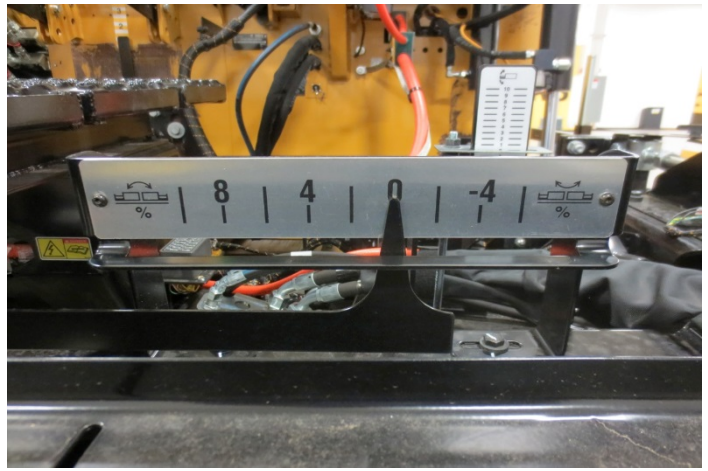
- **Straight line-of-pull**

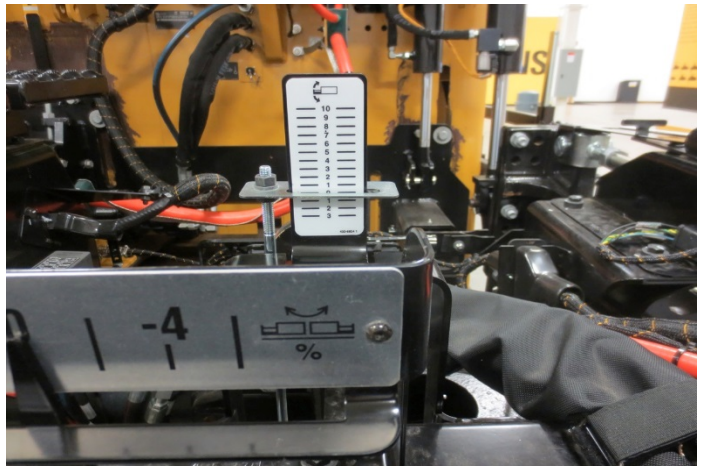


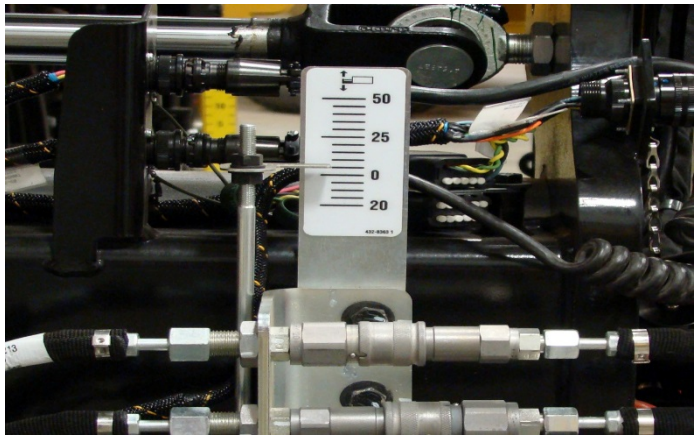
Steps 3 through 6

3. Set paving width
4. Set crown
5. Set extender height
6. Set extender slope



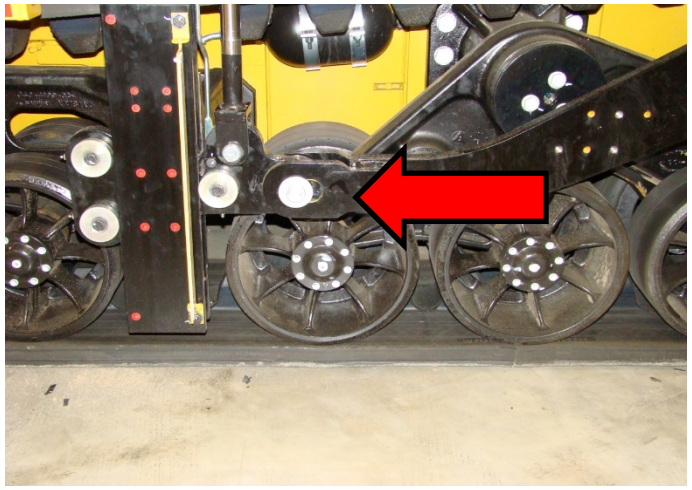






Step 7: Lower Screed

- Place starter boards = to desired mat thickness
- Lower screed onto starting boards in “float” position
- Take out the slack

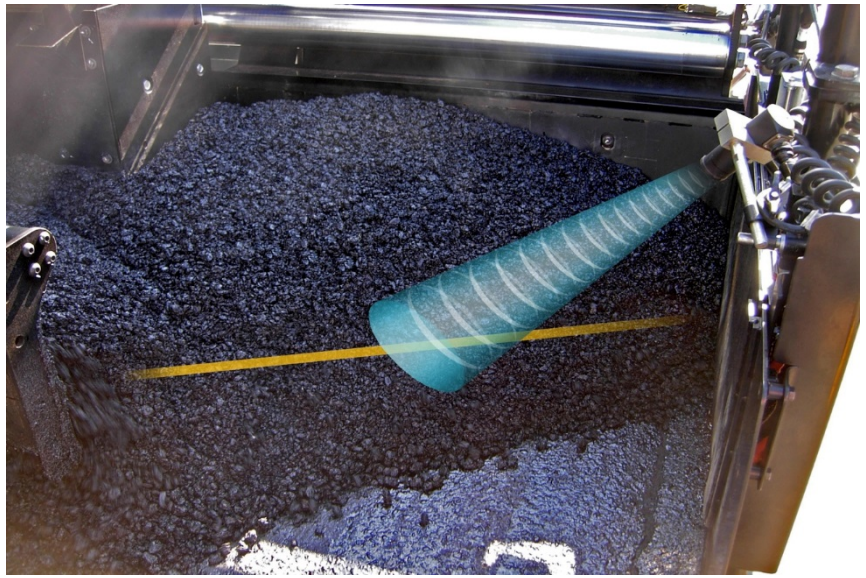


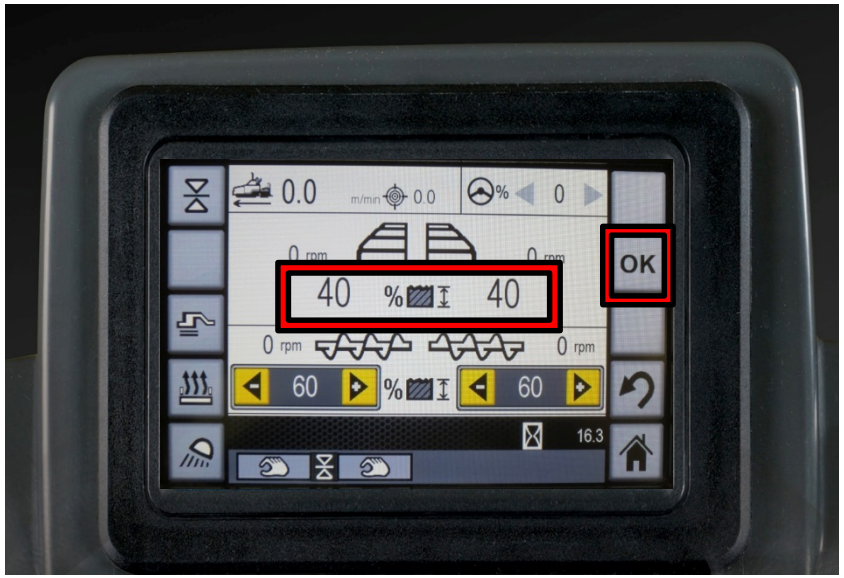
Step 8: Null the Screed

- Nulling the screed removes all the tension in the screed
- Use depth screws on each side until no resistance is felt
- The screed must be “free-floating” on the mix

Steps 9 through 12

9. Position end gates
10. Set auger height
11. Position feed sensors
12. Set feeder controls (conveyor ratio dial and mix height dial)





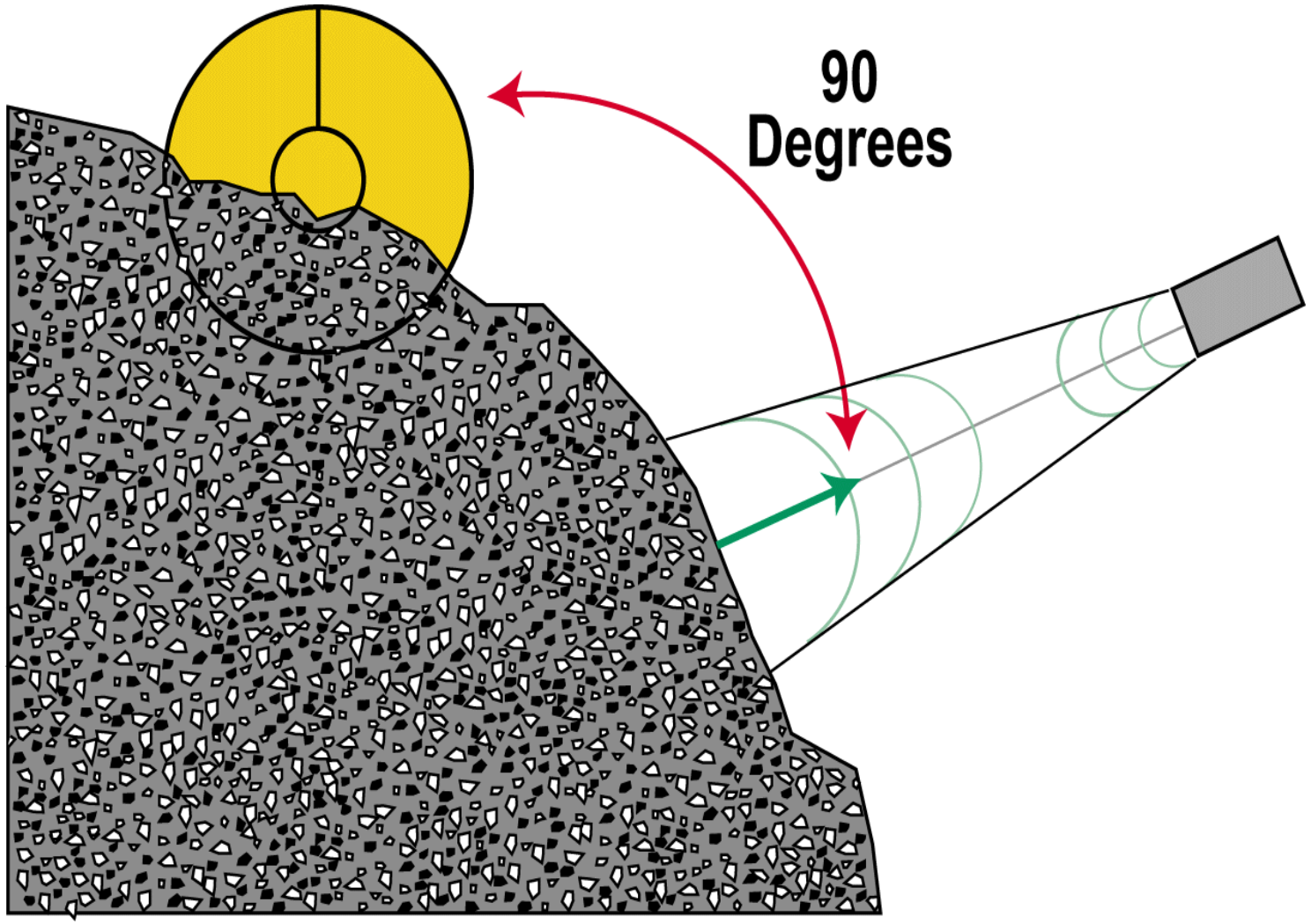
Step 13: Fill the Auger Chamber

- Fill auger chamber with asphalt mix to ½ auger height
- Use conveyors and augers
- Do not overfill

Feed Sensors

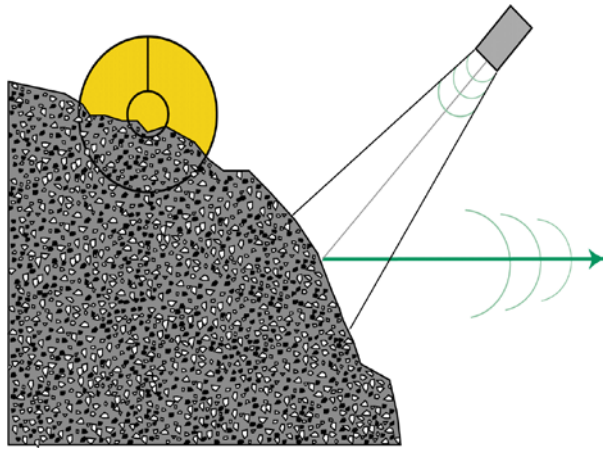
- Mechanical or sonic
- Control level of material
- Position Sensor 18" from end of augers

Sonic Feed Sensors



Sonic Sensor Mounting Distance

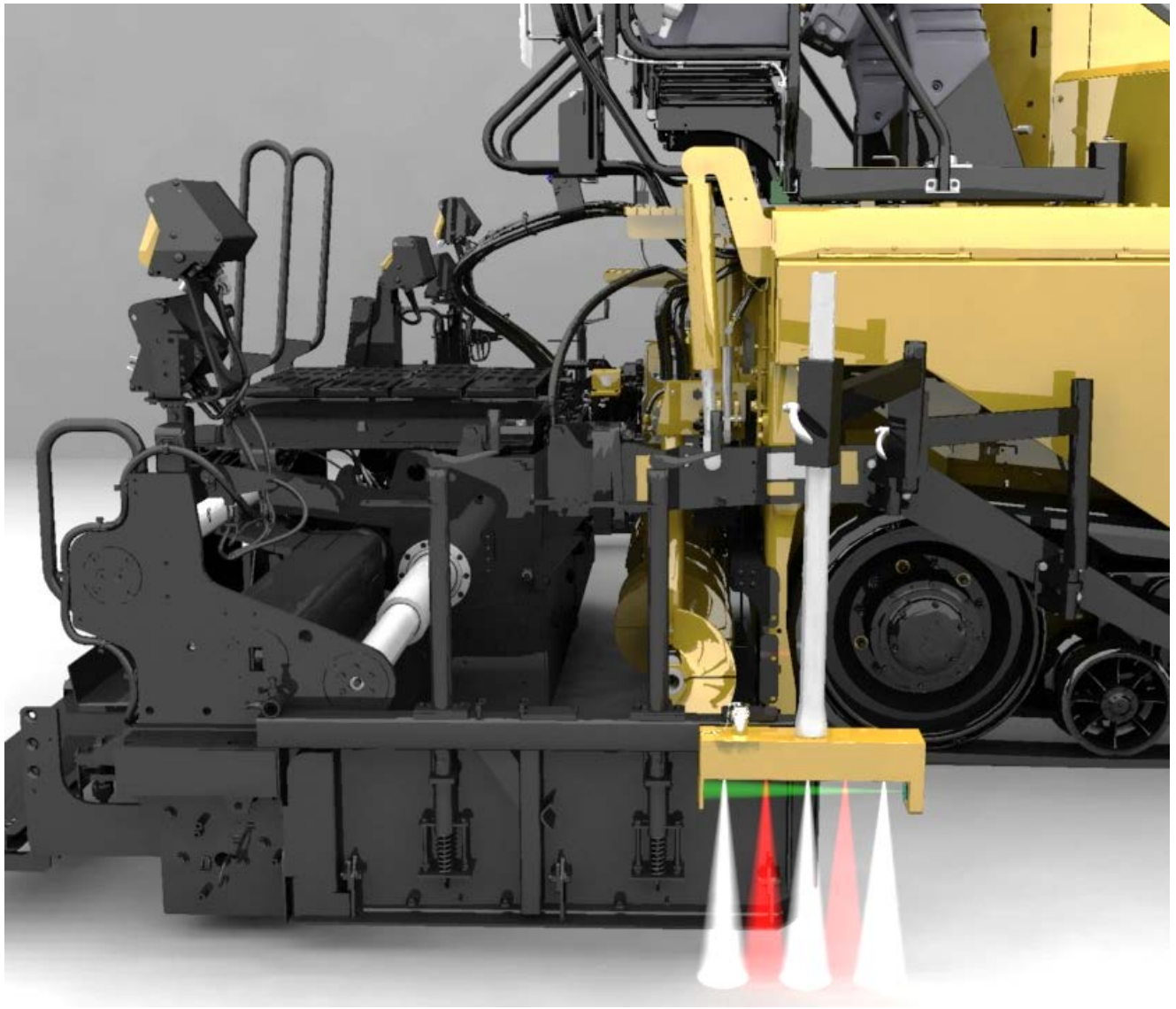
- **Mounting position at 18”**
- **Working range of sonic sensor 12” – 32”**



Steps 14

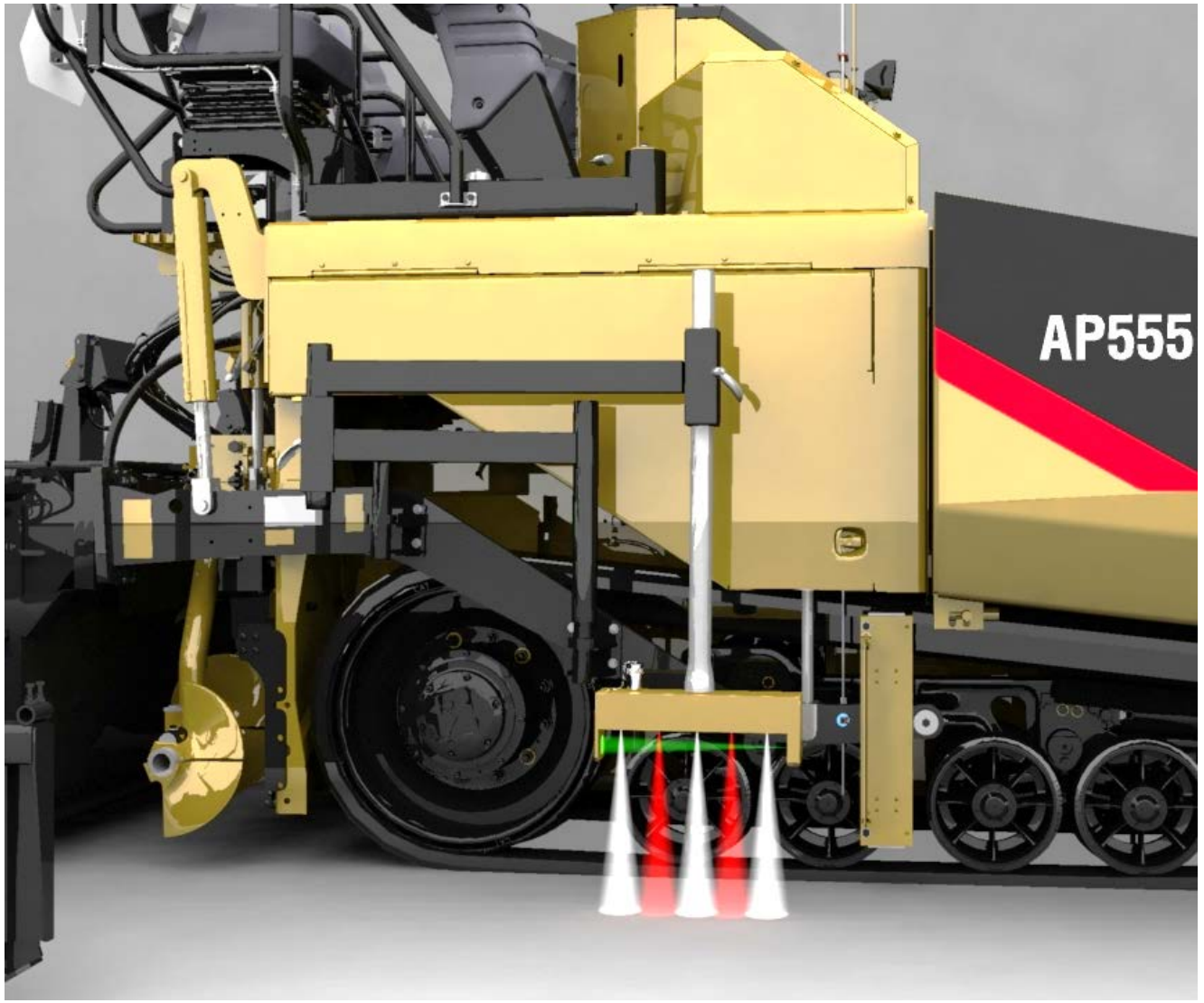
Setup automatic Grade & Slope control (if using)

Step 14: Set Automatic Grade Control



Joint Match

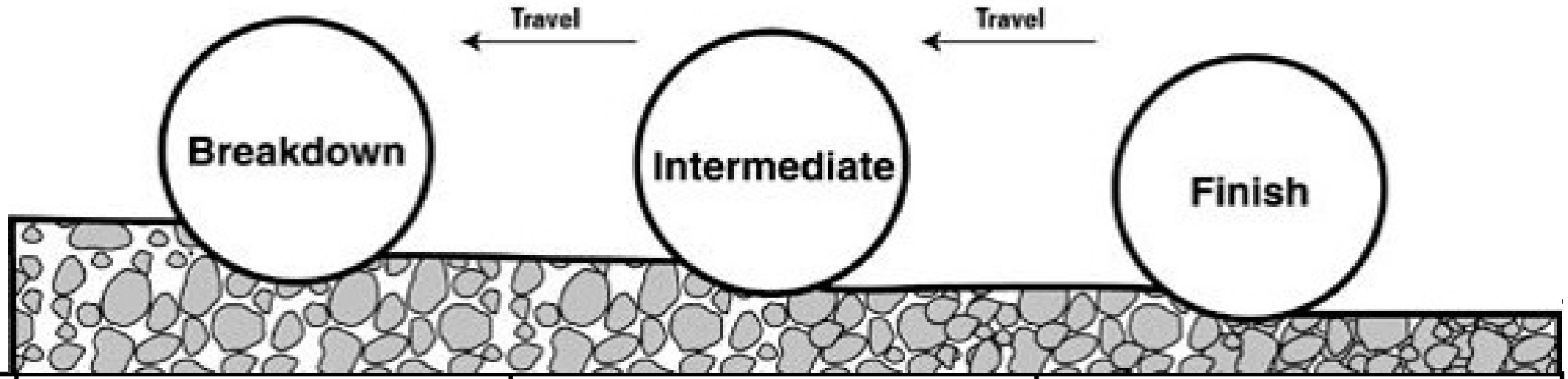
Step 14: Set Automatic Grade Control



Smooth

Steps 15

- Pull off starting boards and quickly get to paving speed
- Check mix feed
- Check auger speed
- Check for lines in mat



%TMD	90-92%	92-94%	94+ %
			
Temp	300-260˚F	260-200˚F	200-160˚F
Coverage	2	2	2 (1 vibe, 1 static)
Settings	High A, Low F	90 psi	Low A, static
	126 feet	200 feet	200 feet

Now, let’s look at roller settings

1 x Cat CB64 (84” wide drum)

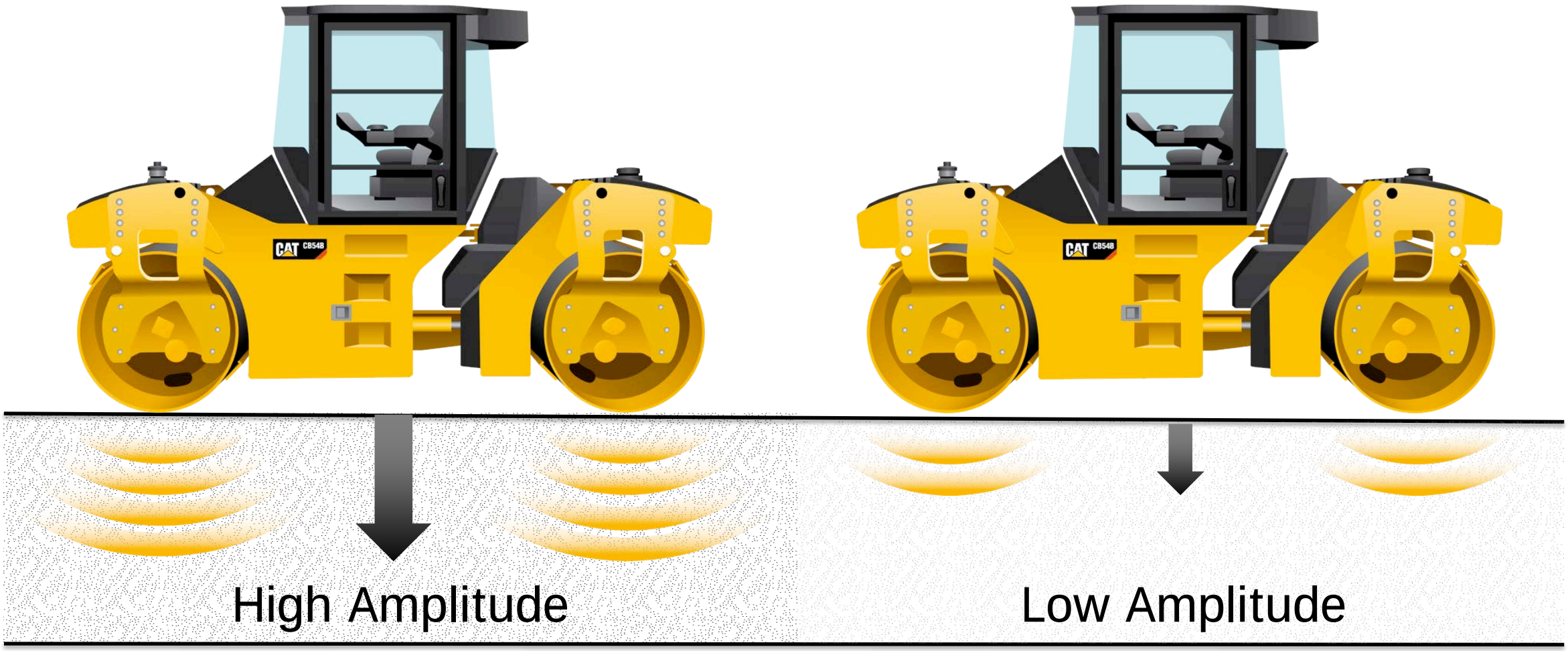
1 x Cat CB54-XW (79” wide drum)

1 x Cat CW34 (82” compaction width)

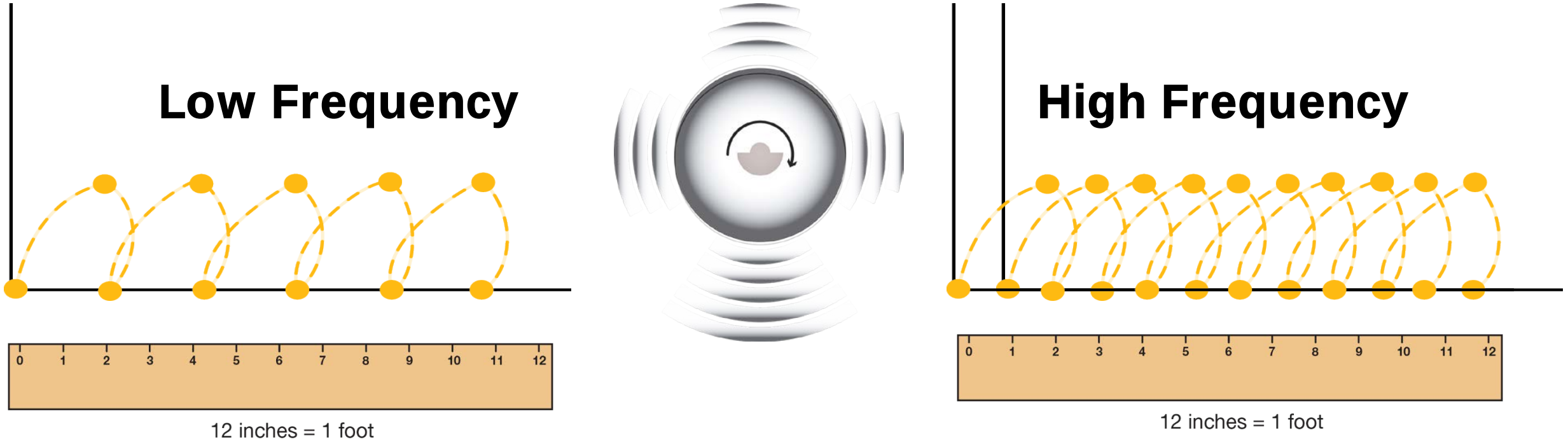
Vibratory Steel Drum

- Breakdown, intermediate and finish rolling
- Settings for amplitude and frequency
- Static mode for finish rolling

Amplitude = compactive effort



Frequency = speed x impacts per foot



Roller speed is constant

Impacts per foot, Frequency & Roller Speed

10 to 14

Impacts per foot

Balancing Plant, Trucking, Paver, Roller

- Expected 2,500 tons/day
- 8-hr paving window
- End dumping (18-ton)
- 12-ft wide, unconfined edge
- 2-inch overlay
- 12.5mm polymer-modified mix
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  - 84” steel vibratory (Cat CB64)
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  - 82” pneumatic (Cat CW34)

Breakdown Compaction

- Develops the majority of the density in the asphalt layer
- Works immediately behind the paver where asphalt is the hottest
- Must match the production / speed of the paver

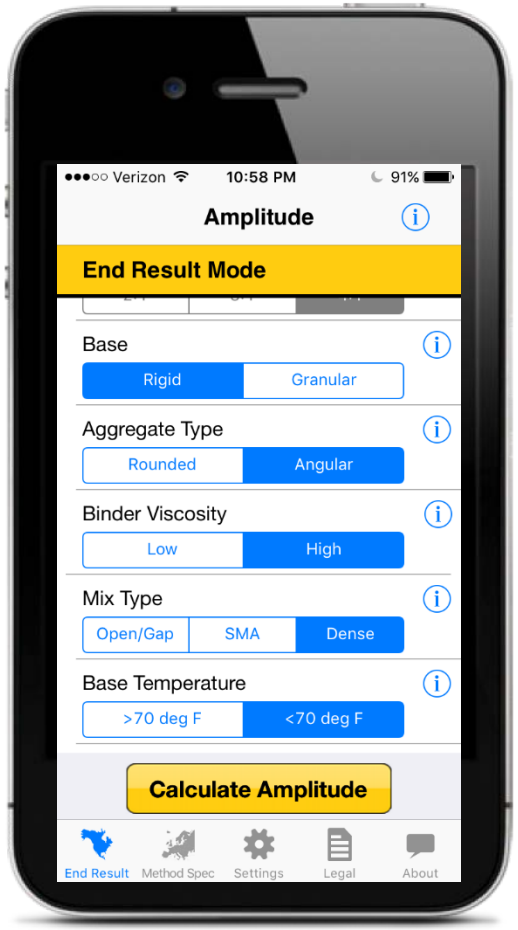
The initial phase roller works close to the paver.

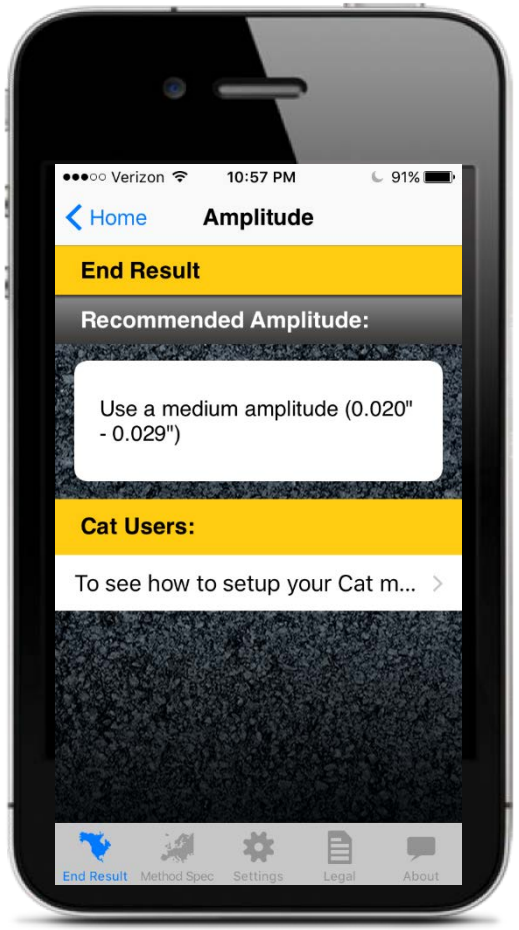
What is a good target density for breakdown?

- **Job spec is 92-97%**
- **Our job target for final density is 94%**
- **A good goal for <u>breakdown compaction</u> is 95% of our overall target density**

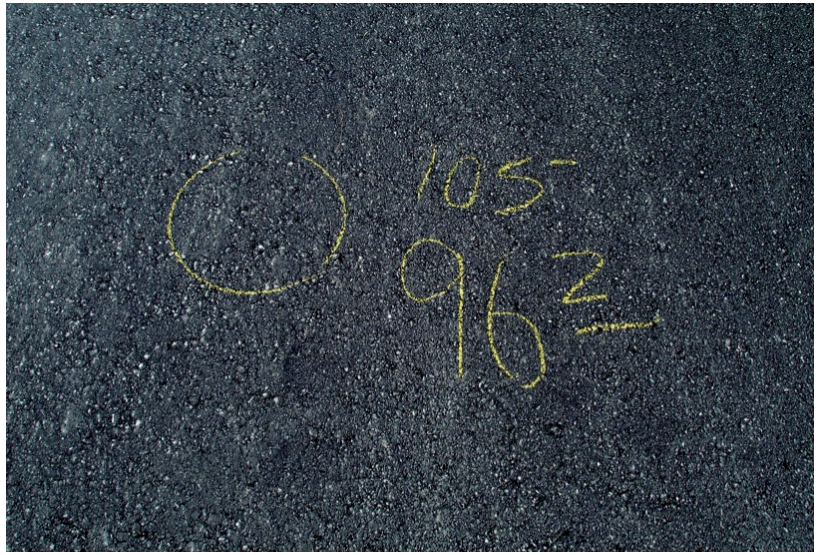
0.95 x 94% ≈ 90%

Amplitude App ≈ 0.020” – 0.029”





Test Strips

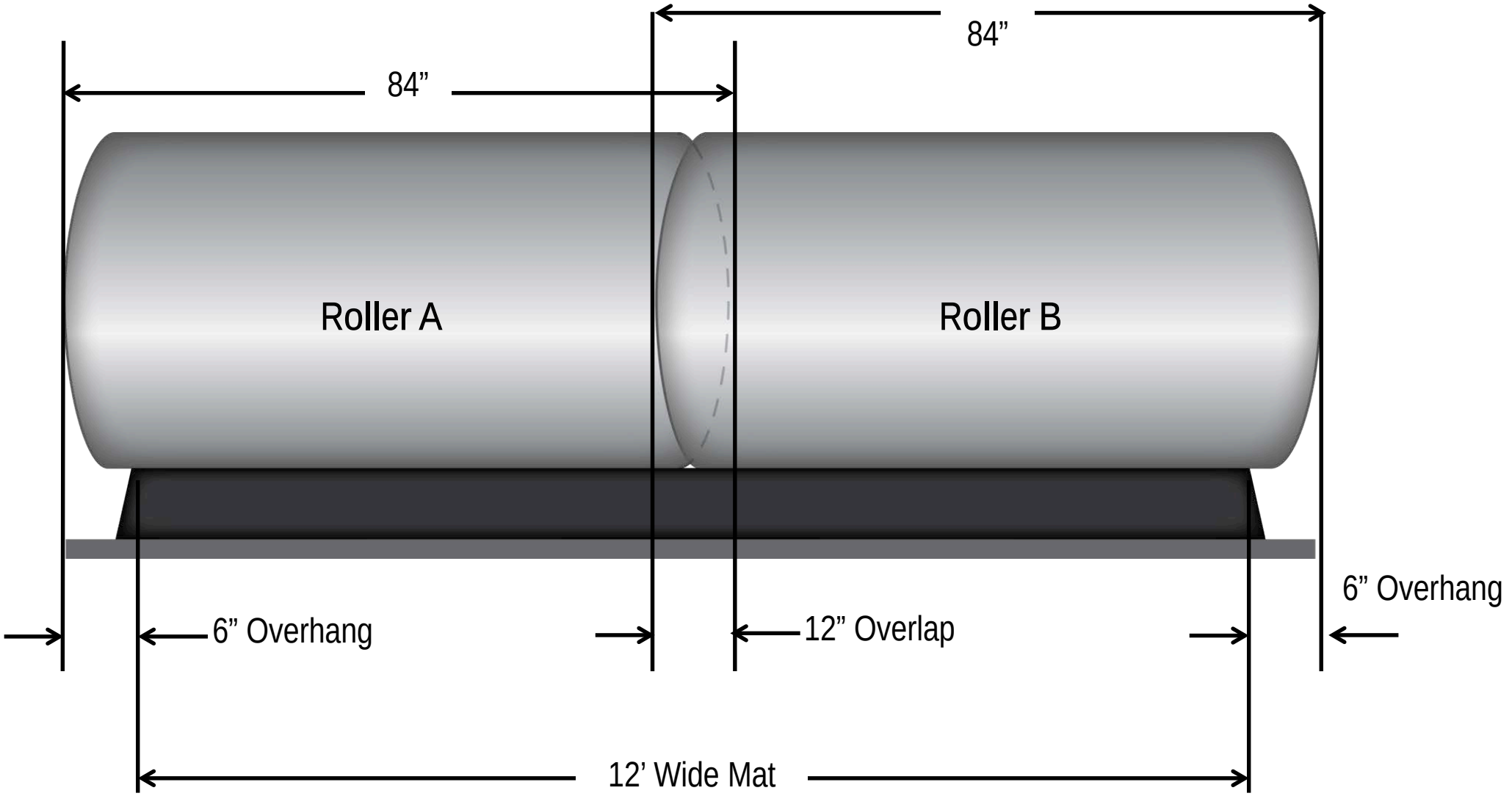


- Verify equipment and patterns develop required density
- Plan each phase of compaction
- Can be done first day of job
  - Sometimes required in advance
  - Don’t fake it
- Communicate plan to all crew members

Number of roller passes

		Breakdown	Intermediate	Finish
→		12-ton DDV	14-ton tire	8-ton DDV
Settings		High A, Low F		1 vibe, low A, high F, 1 static
1st Pass	Temp	275	250	200
	Density	88%	92%	94% (vibe)
2nd Pass	Temp	260	245	193
	Density	90%	93%	94% (static)
3rd Pass	Temp	252	230	
	Density	91%	93.5%	
4th Pass	Temp			
	Density			

12-Foot Wide Lane: 84” x 2 passes



Amplitude 0.020”- 0.029” for 84” drum machine

Versa Vibe™ Vibratory System

CB64

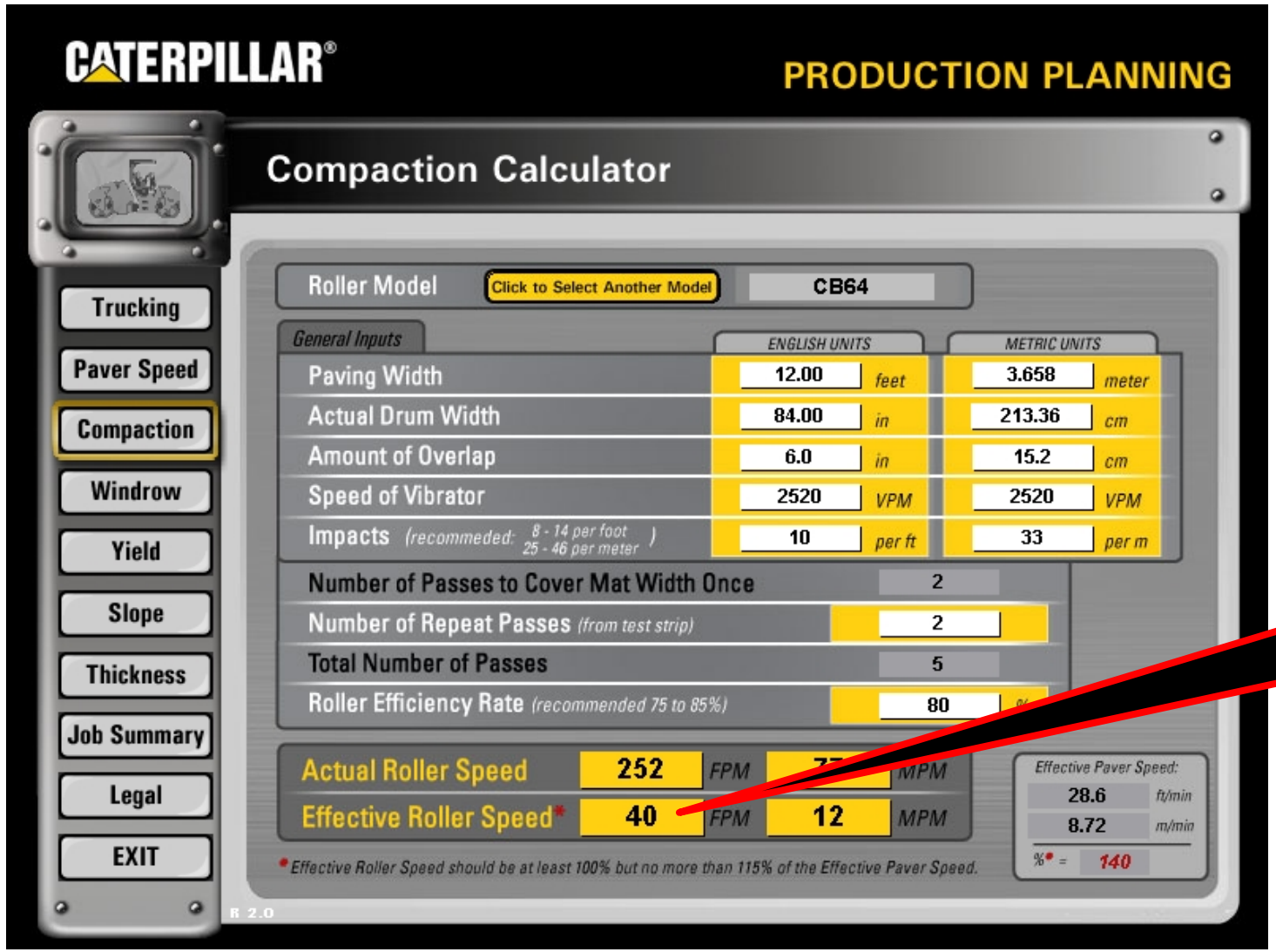
Frequency: 42 Hz (2,520 vpm)

Nominal Amplitude	CB54		CB54 XW		CB64	
High	0.86 mm	0.034 in	0.78 mm	0.031 in	0.67 mm	0.026 in
Low	0.73 mm	0.029 in	0.66 mm	0.026 in	0.57 mm	0.022 in
Centrifugal Force Per Drum						
High	88.8 kN	19,980 lb	88.8 kN	19,980 lb	88.8 kN	19,980 lb
Low	75.4 kN	16,965 lb	75.4 kN	16,965 lb	75.4 kN	16,965 lb

Frequency: 63.3 Hz (3,800 vpm)

Nominal Amplitude						
High	0.44 mm	0.017 in	0.40 mm	0.016 in	0.34 mm	0.013 in
Low	0.33 mm	0.013 in	0.30 mm	0.012 in	0.26 mm	0.010 in
Centrifugal Force Per Drum						
High	103.3 kN	23,243 lb	103.3 kN	23,243 lb	103.3 kN	23,243 lb
Low	77.5 kN	17,438 lb	77.5 kN	17,438 lb	77.5 kN	17,438 lb

Roller speed using 84” drum



- Wider drum
- Lower frequency
- Higher amplitude
- 5-Pass pattern

40 fpm

40 fpm > 36 fpm

Establish an effective rolling pattern

1. Based production and density

2. Equipment Selection

↕ Decision Point

3. Balance paver & roller speed

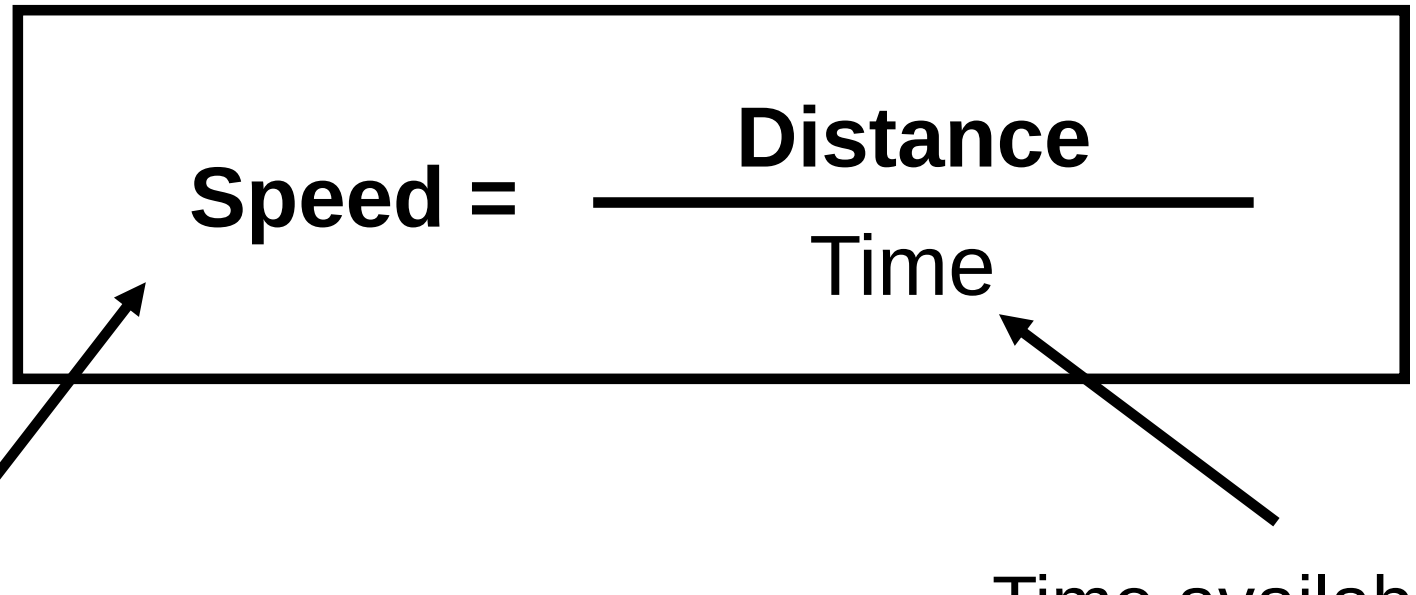
↕ Decision Point

4. Test Strip

5. Verify during production

How far back ?? Breakdown

Length of the Roller Pass



Solve the equation for distance

Length of the Roller Pass

$$Distance = Speed \times Time$$

Roller Ground Speed

Distance = Speed x Time

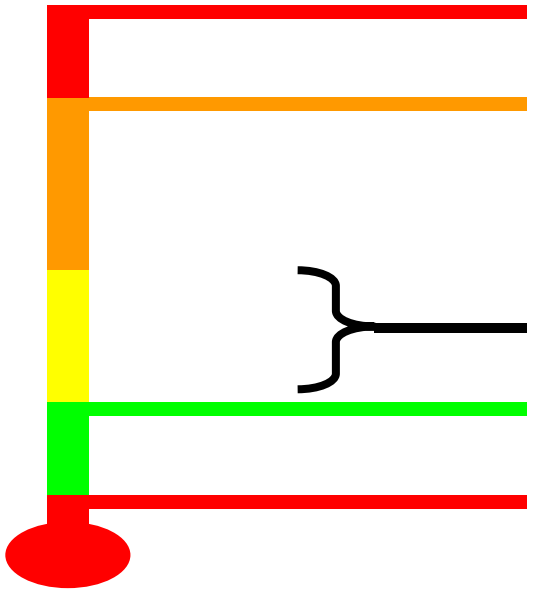
Speed Calculation

Frequency = 2,520 vpm

We want 10 impacts per foot

$$\frac{2{,}520}{10} = \textbf{252 fpm}$$

Time Depends on Temperature



300 - 260 Breakdown rolling

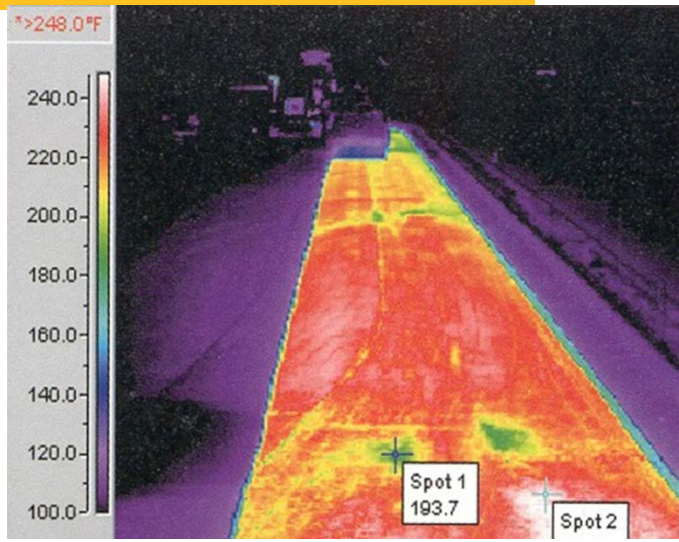
260 - 220 Intermediate rolling

240 - 190 possible tender zone

220 - 160 Finish rolling

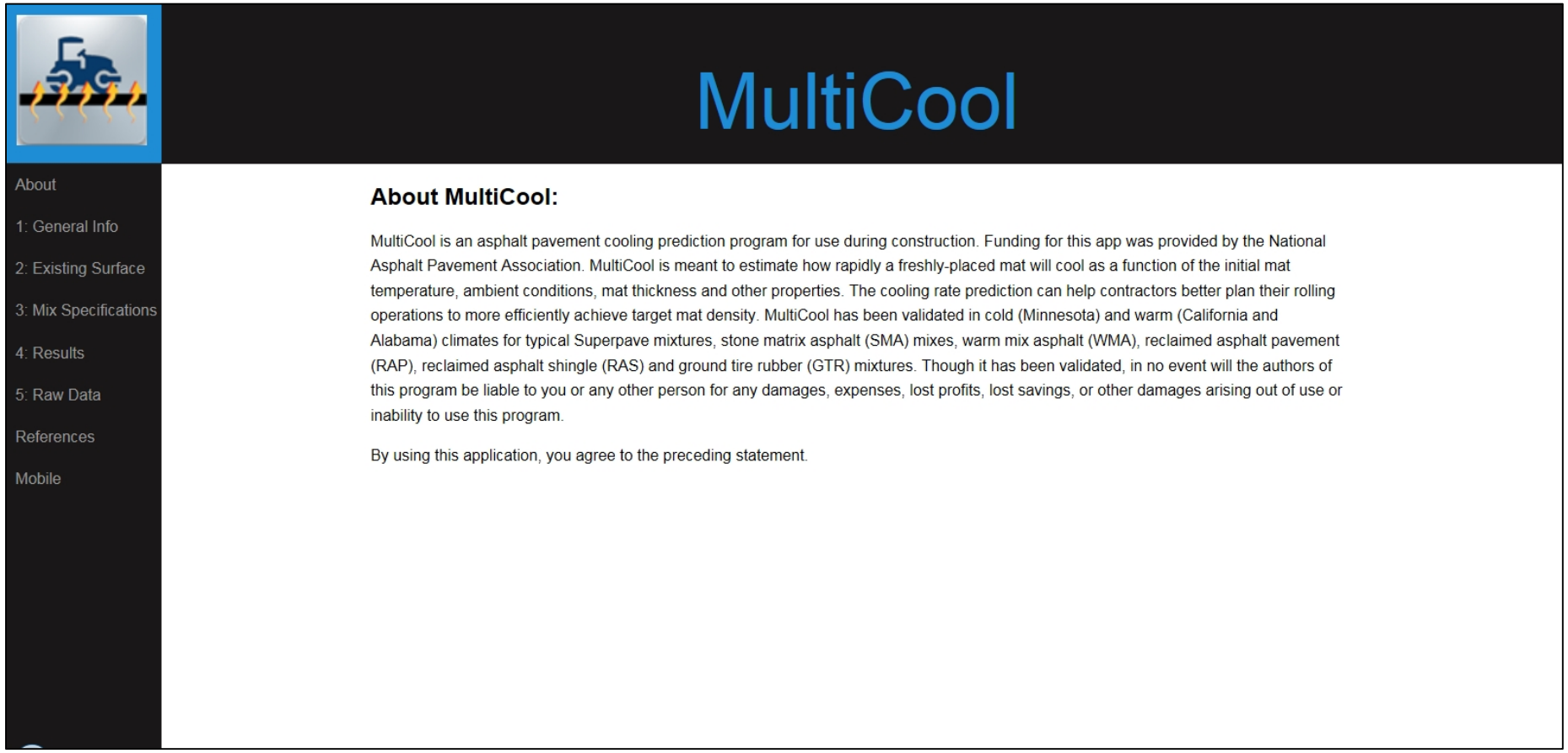
160 – Stop rolling

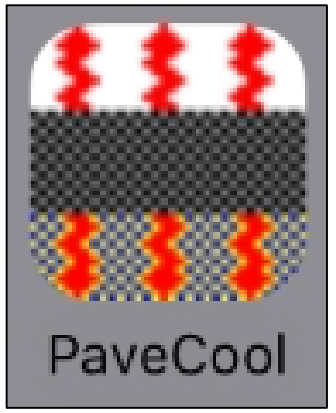
Keep steel drums off the mix!!!



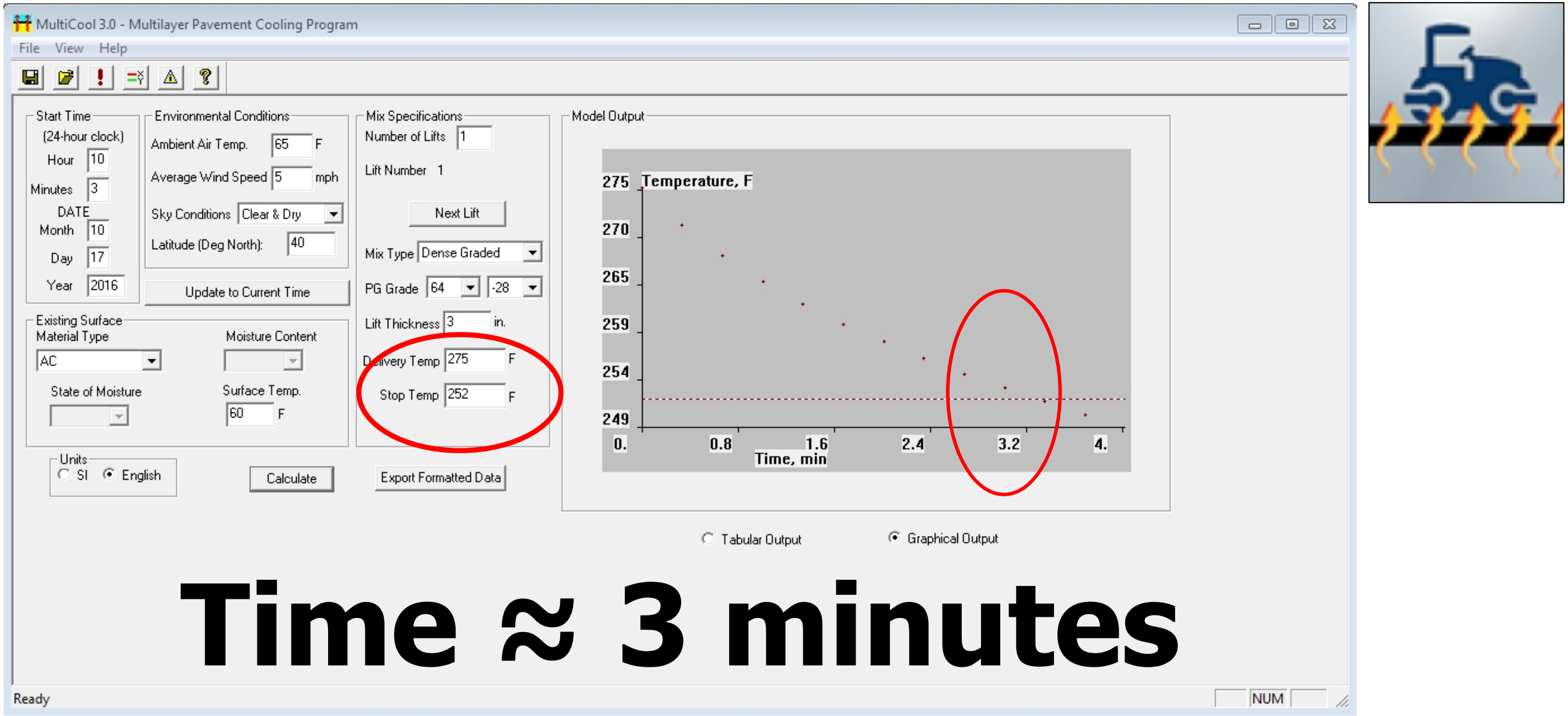
MultiCool Website and Android App

- Google Play App store
- http://www.eng.auburn.edu/users/timmdav/MultiCool/FinalRelease/Main.html





MultiCool from 275°F to 252°F (breakdown roller only)



Time ≈ 3 minutes

Length of the Roller Pass

Roller speed = 252 fpm

Time = 3 minutes

Distance = **Speed x Time**

= **252 x 3**

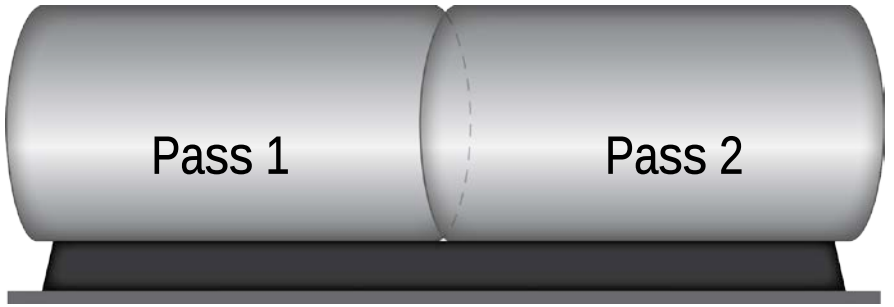
= **756 ft** **(in 3 minutes)**

Length of the Roller Pass

756 feet traveled in 3 minutes

We have a 5-pass pattern (from test strip) to cover the mat twice

756 ÷ 5 = 151 feet



Assume 80% roller efficiency

151 x 0.80 = 120

Length of roller pass = **120 feet**

**If conditions change – re-calculate the length of roller pass

Sequence & Timing

	Breakdown	Intermediate	Finish
%TMD	90-92%	92-94%	94+ %
			
Temp	300-260˚F	260-200˚F	200-160˚F
Coverage	2	2	2 (static)
Settings	High A, Low F	90 psi	Low A, static
	⟷ 120 feet	⟷ 200 feet	⟷ 200 feet

To do all this…we need good base!!


SB-2500B

Joint Compaction Techniques & Issues

Transverse Joints

Longitudinal Joints

Transverse Joint Compaction

Transverse Joint Compaction

- Straight edge tells the story
- Too high – more rolling may help
- Too low – hand work needed to fill in

Poor Transverse Joint Starting Point

Incorrect Starting Reference

- **Rounded face at the joint**
- **Plunge cut too deep**

Good Transverse Joint Starting Point

- Cut straight starting joint
- Butt joint flat

- Tack butt joint
- Clean area where screed will rest

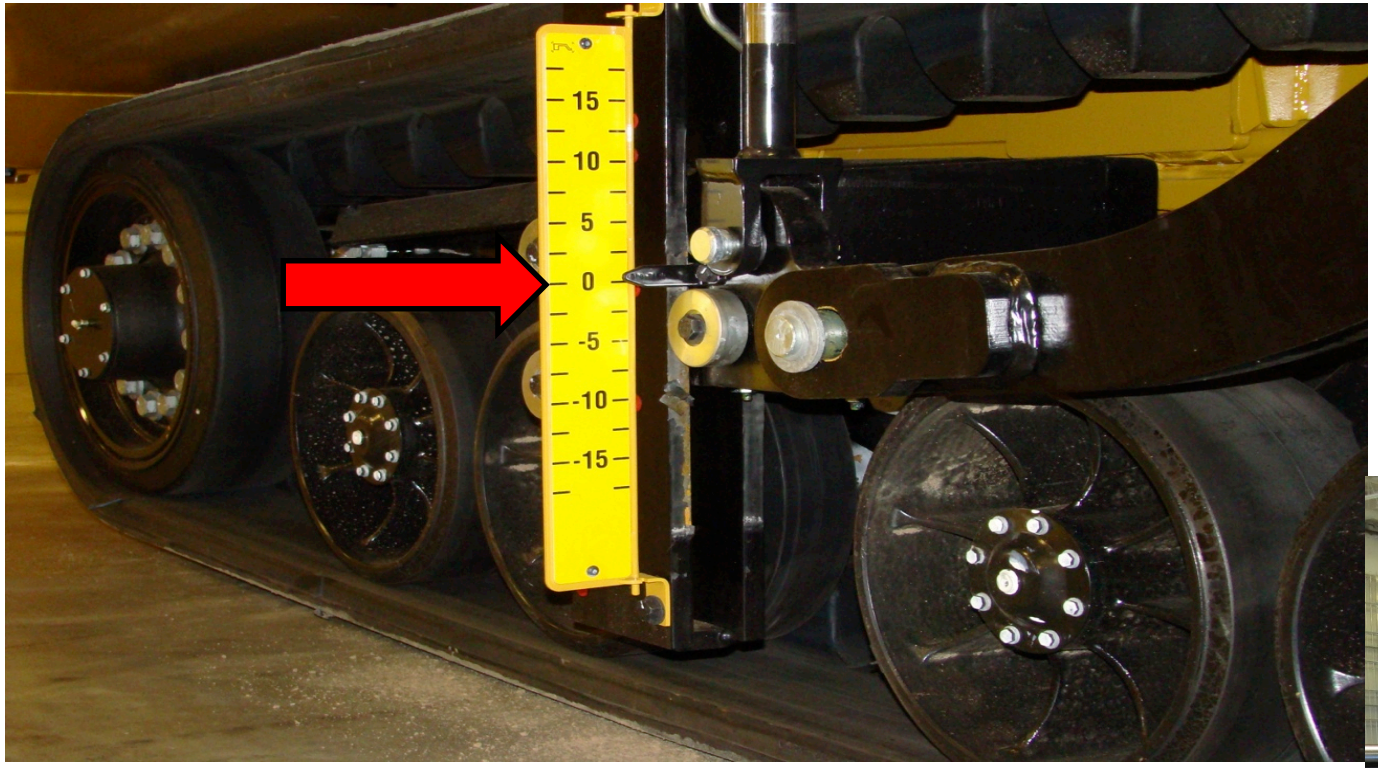
Good Transverse Joint Starting Point

- Measure height of starting joint
- Calculate thickness of starter boards
- General rule vibratory screed: 6 mm (0.25in) compaction per 25 mm (1.0in) loose depth

Correct Pre-Compaction Height

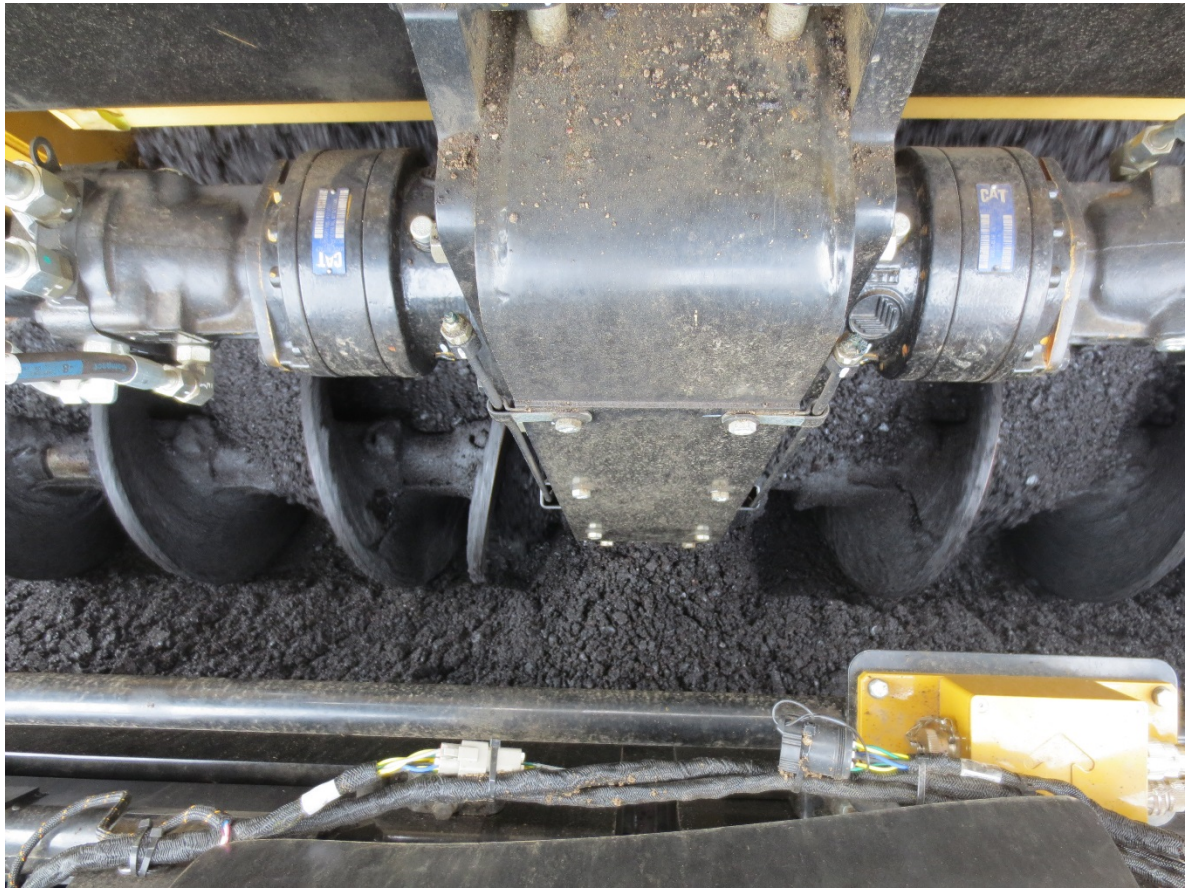
- Select starter boards of proper thickness
- Support main screed and extender screed
- Board length
  0.9-1.2 m (3-4ft)
- Start with good paving and minimal hand work
- Mat depth must allow for rate of compaction
- Rule of thumb: ¼ in of compaction for each 1 in mat depth

Correct Line of Pull



- Adjust both tow point cylinders to match the height of the screed pivot point
- Helps screed come off starting joint parallel to line of paving

Keep Correct Head of Material



- Screed personnel check material level at outboard end of augers
- Adjust mix height controls if needed to maintain material level at 1/2 auger
- No voids

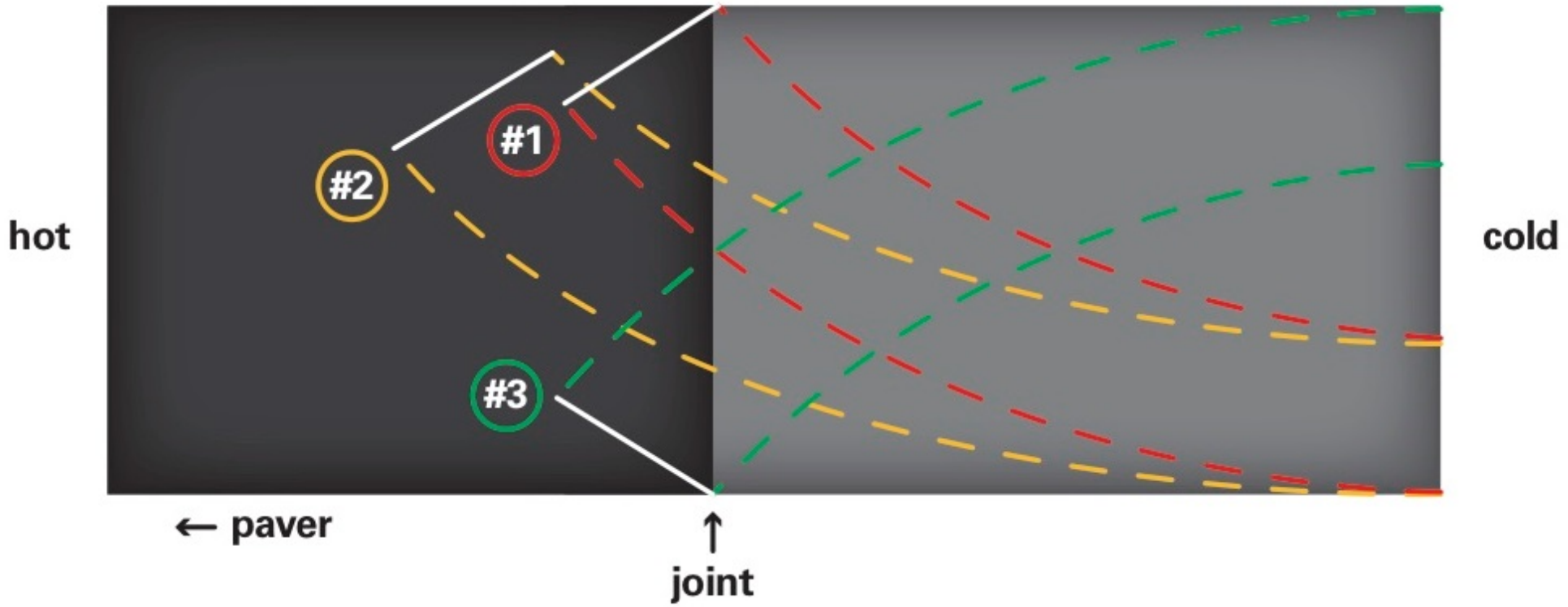
Good Transverse Joint Starting Point

- Minimum hand work is the goal
- Fill in low areas prior to compaction
- Rake off high spots prior to compaction

Transverse Joint Rolling Patterns

- Initial phase compactor starts normal pattern
- Paver should not have to stop and wait for joint to be prepared and compacted

Transverse Joint Rolling Patterns

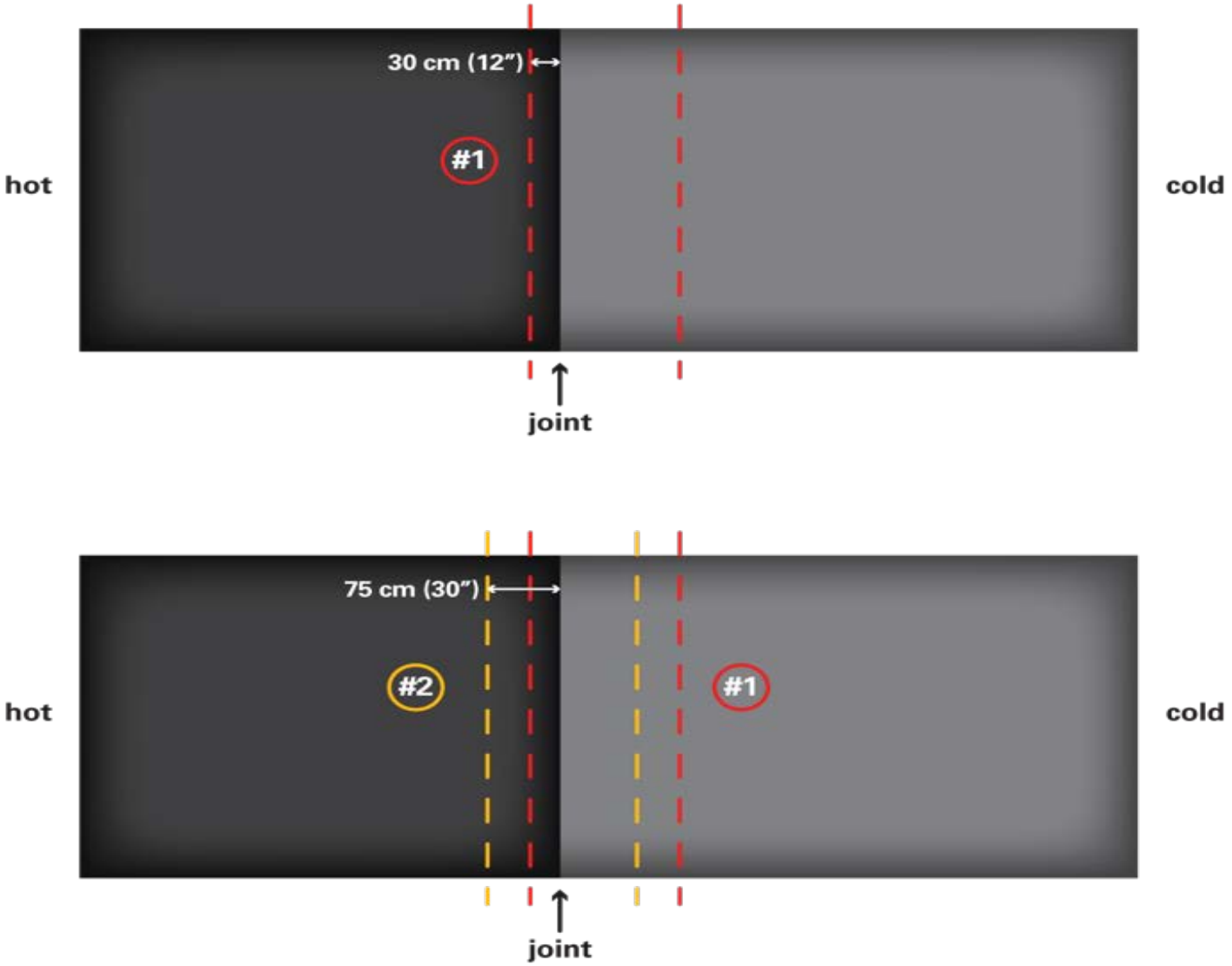


- Pinches joint at angle rather than pushing hot mix away
- All stop marks can be cleaned up during first normal rolling pattern
- Pattern is always available for operator

Transverse Joint Rolling Patterns

- Can pinch joint from the side if space permits
- Utility size compactor makes job easier
- Leaves drum edge cut mark perpendicular to direction of rolling pattern

Transverse Joint Rolling Patterns



- First pass most of drums on cold side
- Check flatness
- Second pass, if needed, move farther onto hot side
- All passes static
- Should not have to vibrate to pinch a transverse joint

Longitudinal Joint Techniques & Issues

Longitudinal Joint -- Build it Right

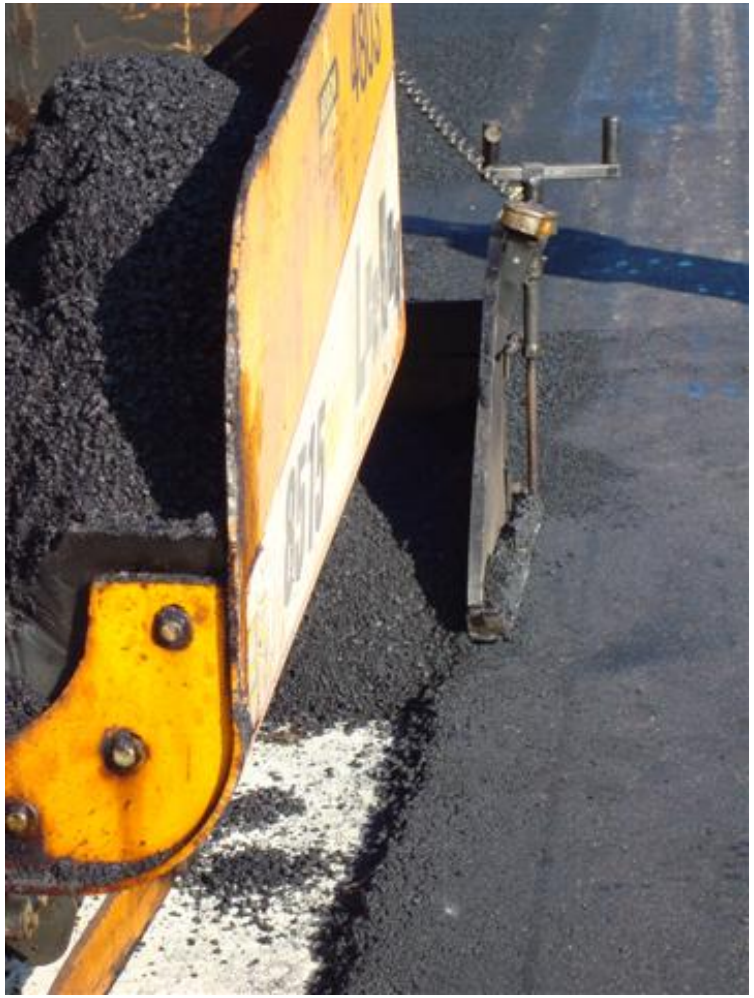
Build Joint Correctly

- Paver leaves straight edge to match
- Makes consistent joint overlap possible
- Can use edge cutter

Joint Overlap / Joint Height

- End gate overlap 1 inch
- Precompaction height ¼ in per inch of mat thickness
- No raking required
- Can use averaging ski or joint matcher

Overlap

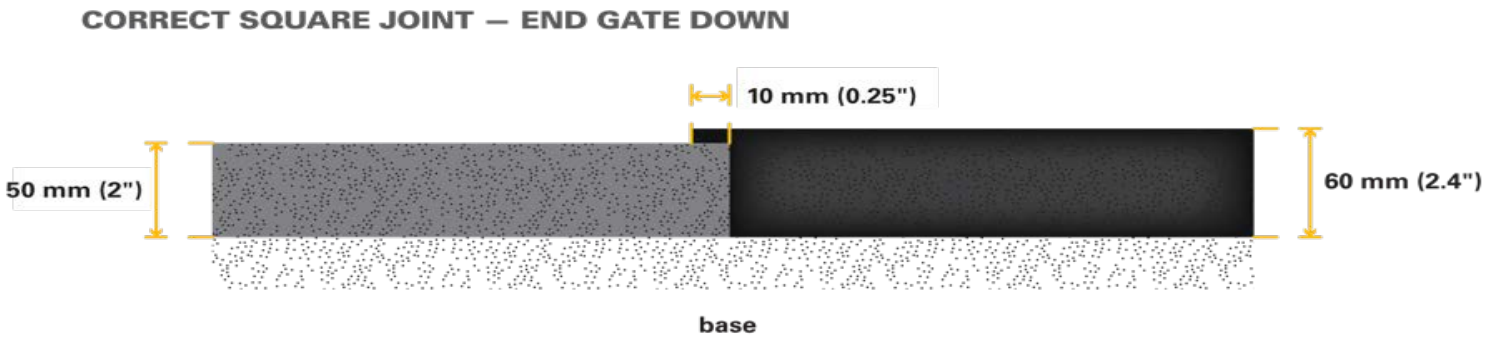


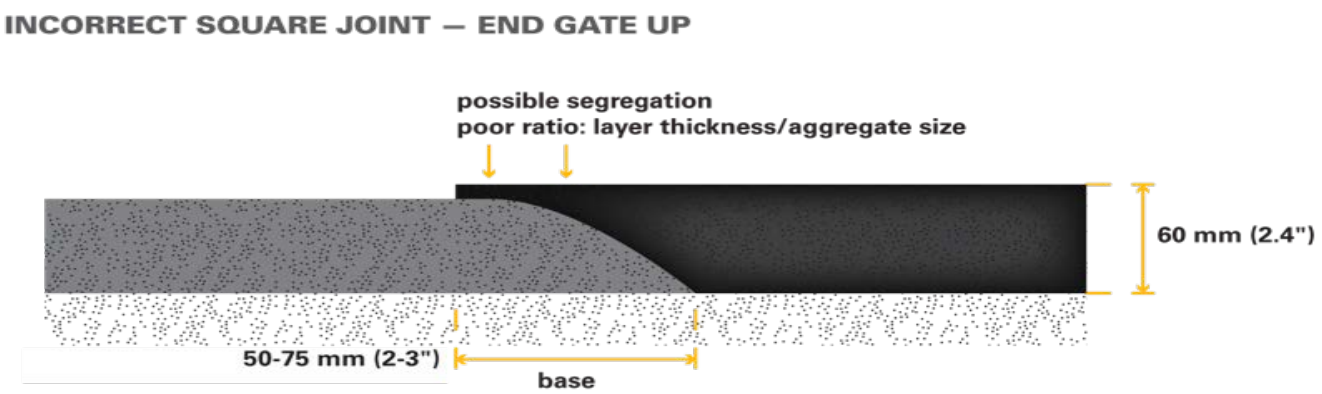
Good overlap

Too much overlap

J.A. Scherocman

End Gate Overlap





Build Joint Correctly

- End gate down to create straight edge
- Overlap cold side 10 mm (1/4in)
- Correct pre-compaction height
- End gate up causes rounded edge, segregation and fractured aggregate

Excessive Overlap

- Poor compaction, loose rock at joint
- Joint needed raking prior to compaction
- Real solution is to control end gate overlap

Raking is not the Answer

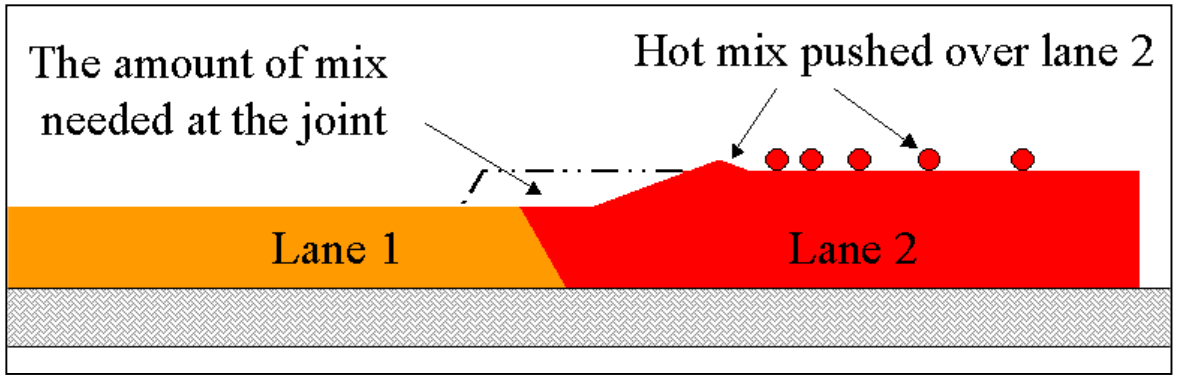
- Creates segregation at the joint
- Pushes mix away from the joint
- Light “bumping” is acceptable

Bumping the joint

- **Light bumping of the joint with coarse mixes**

Dr. Ray Brown

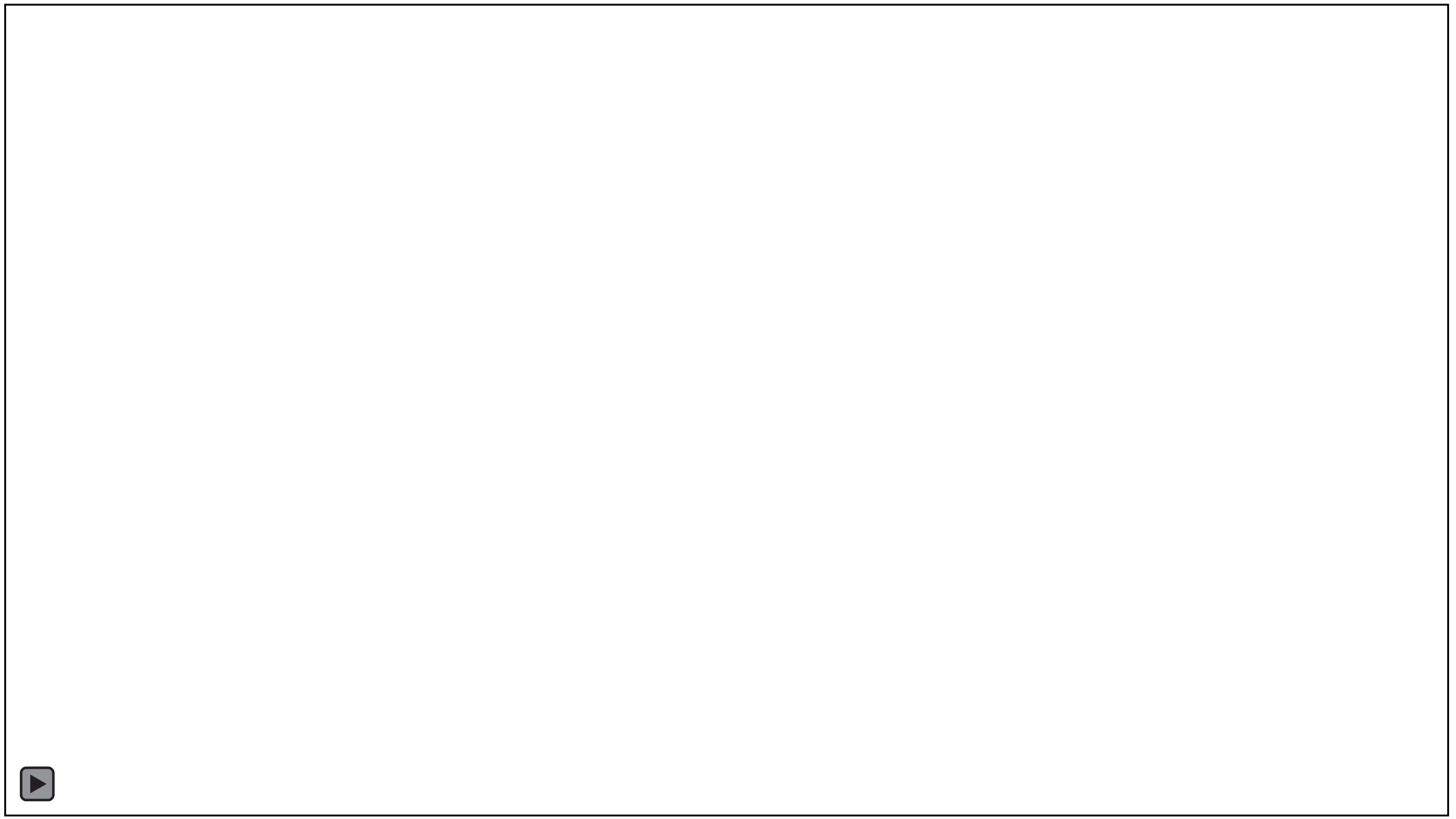
Which side was paved first?



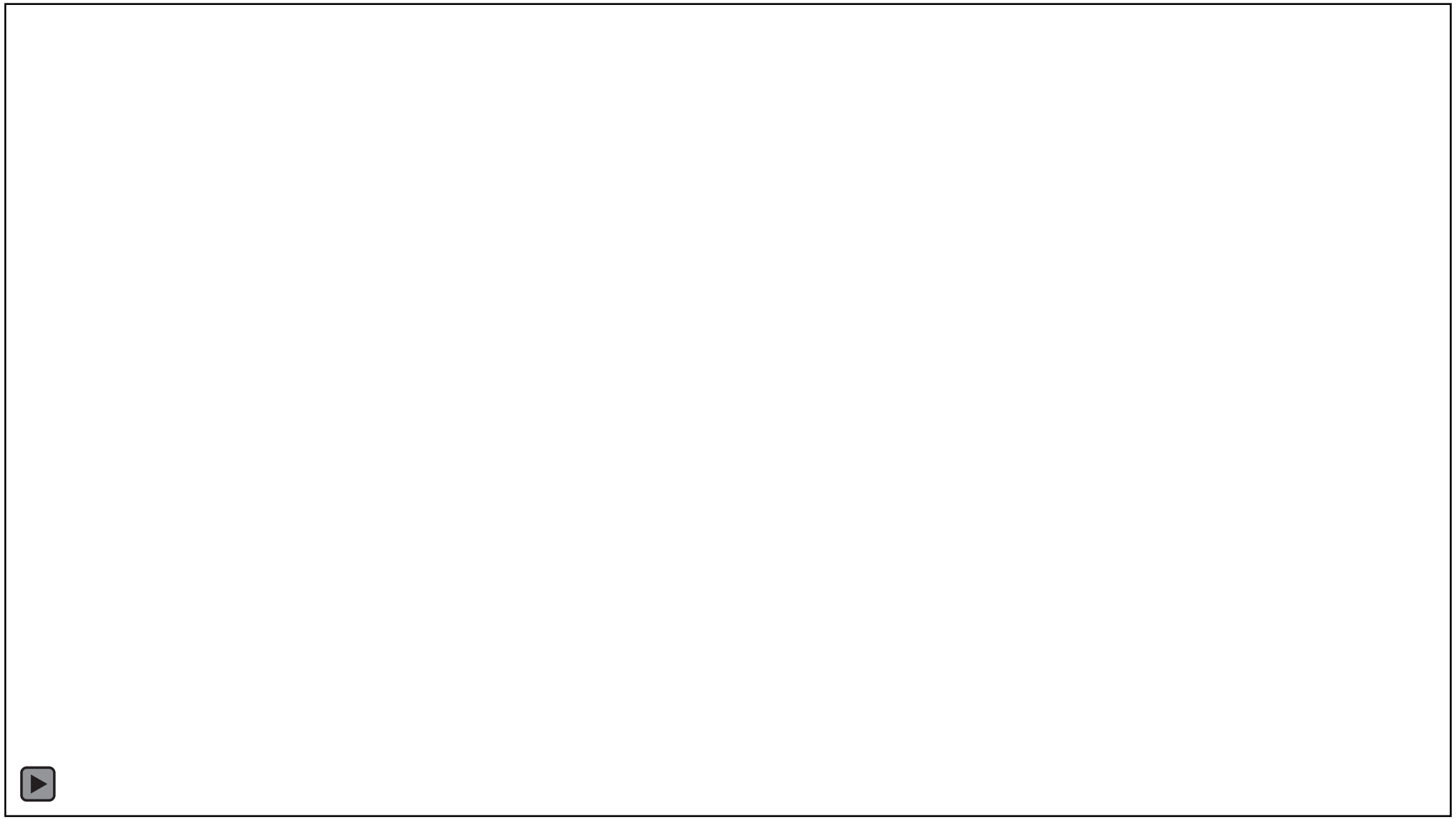
End Gates Down, Auger Extensions

- Get mix out out to end gates
- Have sufficient auger extensions and tunnels

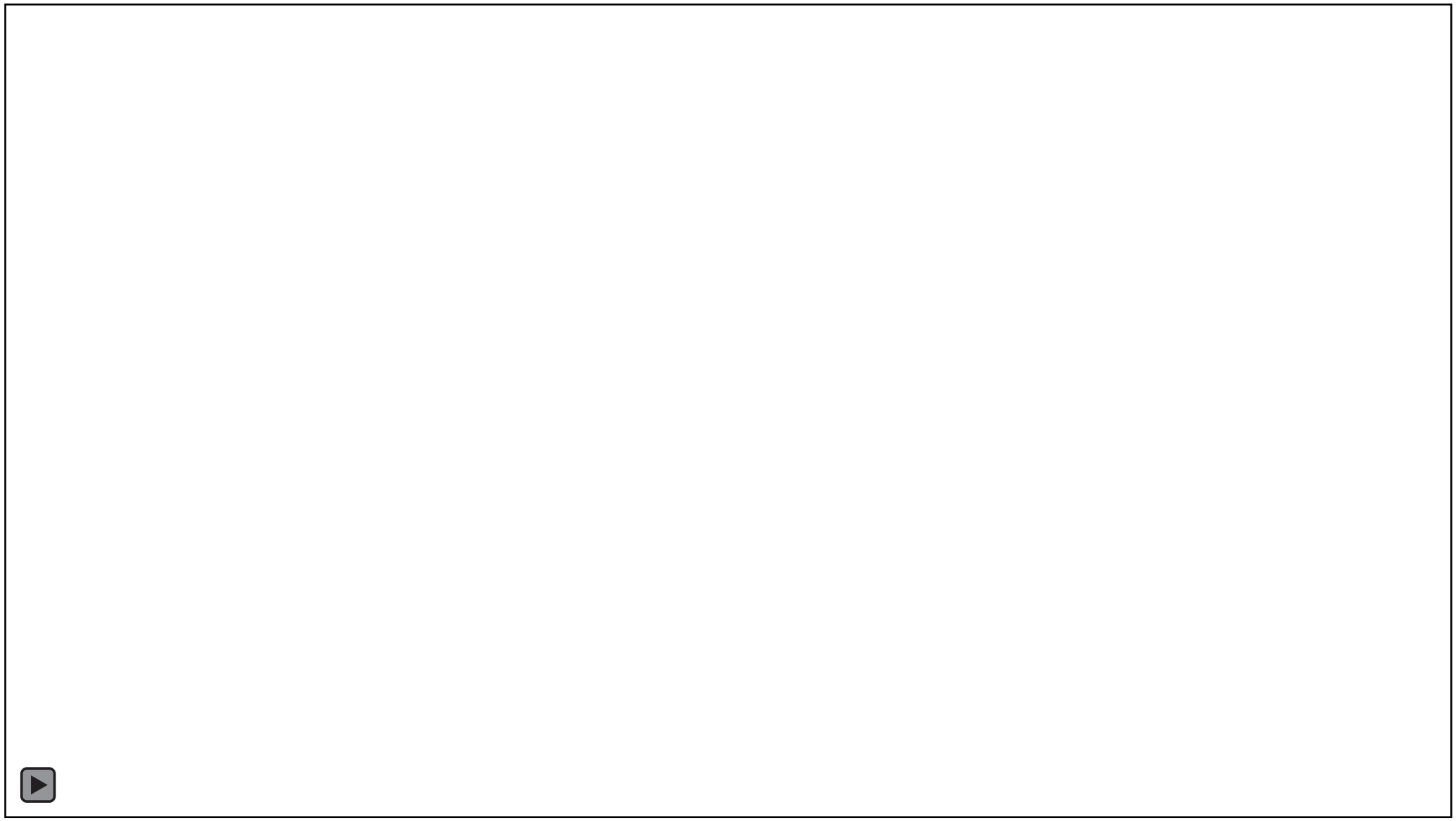
Nice joint – no raking



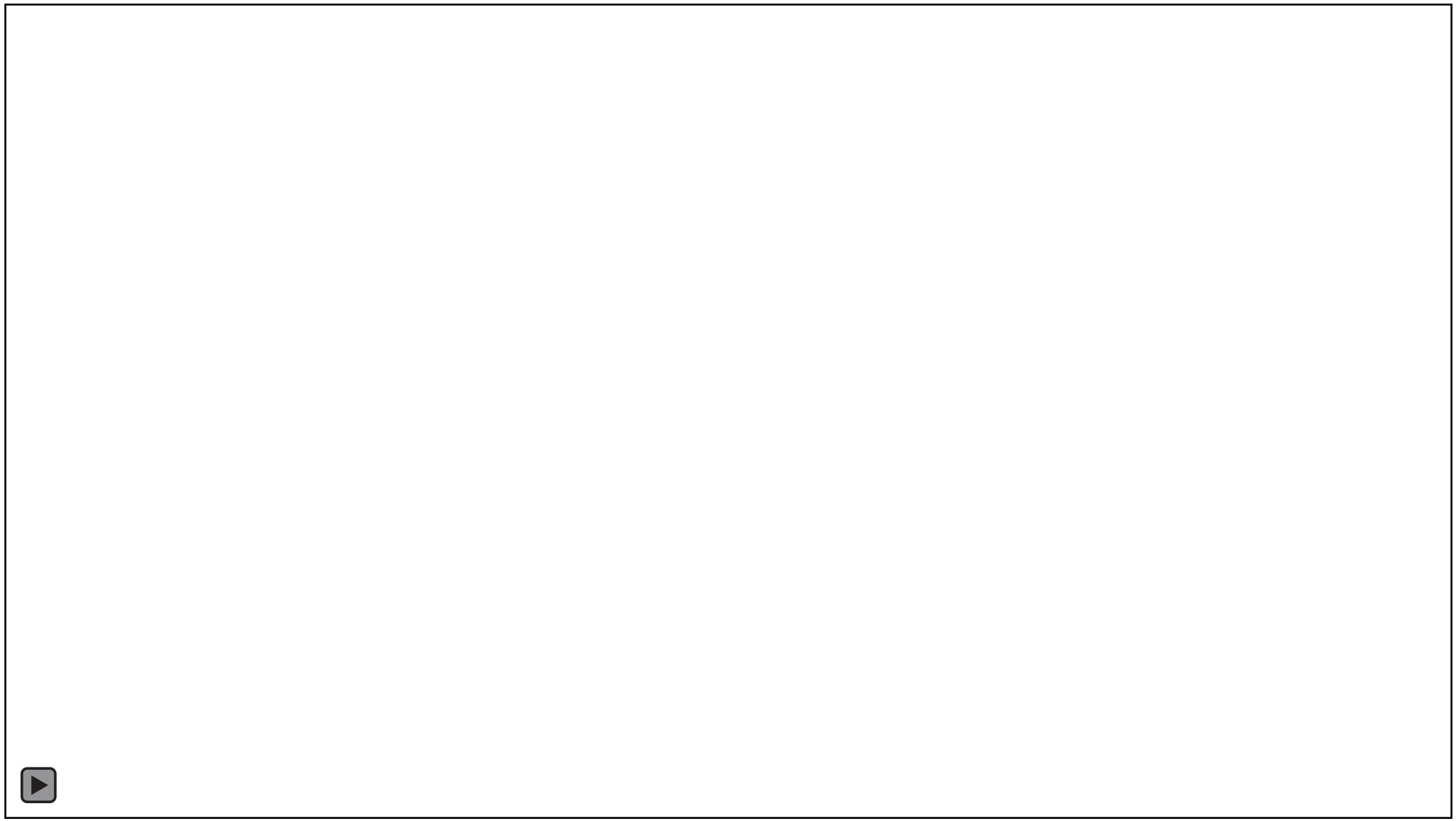
Correct height match



Locking in the Joint



Locking in the Joint



Use Pneumatic to Seal the Joint

- All other phases should overlap the hot / cold joint
- Pneumatic compactors especially good at pinching joints

Keep rubber tire off the edge

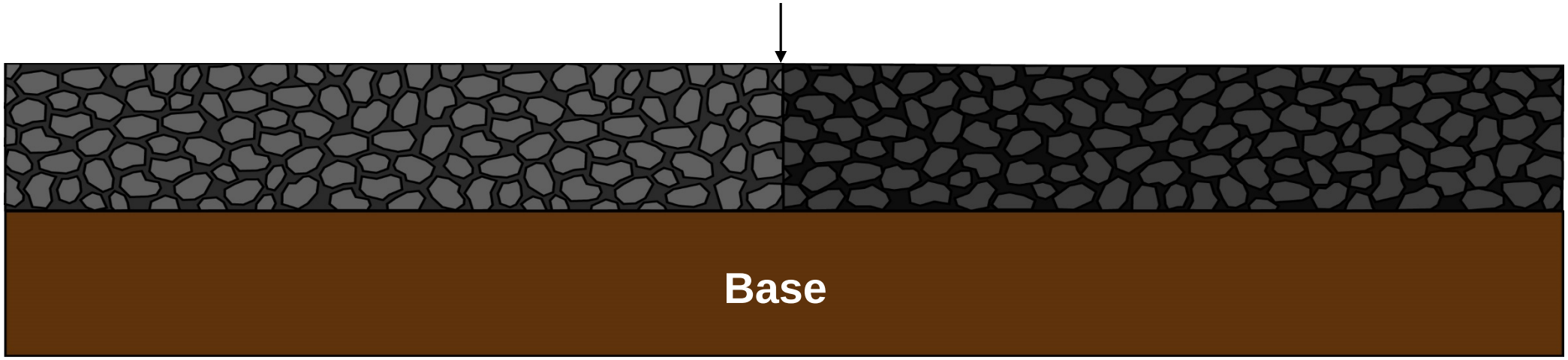
Edge Cutter – airport option

Don’t run inside the unsupported edge

Properly Built & Compacted Joint

Correct Square Joint
End Gate Down

Should pinch down without raking



Don’t Roll Over the Crown!

- **Be careful not to roll over the crown – daylight under both drums ☹**
- **Roll low side to high side**

Summary

- Paving crew builds joint correctly
- Verify overlap and pre-compaction height
- Select rolling pattern that meets project requirements

Thank-you for your attention!

Questions?

Gregory Poole CAT

Carolina CAT