



# Compaction and Best Practices for Tender Asphalt Mixes

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Nova Scotia User Producer Group – April 10, 2014





# Presentation Overview

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- Introduction
- Importance of Compaction
- Compaction Best Practices
- Identifying a Tender Mix
- Common Causes of a Tender Mix
- Contractor Cures
- Closing Thoughts





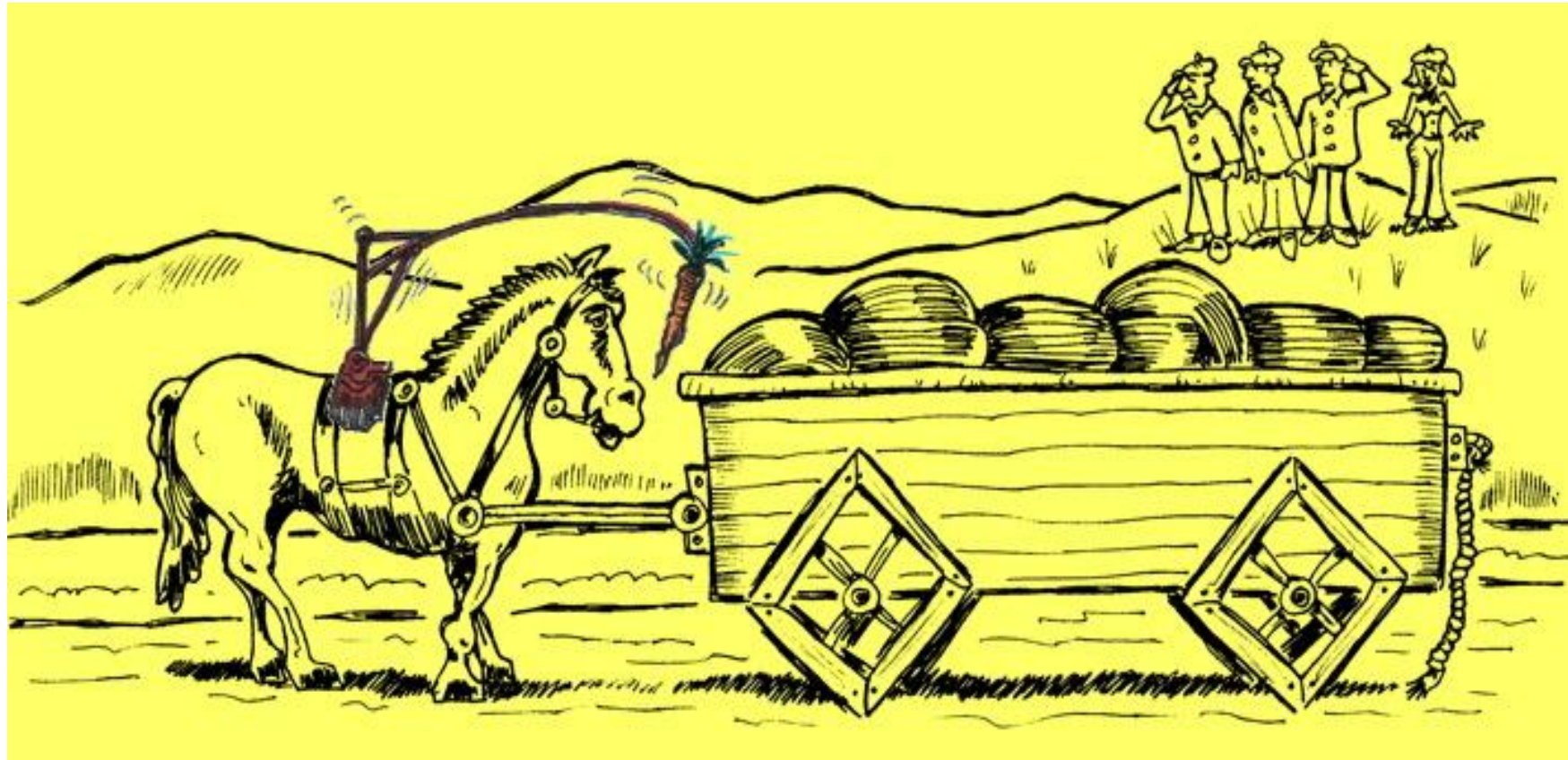
# Introduction

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- The best cure for a tender mix is avoidance
- Design and manufacture hot mixes according to relevant specifications and Best Practices to ensure the mix may be placed as desired
- Employ quality control measures for verification



# Introduction





# Introduction





# Introduction

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# Introduction





# Introduction



“Because you know that someday, you’ll be able to beat the #5%\* out of that cat.”





# Importance of Compaction

- Compaction is the process of mechanically reducing the volume of a mass of material
- To compact a material effectively one must have:
  - Workability
  - Confinement
  - Compactive effort



# Importance of Compaction

- Reduces air voids
- Decreases permeability
- Promotes mix cohesion
- Ensures long-term mechanical attributes of mix are attained (rutting, modulus, shear strength, fatigue resistance, etc.)





# Compaction Best Practices

- Design the lift thickness appropriately for the aggregate size
  - Target 3 – 4 times the Nominal Maximum Aggregate Size (NMAS)
- Ensure mix characteristics are within acceptable ranges
  - AC content, moisture, aggregate shape, micro texture, voids, stability, flow
- Utilize appropriate asphalt cement grade and viscosity
- Adequate substrate support strength and substrate bonding
- Optimum air temperature & base temperature
- Monitor wind velocity

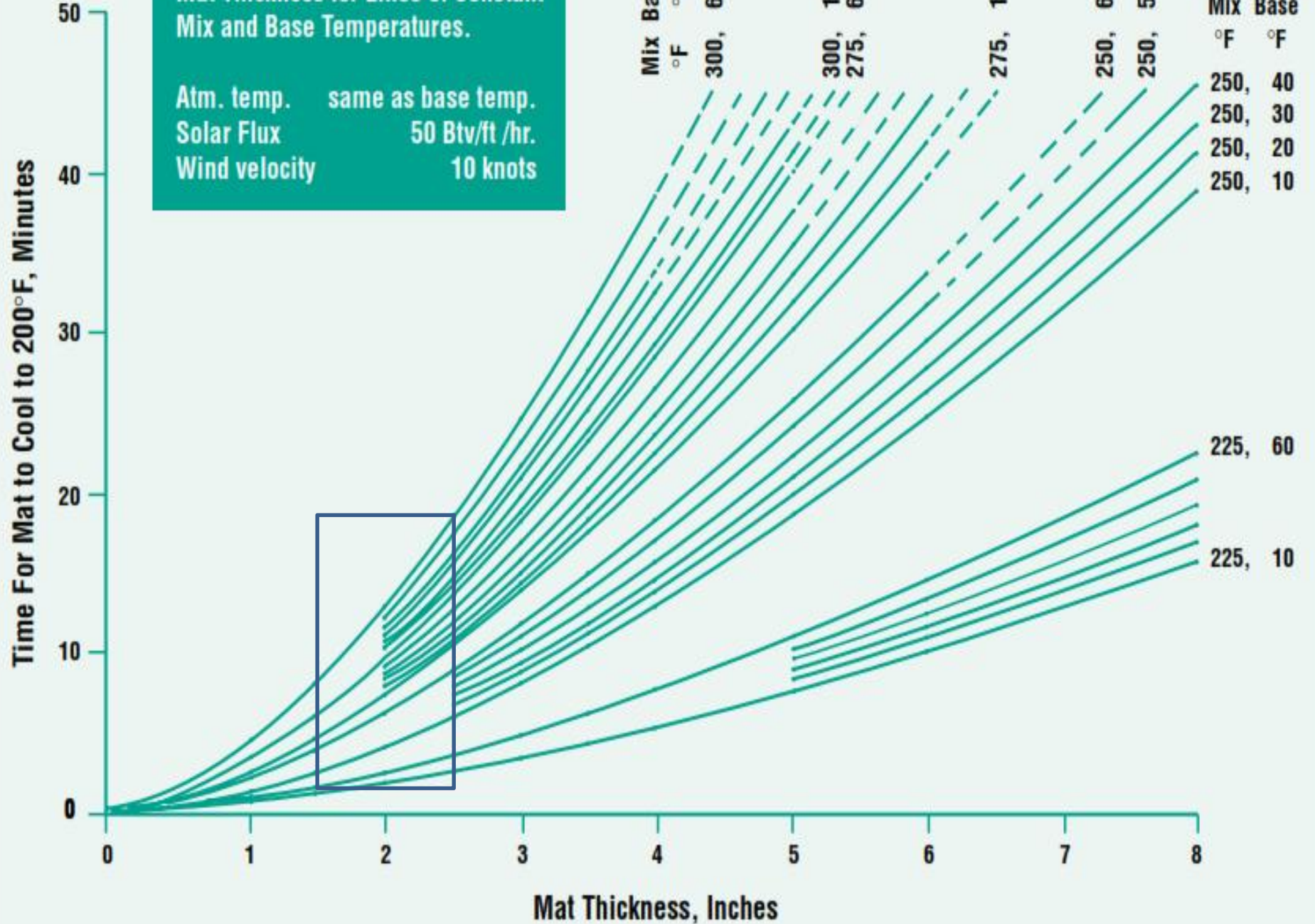


# Compaction Best Practices

- Allow paver to perform initial compaction
- Roll as close to the paver as possible
- Select roller widths and number of rollers to maximize hot and lower temperature zones
- Utilize thermocouples on rollers to determine temperature during rolling
- Pay attention to mix temperature changes
- Maintain smooth and consistent production rate
- Establish and monitor a rolling pattern and a temperature range for each roller

**Time For Mat to Cool to 200°F vs. Mat Thickness for Lines of Constant Mix and Base Temperatures.**

Atm. temp. same as base temp.  
 Solar Flux 50 Btv/ft /hr.  
 Wind velocity 10 knots





# Identifying a Tender Mix

- “Tender asphalt mixes” should not be confused with the “Tender zone” but they can be related
- Tender asphalt mixes are those that exhibit excessive lateral displacement, shoving, and/or check cracking while being compacted.
- The “tender zone” exists when the hot mix temperature is generally between 115-90°C (240-193°F)



# Identifying a Tender Mix

- The mix is difficult to roll
  - The desired density is difficult to achieve
- 
- The pavement ruts after construction is complete
  - The pavement is soft after completion and will displace when traffic is applied
  - The pavement shoves, slips, or scuffs under traffic



# Identifying a Tender mix

Mix instable  
(soft)



6-12" mix  
movement

Low stability

Mix stiff  
(stiff)



High stability

*Bomag Basic Principles of Asphalt Compaction, 2<sup>nd</sup> Edition, 2009.*

ONLY THE BEST



BEST  
MANAGED  
COMPANIES



GREATER  
TORONTO'S  
TOP 400  
EMPLOYERS





# Identifying a Tender Mix



- Mix may also shove under pneumatic tire compaction
- Ensure tire pressure, and tire width appropriate



# Identifying a Tender Mix

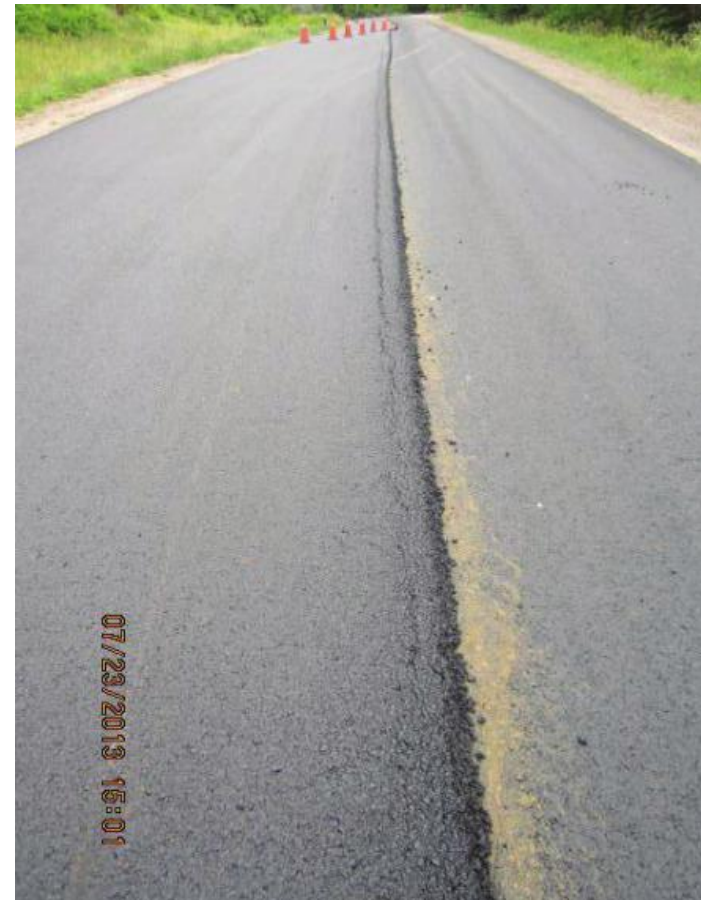


- Tender mixes are sometimes associated with “check marks” which are typically 25-100 mm in length, spaced 25-75 mm apart.
- Not visible when paver places the hot mix
- Normally ½”-3/8” in depth



# Identifying a Tender Mix

- Tender mixes may also exhibit longitudinal cracking when the roller is applied to the mat
- Typically the longitudinal cracking will be consistent with the roller's edge





# Common Causes of a Tender Mix

- Design and manufacturing related causes:
  - Insufficient lift thickness
  - Excessive moisture content
  - Excess asphalt cement content
  - Low VMA
  - Rounded aggregate particles
  - Excess midsize fine aggregate (b/w 0.600 mm and 0.300 mm sieves)
  - Insufficient fines passing the 75 um sieve
  - Excessive mix temperature
  - Insufficient binder stiffness



# Common Causes of a Tender Mix

0.45 Power Gradation Chart

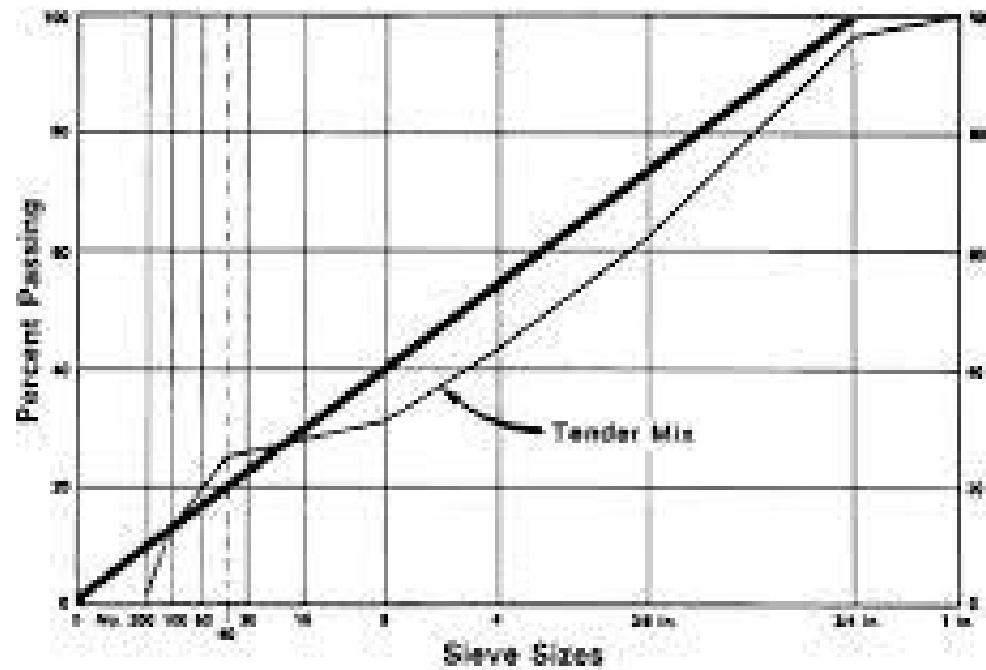


Figure #4



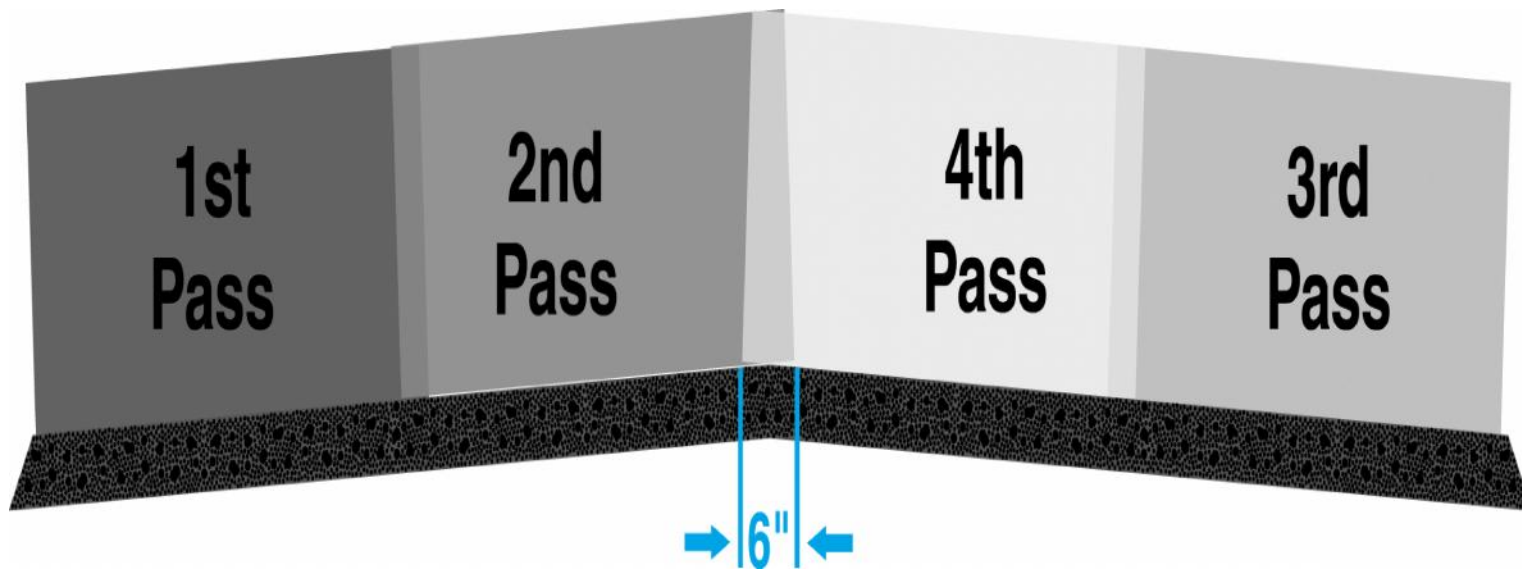
# Common Causes of a Tender Mix

- Site related causes:
  - Abnormally high ambient temperature
  - Poor bonding to the existing pavement
  - Insufficient tack coat
  - Poor compaction techniques/roller pattern
  - Contamination with diesel or other petroleum products



# Contractor Cures

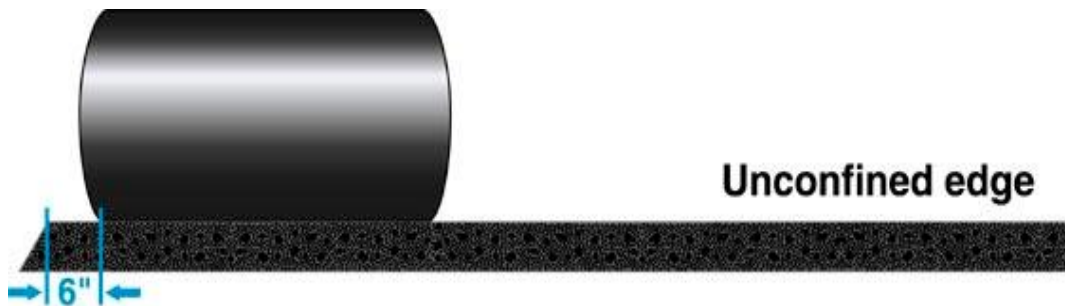
- Compact mat from outside to the crown
- Overlap 6" on each pass





# Contractor Cures

- Leave 6" from mat edge on first pass to build strength

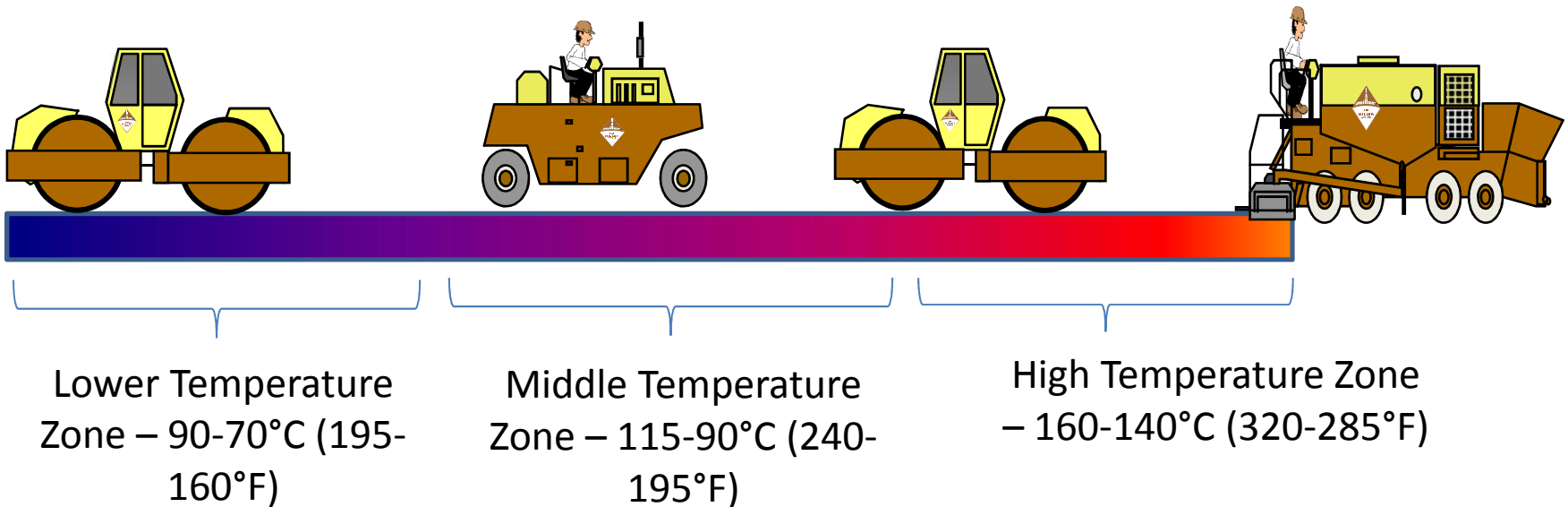






# Contractor Cures

- Recognize the importance of the three main temperature ranges of hot mix asphalt cooling





# Contractor Cures

- High Temperature Zone – 160-140°C (320-285°F)
  - Mix will generally be stable when compactive effort applied except when mix is very tender
  - Temperature where most compaction effort should be applied to obtain maximum density
  - Vibratory or static mode may be used
  - Lower temperature is not exact
  - Zone may need to be completely avoided in severe tenderness cases



# Contractor Cures

- Middle Temperature Zone – 115-90°C (240-195°F)
  - Mix will typically move, shove and/or check crack under compaction regardless of “mix tenderness”
  - Large bow wave forms in front of steel drums thereby moving mix longitudinally
  - Mix will also move transversely and mat will widen if not supported
  - Utilize a rubber roller in this zone if required; progress to steel static when mix cools/stiffens



# Contractor Cures





# Contractor Cures

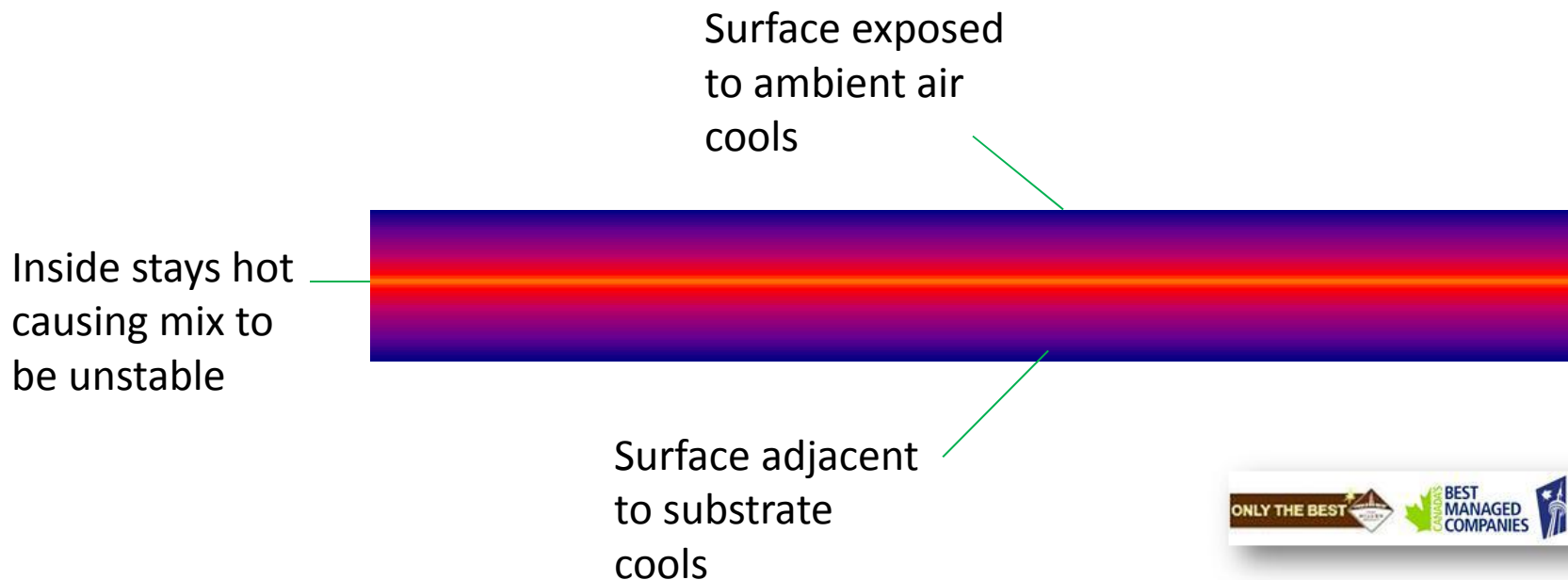
- Low Temperature Zone
  - 90-70°C (195-160°F)
  - Internal mix stability increases again
  - If “tenderness” occurs in high temperature zone, most compaction will be achieved in this zone





# Contractor Cures

- Recognize the probability of a temperature sandwich
- Generally expected on cool days where substrate is cool, air is cool, and wind is present





# Contractor Cures

- Try different static/vibratory combinations for temperature zones if issues still exist
  - Low amplitude with more passes
  - Adjust frequency settings
  - Static First
  - Combination of vib/static second with trailing drum in vibrate
- Decrease roller speed
- Make gradual roller turns



# Contractor Cures







# Contractor Cures

- A rubber tire roller may be attempted during the hot temperature zone to see if any densification without cracking occurs
  - Tire pressure may also need to be reduced depending on mix tenderness
- For very tender mixes, compaction may need to be delayed entirely until the lower temperature zone of 90-70°C
- May need to delay all rollers to lower temperature zone to achieve density



**FAIL**

i told you not to move the red one.



# Innovate To Succeed



© Anne Brunell 2008





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