

# Introduction to Paving Fundamentals

Idaho Asphalt Conference  
October 28<sup>th</sup>, 2021



Presented by Todd Mansell, Caterpillar Paving



1

## Paving Fundamentals



Caterpillar: Confidential Green

1. Paver setup and takeoff
2. Temperature
3. Continuous Paving
  - Balanced Paving & Compaction operation
  - Smoothness
    - Quick starts & stops
    - Head of Material
    - Automatic Grade & Slope Controls
4. Segregation
5. Compaction
  - Longitudinal Joints



2

## Role of the Paver



Caterpillar: Confidential Green

- To meet specifications for grade, texture & smoothness



3

## The Paver: Tractor & Screed



### Tractor

- tows screed
- Accepts mix from trucks, MTV, etc.
- Pushes trucks
- Feeds mix to screed

### Screed

- Floats on the mix
- Free to rise and fall according to many factors



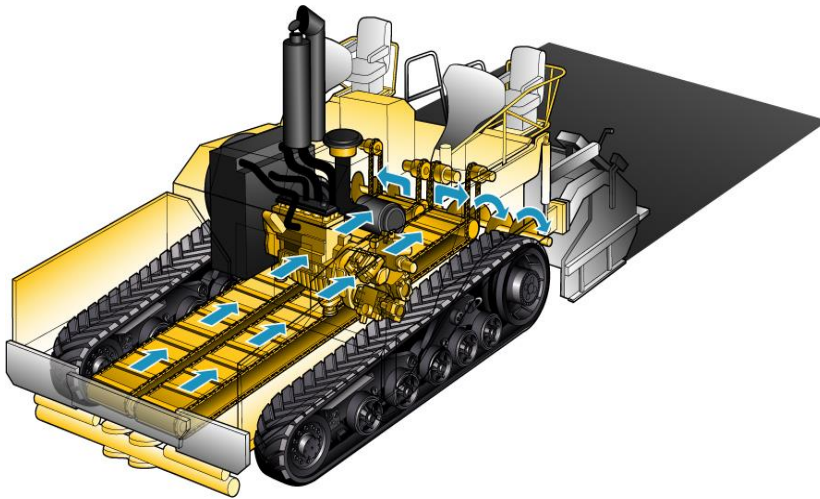
4



# Tractor

## Material Feed System

1. Hopper
2. Feeder bars
3. Adjustable height augers
4. Feeder sensors (not shown)



Caterpillar: Confidential Green

5



## Feeds mix from hopper to screed



Caterpillar: Confidential Green

6





# Front-mount Screeds



9

# Rear-mount Screeds

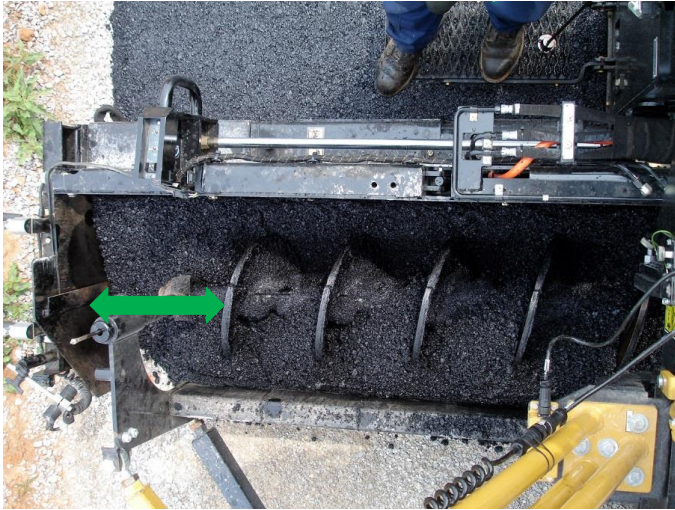


Caterpillar: Confidential Green

10



## Auger Extensions (18" front 36" rear)



**18" with front-mount**

Caterpillar: Confidential Green



**36" with rear-mount**

## Free-Floating Screed

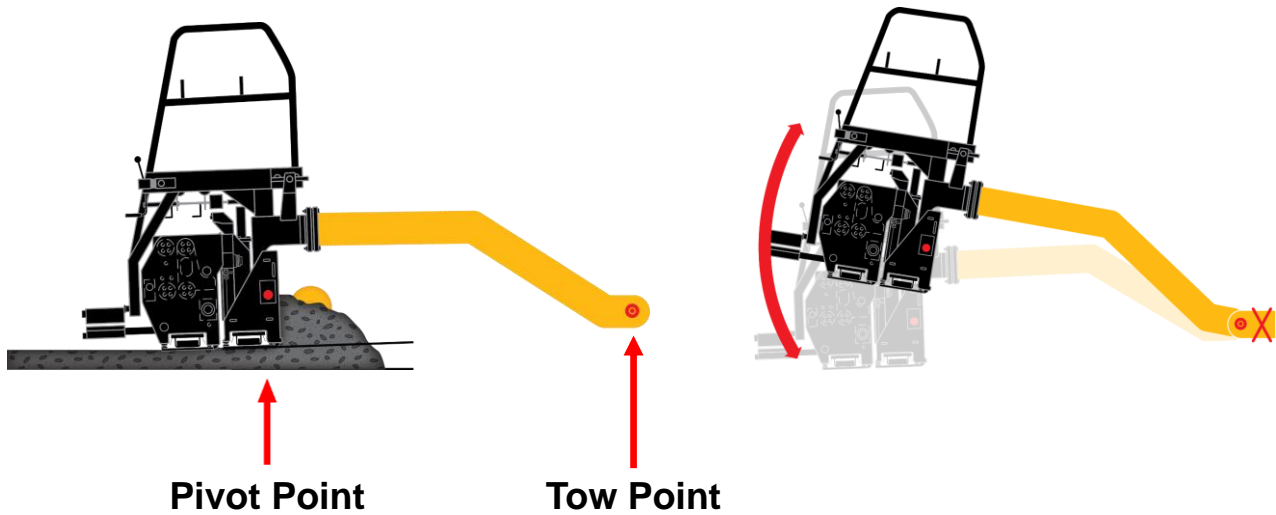


- Principle has not changed since Barber-Greene invented the free-floating screed in 1934

Caterpillar: Confidential Green



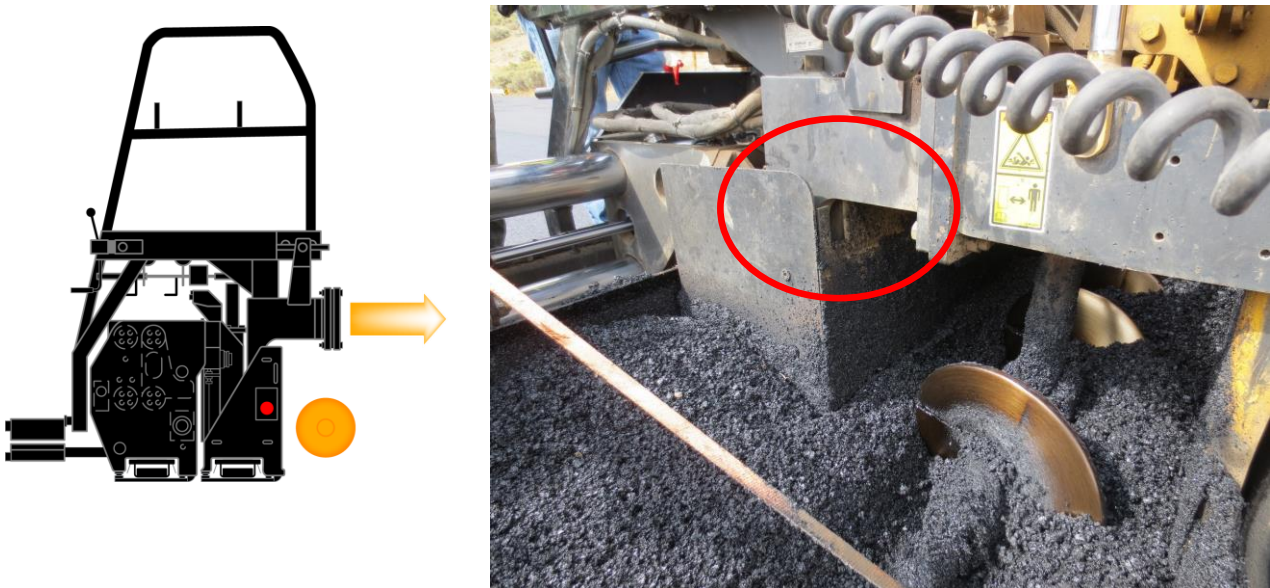
# Pivot Points & Tow Points must be clean!



Caterpillar: Confidential Green

13

# Pivot Points can get plugged up



Caterpillar: Confidential Green

14

## Pivot Points - keep clean & free 😊



View looking down on top of pivot point



Remove side cover

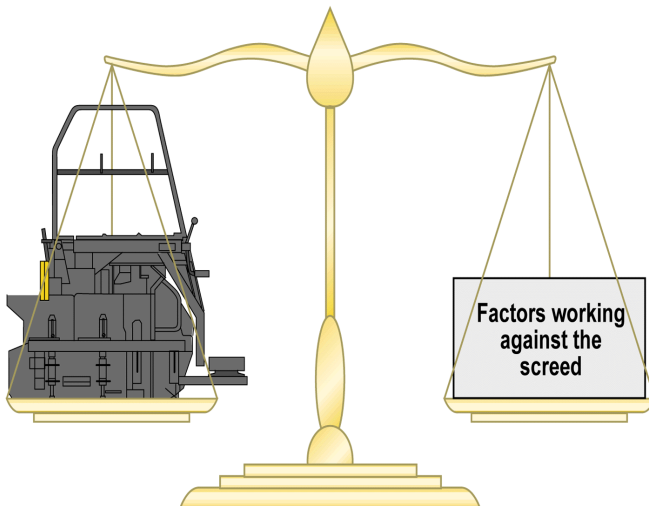


Clean hardened mix out

Caterpillar: Confidential Green

15

## Free-Floating Screed



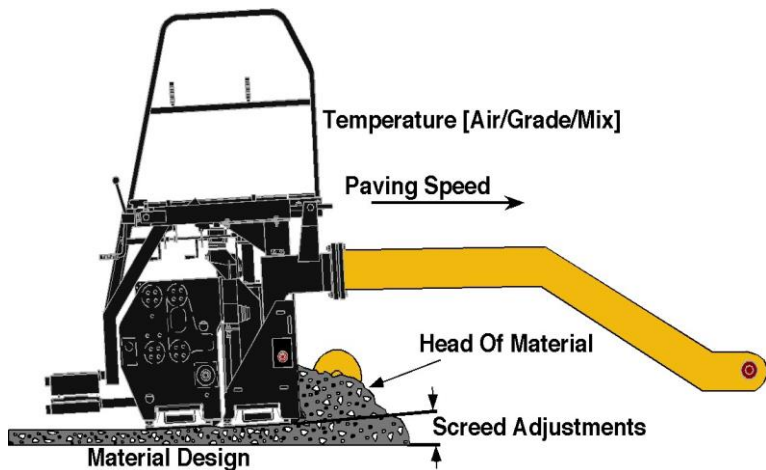
- Screed position determines mat thickness
- Screed position is constant as long as all factors remain constant

Caterpillar: Confidential Green

16



## Factors Affecting the Screed

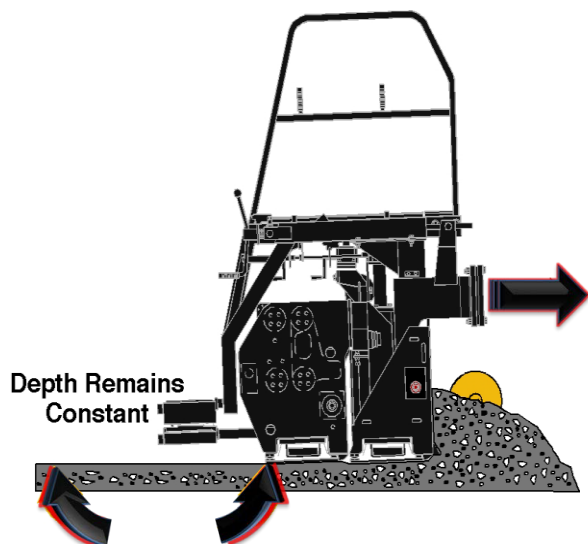


- Paving speed
- Head of material
- Screed adjustments
- Mix design
- Mix temperature
- Air temperature
- Grade temperature

Caterpillar: Confidential Green

17

## Factors Affecting Screed – Crew Controls

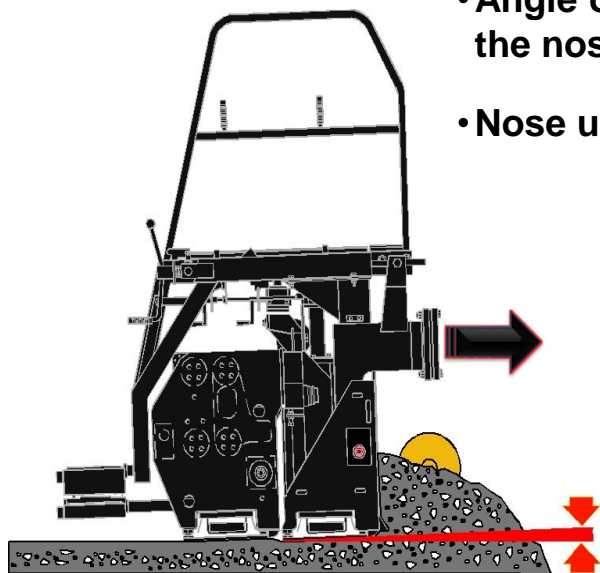


1. Constant Speed
  2. Consistent Head of Material
  3. Screed Adjustments
- Shear factor is constant
  - Depth remains constant

Caterpillar: Confidential Green

18

## Angle of Attack

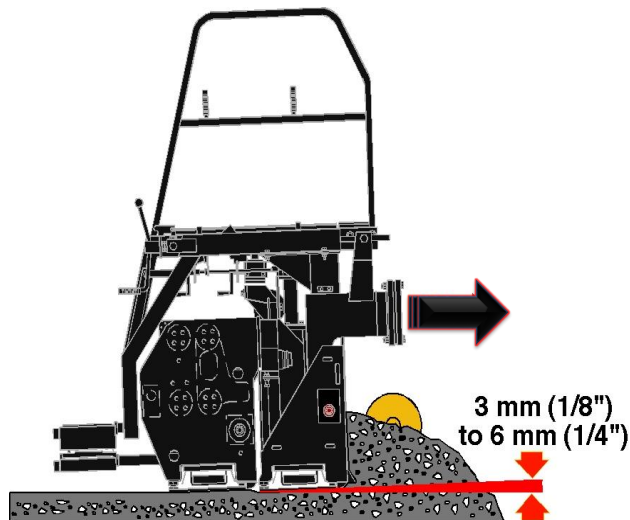


- Angle of attack is the relationship between the nose of the screed & the grade
- Nose up attitude



19

## Angle of Attack



- Normally 1/8" to 1/4"
- Angle too high
  - compacts with trailing edge
  - shiny appearance
- Erratic screed behavior
- Angle too low increases shear factor and wear
  - open mat texture

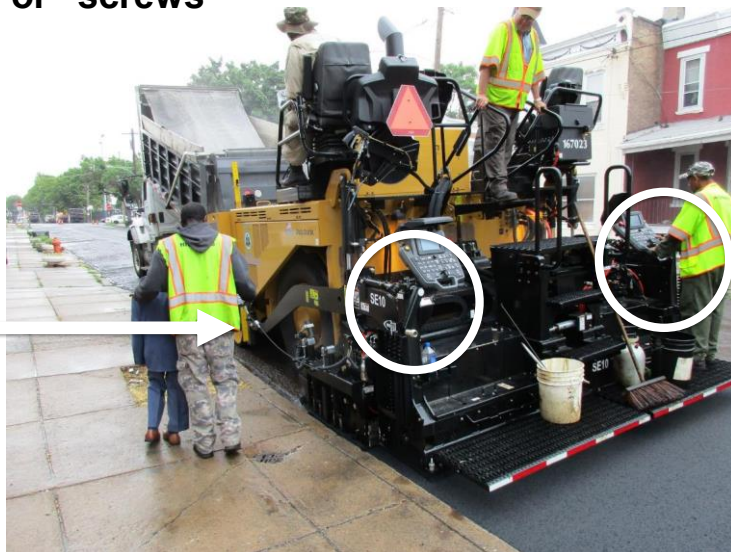
Caterpillar: Confidential Green



20

## Change Thickness and Slope by Changing Angle of Attack

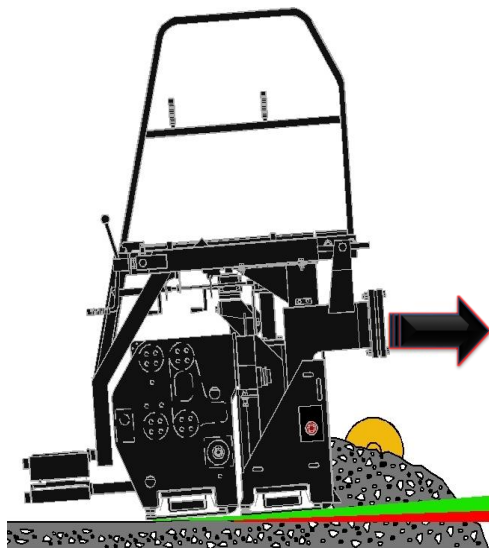
- Use depth control cranks or “screws”
- Use tow points



Caterpillar: Confidential Green

21

## Increase Angle of Attack



- More material passes under screed
- Screed rises to new level
- As screed climbs, angle of attack decreases
- Re-establish same angle, but at increased depth
  - remember, screed travels through arc and reaches equilibrium @ new thickness

Caterpillar: Confidential Green

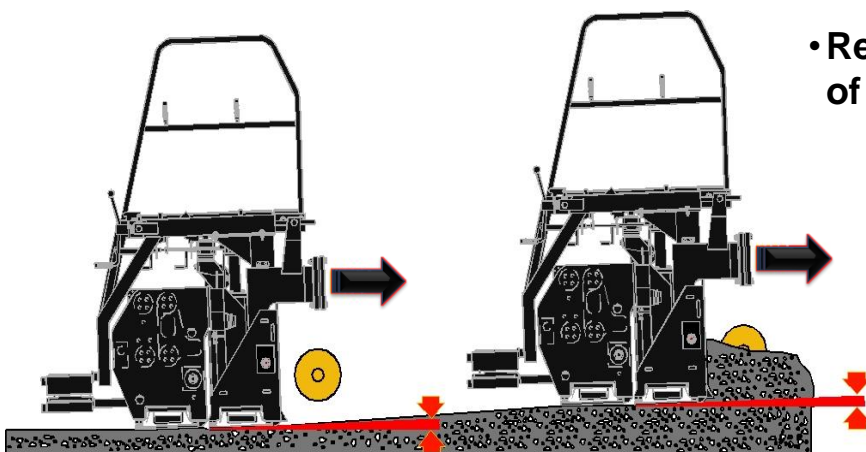
22



## Changing Thickness

- Achieves equilibrium at new thickness

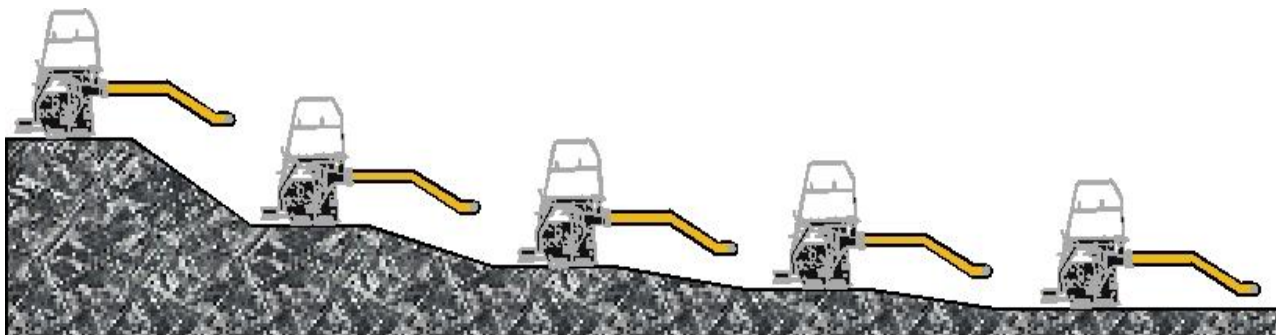
- Resumes original angle of attack



23

## Change Over 5 Tow Arm Lengths

- 65% of change occurs in the first tow arm length
- 35% of change occurs over 4 tow arm lengths



24

## Automatic Grade & Slope



Controls tow point movement based on sensor inputs to change thickness and/or slope



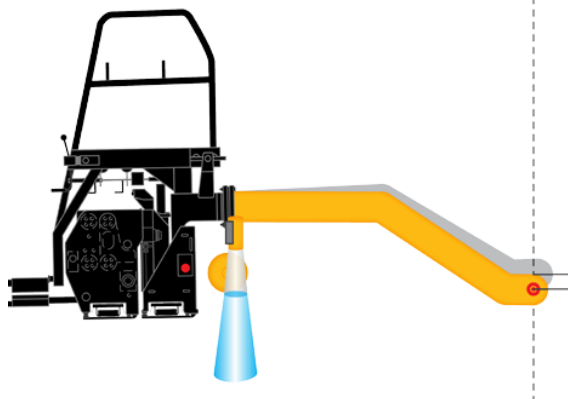
Caterpillar: Confidential Green

25

## Sensor Position for Joint Matching = Yield



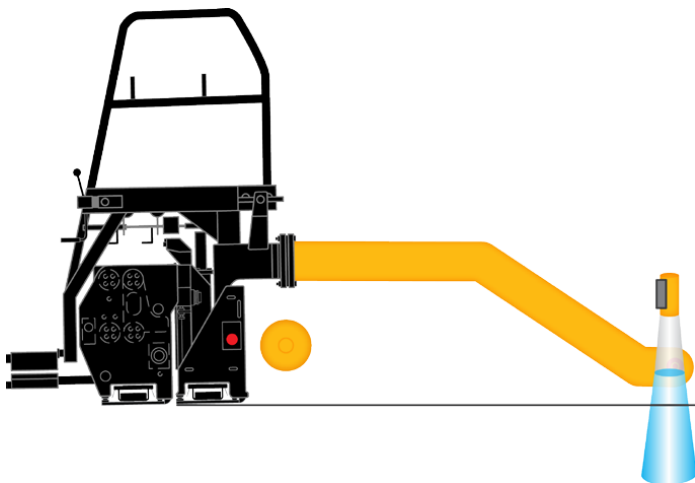
- Sensor at auger for joint matching
- Follows existing grade - no improvement
- Precise yield
- Fast reaction
- Tow point movement = 4x measured deviation, or 4:1



Caterpillar: Confidential Green

26

## Sensor Position for Smoothness ≠ Yield

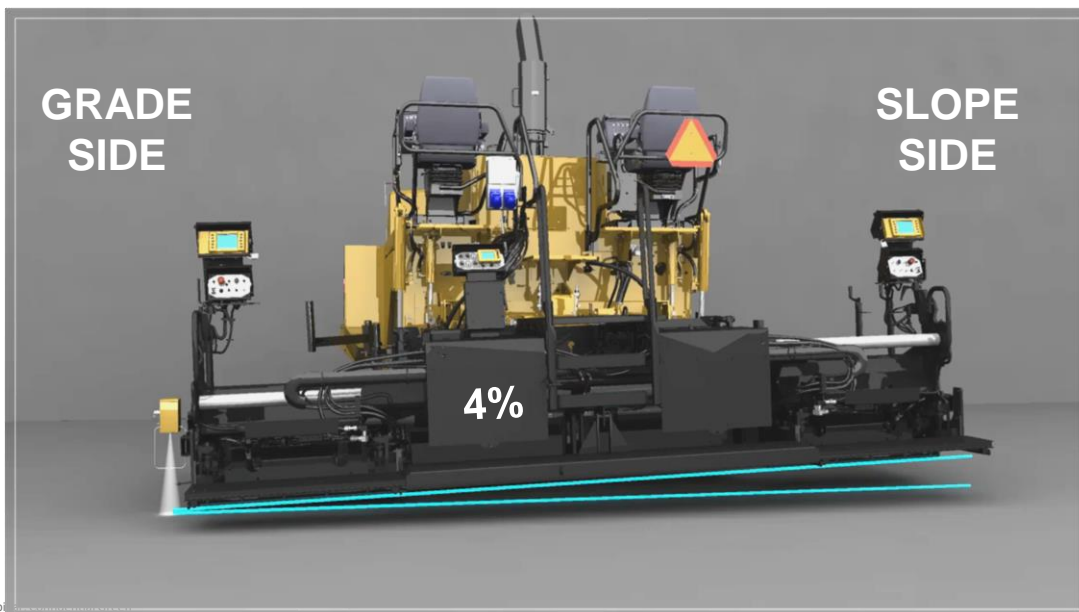


- Sensor at tow point for smoothness
- Slow reaction
- Fills in lows, smooths off high spots
- Difficult to control yield
- Tow point movement = 1x measured deviation, or 1:1
- Screed reacts over 5 tow arm lengths

Caterpillar: Confidential Green

27

## Slope FOLLOWS Grade Side Changes



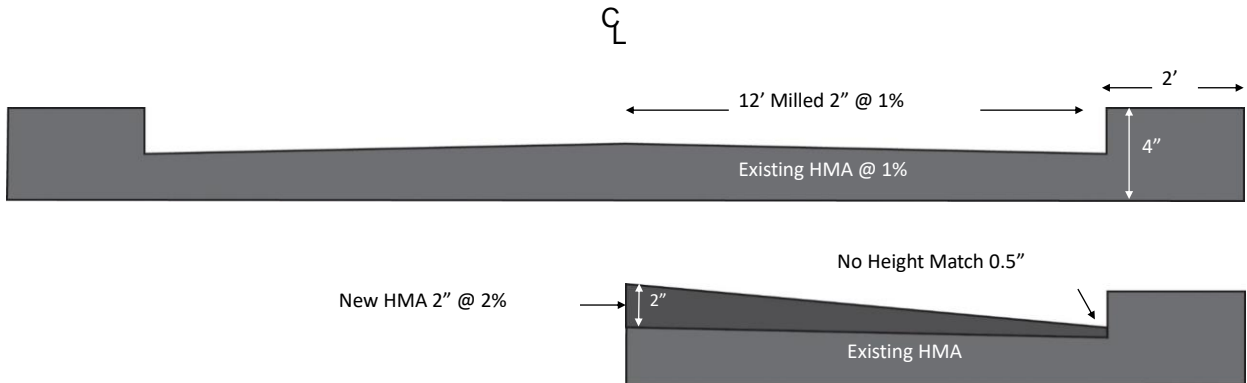
Caterpillar: Confidential Green

28



## This is why I can't have both yield & slope!

- Unless my base is already profiled (milled) PERFECTLY!
- This is why I want my BASE to be right!!



Caterpillar: Confidential Green

29

## Taking off: Is this a good place to start?



Caterpillar: Confidential Green

30

## Good Starting Point



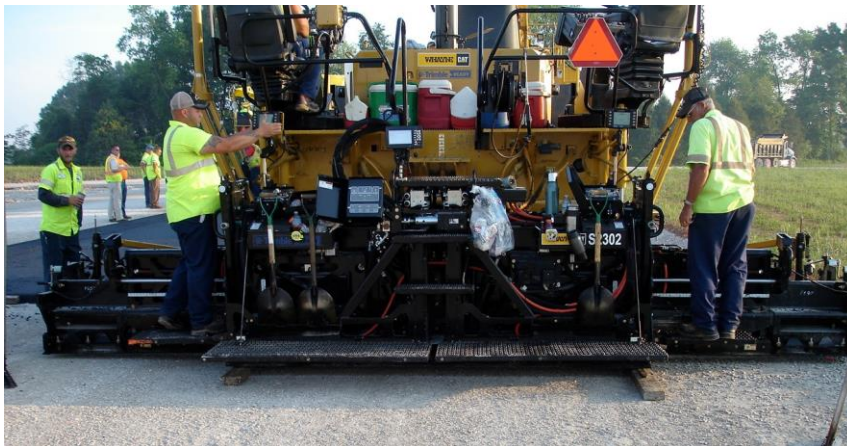
- Cut straight starting joint
- Butt joint flat

- Tack butt joint
- Clean area where screed will set down

Caterpillar: Confidential Green

31

## Paver Setup & Take Off



### PAVING BY THE NUMBERS

1. Heat the screed
2. Set the tow points
3. Set paving width
4. Set crown
5. Set extender height
6. Set extender slope
7. Lower screed and remove slack
8. Null the screed
9. Position end gates
10. Set auger height
11. Position feeder sensors
12. Set feeder controls
13. Fill auger chamber/place in auto
14. Set accessory functions
15. Pull off starting reference



UEX01403-01  
(Replaces DES/CI 403-00)

© Caterpillar 2014  
All rights reserved.

Caterpillar: Confidential Green

32



## Build a Pad or use Starter Boards

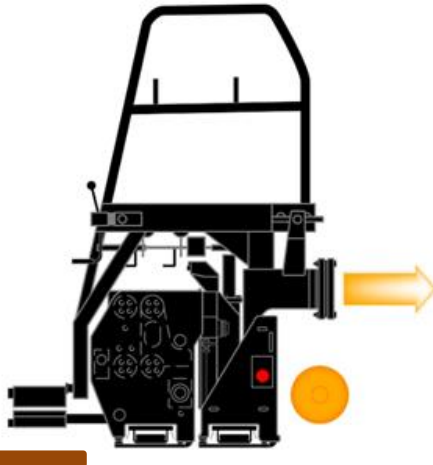


Caterpillar: Confidential Green

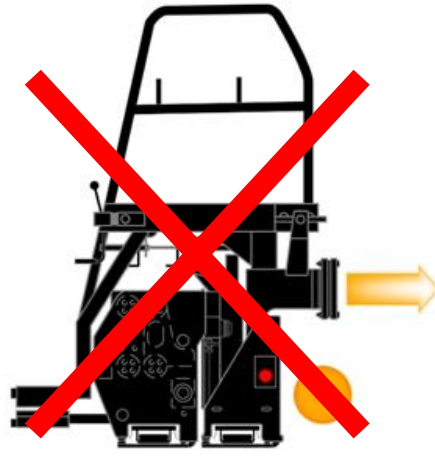
- Support full length of screed & extenders
- 3 to 4 feet long boards
- Based on uncompacted mat thickness (1/4" per 1")

33

## Boards must support main & extenders



Full Support Main & Extenders



Screed will drop or 'nose over'

Caterpillar: Confidential Green

34



# Position Tow Point Cylinders



- Straight line-of-pull



Caterpillar: Confidential Green

# Straight Line of Pull



Caterpillar: Confidential Green

## Null the Screed



Caterpillar: Confidential Green

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



37

## Null the Screed



Caterpillar: Confidential Green

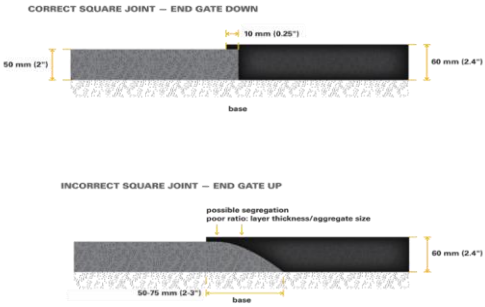


38

# Why are end gates important?

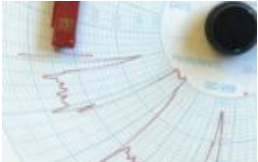


Keep end gates down to build a good longitudinal joint



Caterpillar: Confidential Green

# Managing Temperature



- At the plant
- During the haul
- Through the paver
  - smoothness
- During compaction
  - Uniformity of compaction

**CONSISTENCY!**



Caterpillar: Confidential Green



# Managing Temperature - silos



Batchers working?

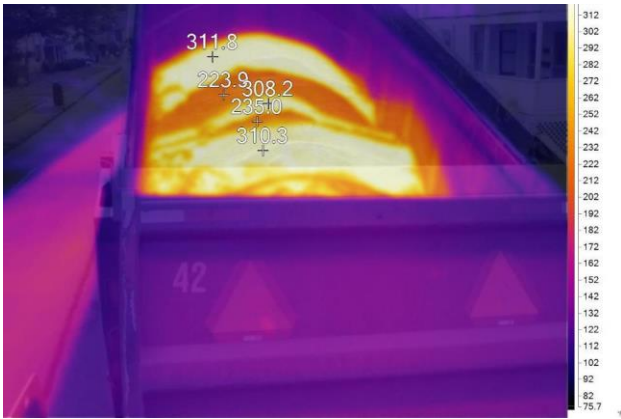


Caterpillar: Confidential Green



41

# Managing Temperature



Caterpillar: Confidential Green



42

## Continuous Paving



- **MTVs can help**
  - Windrow elevators
  - Re-mixing type
- **Approximately 15% improved smoothness**

Caterpillar: Confidential Green



43

## Paver Stops & Starts...



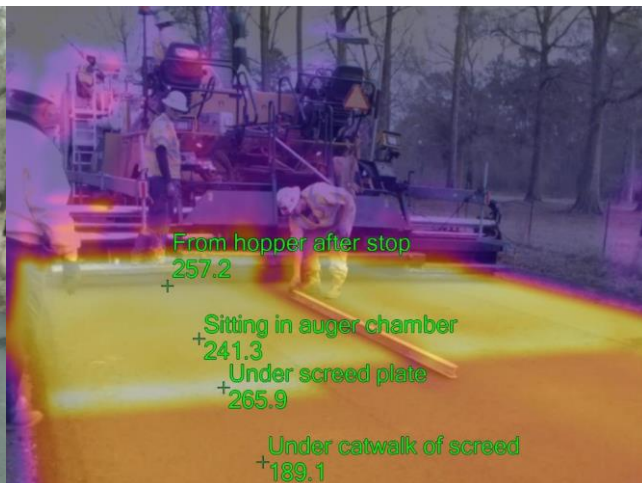
- **Smoothness issue**
  - Will it roll out?
- **Non-uniform compaction**
  - Temperature differentials
- **Inefficient trucking?**
- **Stops > 6 min = bump**

Caterpillar: Confidential Green



44

## Paver Stops - density & smoothness



Caterpillar: Confidential Green



45

## Planning a Balanced Paving Operation



- Goal is non-stop paving
- Set to match mix delivery
- Balance with rollers
- Quick starts/stops
- 60 fpm maximum



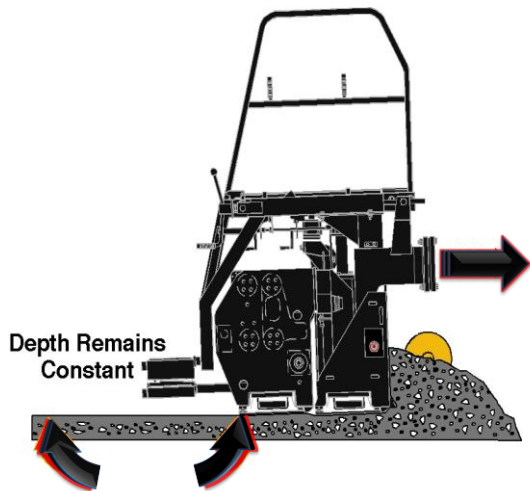
Caterpillar: Confidential Green



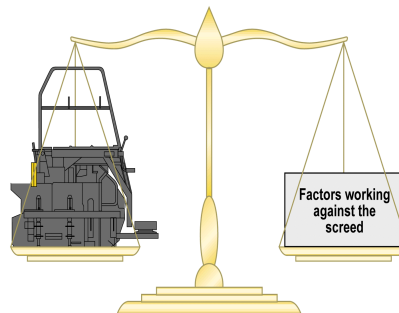
46



# Pavement Smoothness

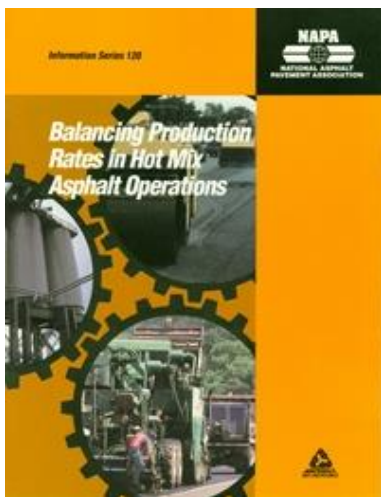


- Shear factor is constant
- Depth remains constant



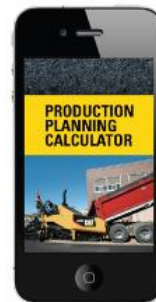
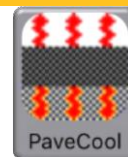
Caterpillar: Confidential Green

# 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
  - PaveCool App



Caterpillar: Confidential Green



## Paver Speed - Real World Paving

- Do not panic
- Stay with the plan
- Get rid of trucks in an orderly fashion
- Establish a uniform trucking pattern
- Will help density & smoothness



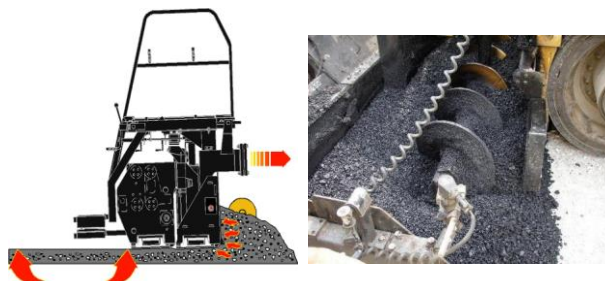
Caterpillar: Confidential Green

49

## Managing Head of Material @ 1/2 Auger



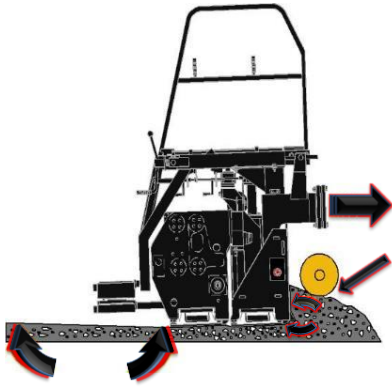
1. Ratio dials (or flow gates)
2. Auger height
3. Feed sensor position
4. Auger speed



Caterpillar: Confidential Green

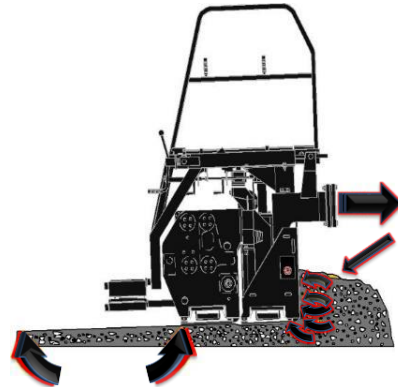
50

## Changes in Head of Material



### Head of Material Decreases

- Resistance decreased
- Depth decreases



### Head of Material Increases

- Resistance increased
- Depth increases

Caterpillar: Confidential Green

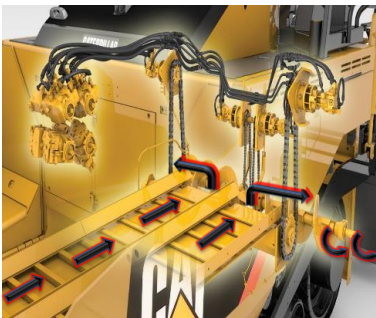


51

## Controlling Head of Material: Mix Feed



- Material level at center of auger chamber
- Material level in center area controls auger speed
- Flow gates on some pavers



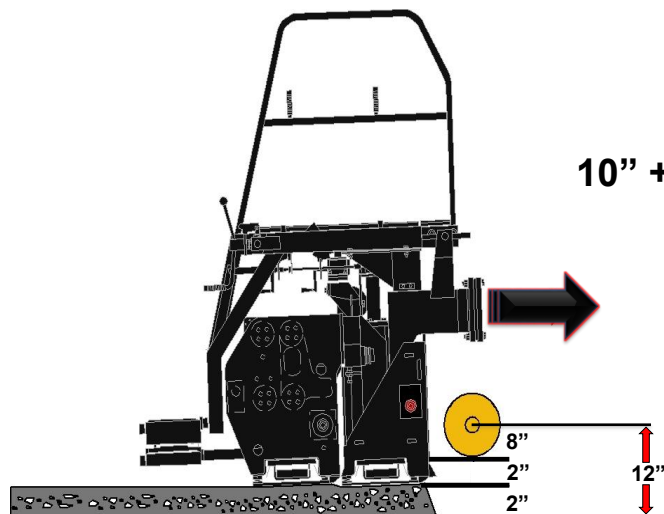
Caterpillar: Confidential Green



52



## Controlling Head of Material: Auger Height



- Start at 2" above level of mat
- Adjust up or down depending on mix type and appearance of mat

**10" + mat thickness = auger height**



Caterpillar: Confidential Green

53

## Aiming Sonic Feed Sensors



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



Caterpillar: Confidential Green

54



## Controlling Head of Material: Auger Speed



- Auger speed uniform
- 20-40 rpm
- 2s per revolution
- Auger speed too high or too low can cause stripes in the mat

Caterpillar: Confidential Green



55

## Truck Exchange – HoM – Bumps & Dips



Caterpillar: Confidential Green

56

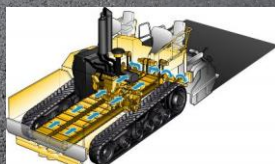


# Quick Starts & Stops



Caterpillar: Confidential Green

# Managing Segregation



Caterpillar: Confidential Green



# Managing Segregation – Truck Exchange



## Four step procedure

1. Release truck
2. Continue paving
3. Pave & fold hopper wings
4. Stop quickly

Caterpillar: Confidential Green



# Managing Segregation – Truck Exchange



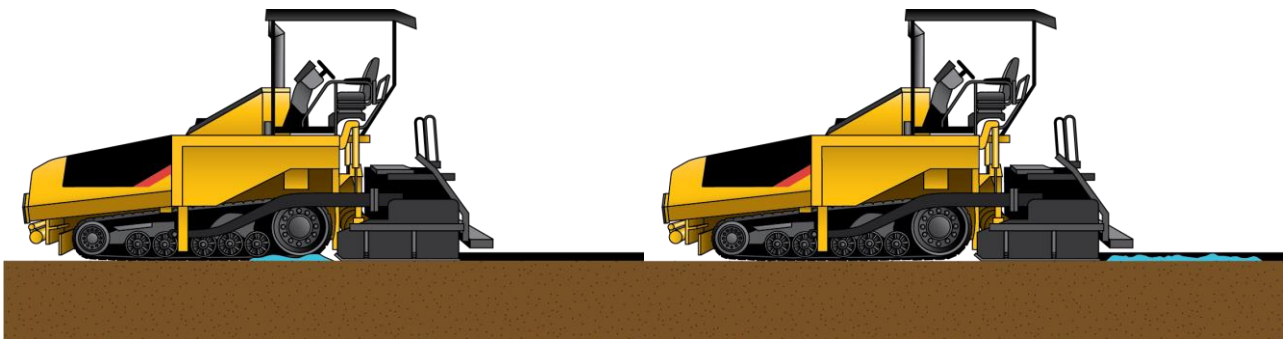
Caterpillar: Confidential Green

# Defects Related to Truck Exchange



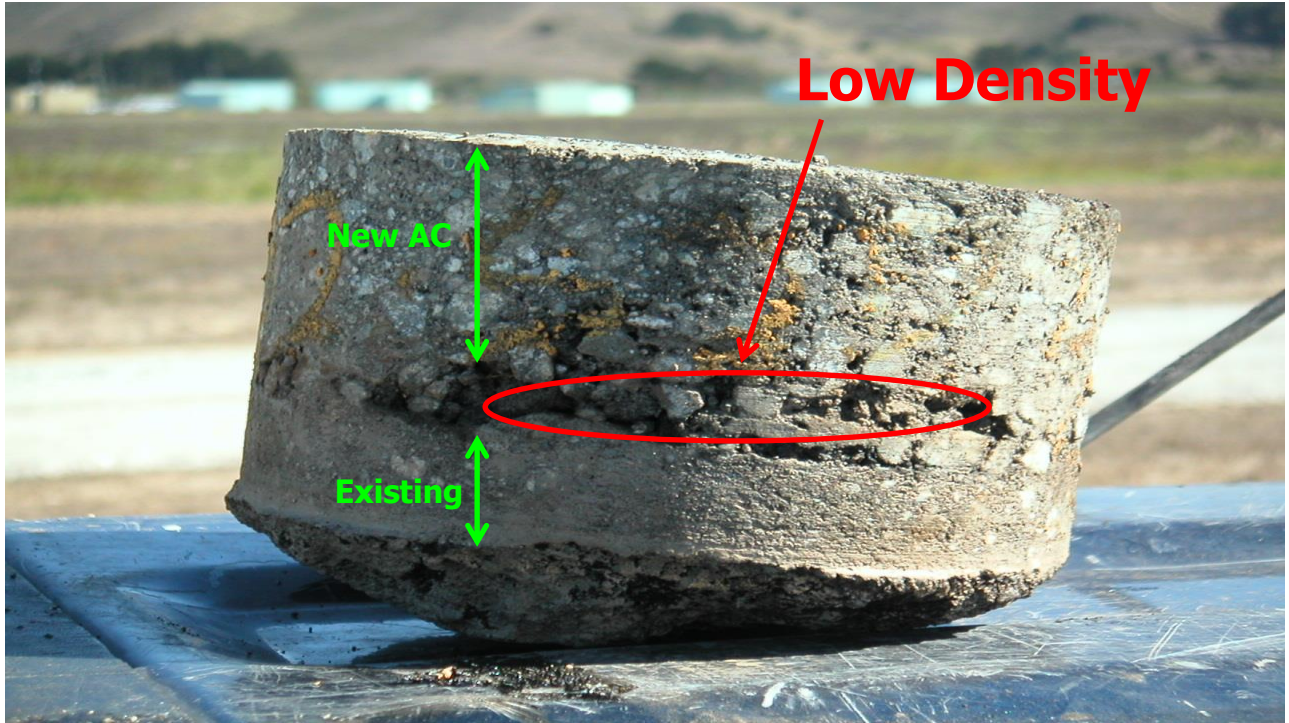
61

# Spills on grade are BIG mistakes!



62





63

## Trucks Bumping the Paver







Caterpillar: Confidential Green

64



# Compaction & Rolling Patterns

	Breakdown	Intermediate	Finish
%TMD	90-92%	92-94%	94% + take out marks
			
Temp	280-252°F	252-230°F	200-163°F
Coverage	2	3	2 (1 vibrate/1+ static)
Settings	High A, Low F	90 psi	Low A, High F, static
Distance	← 120 feet →	← 200 feet →	← 200 feet →
Speed	252 fpm	300 fpm	350 fpm

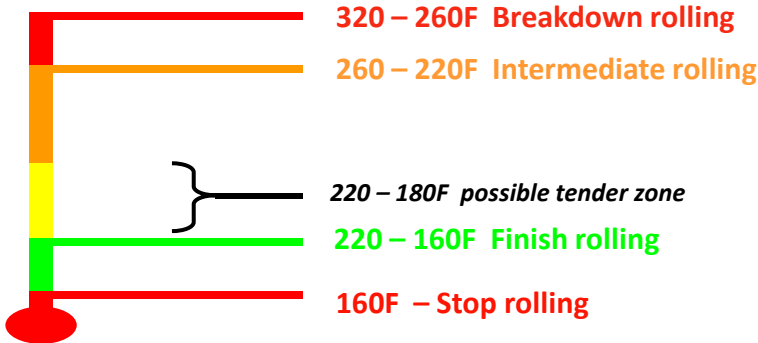
Caterpillar: Confidential Green



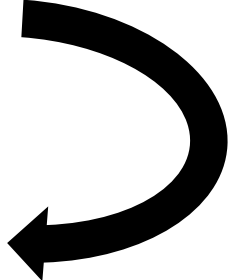
65

# Temperature is Critical

*Internal mat temperatures*



***Keep steel drums off the mix!!!***



Caterpillar: Confidential Green

66

# 10 – 14 Impacts per Foot (ipf)



Caterpillar: Confidential Green

67

# Don't Stop Square to the Mat = Bump



68



Caterpillar: Confidential Green

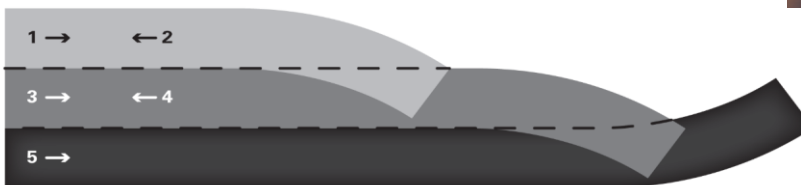
68

## Stop at an angle to the mat

- Roller stops at an angle
- Turn off vibration before roller turns out
- Next pass rolls through stop mark
- Stop marks are staggered



### REVERSING



Caterpillar: Confidential Green

69

69



## Smooth Arcing Stop = No Bump



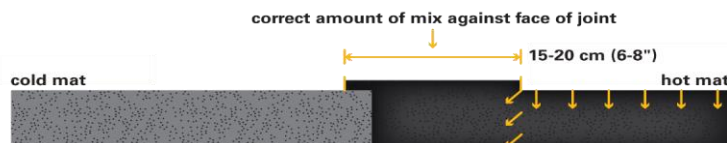
Caterpillar: Confidential Green

70





## Longitudinal Joints



Caterpillar: Confidential Green



71

## CONSISTENCY is the Key to Success!

• Do the fundamentals right

• Avoid BIG mistakes

• Quality costs nothing

1. Paver setup and takeoff
2. Temperature
3. Continuous Paving
  - Balanced Paving & Compaction operation
  - Smoothness
    - Quick starts & stops
    - Head of Material
    - Automatic Grade & Slope Controls
4. Segregation
5. Compaction 10-14 ipf

Caterpillar: Confidential Green



72



**Thank-you for your attention!**



**CAT**  
**BUILT FOR IT.**

© 2021 Caterpillar. All Rights Reserved.

Materials and specifications are subject to change without notice.

Featured machines in photography may include additional equipment for special applications.

CAT, CATERPILLAR, BUILT FOR IT, their respective logos, Caterpillar Yellow, and the POWER EDGE trade dress, as well as corporate and product identity used herein, are trademarks of Caterpillar and may not be used without permission.

